FRV40-225-001-010

DESCRIPTION, OPERATION, INSTALLATION AND MAINTENANCE INSTRUCTIONS

Acoustic Doppler Current Profiler
Model: Ocean Surveyor

Halter Marine, Inc.
13085 Seaway Rd.
P.O. Box 3029
Gulfport, MS 39505
50-SPNA-1-00031

PUBLISHED BY DIRECTION OF NOAA

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26 SEP 2005

RECORD OF CHANGES

Change No.	Date	Title and/or Brief Description	Signature of Validating Officer

APPROVAL AND PROCUREMENT RECORD PAGE

APPROVAL DATA FOR: FRV40-225-001-010

TITLE OF MANUAL: Acoustic Doppler Current Profiler
APPROVAL AUTHORITY: NOAA

Contract Number	Ship Applicability	Qty Of Manuals	Building Yard
50-SPNA-1-00031	FRV40-225	2 EA	Halter Marine Inc.

REMARKS:

CERTIFICATION: It is hereby certified that FRV40-225-001-010 to be provided under contract 50-SPNA-1-00031 has been approved by the approval data shown above.

Date:_______________
CHAND, LLC
Mathews, LA 70375
CAGE CODE: 0D5X4

VALIDATION PERFORMANCE

Title of Publication

Acoustic Doppler Current Profiler

Contractor	Sub-Contractor(If Performing Validation)
Halter Marine Inc.	

Contract No. (s) and Purchase Orders, If Applicable
50-SPNA-1-00031

Chapter	Section	Paragraph	Date Validation Completed	Check here if Not validated

Contents of this manual have been validated and certified to be applicable to the equipment furnished under the above procurement as specified for Validation.

Name & Authority of Validating Officer:	**Signature of Validating Officer:**

FOREWORD

This manual is intended to clearly and accurately reflect the actual configuration of the installed equipment described for the FRV40-225 Acoustic Doppler Current Profiler. Users are urged to report instances noted wherein the manual does not achieve this objective.

This technical manual provides the instructions necessary to operate, to perform maintenance on and troubleshooting of the Acoustic Doppler Current Profiler. The text is broken down as follows:

Section 1- Introduction

Section 2- Installation Guide

Section 3- Maintenance Guide

Section 4- Test Guide

Section 5- Troubleshooting Guide

Section 6- Ocean Surveyor User's Guide

Section 7- Command and Output Data Format Guide

Section 8- Quick Reference Card

Section 9- Command Quick Reference Card

Section 10- Vessel Mounted Installation Guide

Section 11- Vessel Mounted DAS User's Guide

Section 12- Vessel Mounted DAS Quick Start Guide

Section 13- Field Service Bulletins

Section 14- Interim Change Notices

Ocean Surveyor

Read This First

RD Instruments

Acoustic Doppler Solutions

P/N 95A-6017-00 (January 2001)

Ocean Surveyor

Shipboard Installation Guide

RD Instruments

Acoustic Doppler Solutions

P/N 95A-6019-00 (January 2001)

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Ocean Surveyor Shipboard Installation Guide

1 Introduction

This book is a guide for installing a RD Instruments (RDI) Ocean Surveyor Acoustic Doppler Current Profiler aboard a vessel (ship), or platform. Use this section to plan your installation layout. You also can use this book to see what requirements you must consider before purchasing an ADCP. We recommend you distribute this book to your organization's decision-makers and installation engineers.

We are not experts in installing the ADCP aboard a ship. There are too many installation methods. We suggest you seek expert advice in this area because of its importance in ADCP performance. However, we can give you information about how others have installed their systems. In return, we do appreciate receiving information about your installation and the results.

2 Ocean Surveyor System Components

The standard Ocean Surveyor is an AC-powered, two-part unit. It consists of a bronze transducer assembly mounted in the ship's hull and an electronics chassis you can place in the ship's lab. Several options are available.

The basic system includes:

- Transducer assembly - Contains the transducer ceramics and electronics. Standard acoustic frequencies are 38, 75, and 150kHz. See the outline drawings for dimensions and weights.
- Electronics chassis - Contains the processing electronics.
- Maintenance kit - Contains spare parts and basic tools needed for routine maintenance.
- Ocean Surveyor technical manual and user's guide.

- Waterproof dummy plug.
- *VmDas* Software - Controls the ADCP and displays its data through a Windows compatible computer.
- Utilities software - Several programs to help you talk directly to the ADCP (*DumbTerm*), view data (*WinADCP*) and other DOS utility programs (*RDI Tools*).

Standard options include:

- Input/Output (I/O) cables and connectors (length determined by customer).
- Gyrocompass (gyro) interface - Connects the ship's gyro to the electronics chassis.

3 Transducer Mounting Considerations

You must consider several potential problems before installing the transducer assembly. Read this section before deciding where to install the transducer assembly. See the outline installation drawings (see "Outline Installation Drawings," page 35) for specifications on our standard Ocean Surveyor transducer.

3.1 Location

Ideally, you want to install the transducer assembly:

- Where it is accessible both internally (for access to transducer electronics) and externally (to remove biofouling).
- Where the I/O cable length is 100 m (328 feet) or less.
- Away from shipboard protrusions that reflect ADCP energy. Allow for a reflection-free clearance of 15° around each beam (see the outline installation drawings).
- Away from other acoustic/sonar devices, especially those operating at the same frequency (or harmonic) of the ADCP.
- Close to the ship's fore-to-aft centerline. As distance from the centerline increases, vertical accelerations caused by the roll of the ship also increase. These accelerations can cause additional uncertainties in ADCP velocity measurements.

3.2 Orientation

The 38kHz oval transducer should always be mounted with the transducer's beam 3 mark on axis (forward). If you have a round Ocean Surveyor transducer, then we recommend you mount the transducer head with Beam 3 mark rotated to a ship-relative angle of 45°. Figure 11, page 31 shows the beam orientation. This causes the magnitude of the signal in each beam to be about the same. This improves error rejection, reduces the effect of ringing (see "Acoustic Isolation," page 10), and increases the ADCP's effective velocity range by a factor of 1.4. If you align Beam 3 at an angle other than zero, you must nullify this offset (see "Alignment Procedures (Overview)," page 30). You can do this through our *VmDas* program or using a direct command.

Use the ship's roll and pitch reference to mount the transducer head as level as possible. If the head is not level, depth cell (bin) mapping will be incorrect. Large misalignments can cause large velocity measurement errors. If you cannot mechanically make the transducer head level, you can use *VmDas* to enter offset values for roll and pitch, or use direct commands for roll/pitch offsets (see "Alignment Procedures (Overview)," page 30).

3.3 Floating Objects

Our transducer assembly is sturdy, but we did not design it to withstand collisions with all floating objects. We strongly suggest you use one of the following.

3.3.1 Sea Chest

A sea chest (Figure 1 through Figure 3, page 4) is a fixture that surrounds and holds the transducer head, protecting it from debris in the water. The bottom of the sea chest must be open to seawater to allow the acoustic beams to pass through freely. If using a sea chest interests you, call us for the latest information.

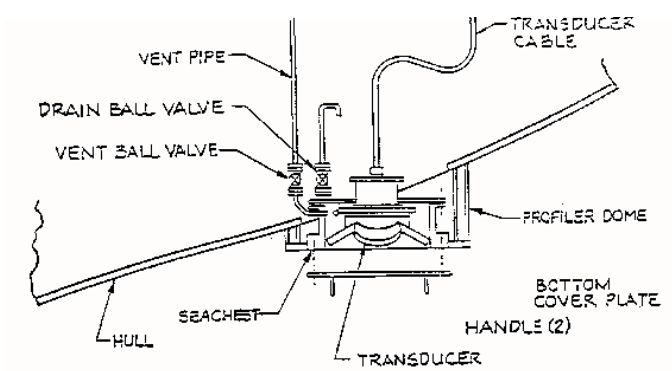


Figure 1. Sea Chest Mounted Transducer (Sloped Hull)

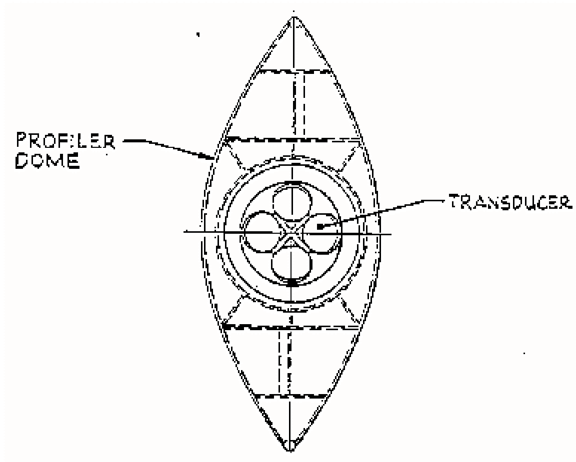


Figure 2. Profiler Dome

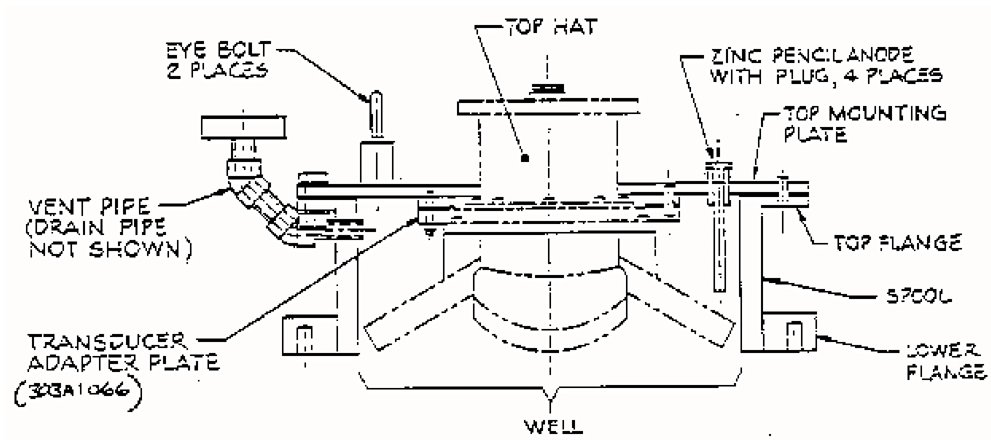


Figure 3. Expanded View of a Sea Chest

3.3.2 Fairing

A fairing is a structure that produces a smooth outline and reduces drag or water resistance. The fairing also diverts floating objects away from the transducers. A fairing shaped like a teardrop, slopped such that the leading edge (closer to the bow) is higher than the back edge, and extends below the hull (typically 12 inches) will divert the air bubbles away from the transducer faces.

3.3.3 Acoustic Window

While we do not fully understand windows, we do believe that windows can be used to produce overall performance improvements in vessel-mounted ADCPs. Additionally, if the ship operates where there is danger of barnacle damage or a high density of ice or other floating objects, then the use of an acoustic window is the only option.

It is theoretically possible to use a window successfully, however there are several pros and cons to consider before using an acoustic window.

Advantages

- Well will not fill with air bubbles caused by the ship moving through the surface water (see "Air Bubbles," page 8).
- Flow noise is reduced (see "Flow Noise," page 8).
- The well can be filled with fresh water to limit corrosion (see "Corrosion and Cathodic Disbondment," page 8).
- Barnacles can not grow on the transducer faces. Barnacle growth is the number one cause of failure of the transducer beams (see "Maintenance," page 11).
- The transducer is protected from debris floating in the water.

Disadvantages

- The range of the ADCP can be reduced because the window can and will absorb some of the transmit and receive energy.
- The transmit signal could be reflected into the well, causing the well to "ring" like a bell. This will cause the data being collected during the ringing to be biased. Some ships have reported a loss in range as great as 50 meters. The ringing may be dampened by applying sound absorbing material on the well walls (see "Ringing," page 9).
- The transmit signal could be reflected off of the window and back into the other beams (see "Acoustic Isolation," page 10).

Our experience has allowed us to put together some minimum specific recommendations:

Window orientation. The acoustic window should be flat and parallel to the transducer mounting plate. Note this is not an absolute requirement. However, if the water temperatures inside the window and outside the window are not the same, all four beams will be refracted and actual velocity components will be rotated into a new coordinate system. In particular, some of the horizontal velocity will appear as a vertical velocity.

Window material. Important acoustic properties of the window include acoustic refractive index (which should be as close as possible to that of water), insertion loss (which should be as small as possible) and speed of sound. There are two acoustic refractive indices: one for shear waves and one for plane waves. The acoustic refractive indices are simply the ratios of speed of sound in water to speed of sounds in the material. Insertion loss combines absorption and reflection of sound, and it depends on both the thickness and the material properties of the window. In particular, you should avoid using window thickness equal to odd multiples of shear mode quarter-waves (Dubbelday and Rittenmeyer, 1987; Dubbleday, 1986). Refer to Selfridge (1985) and Thompson (1990) for more information. Note that the speeds of sound in plastics decrease with increasing temperature and that causes the resonant frequencies to shift. This can be a large effect. Neither Selfridge nor Thompson has much information on the temperature coefficients of sound speeds.

Our experience has shown that Polycarbonate windows are very good for the Ocean Surveyor (OS), WorkHorse (WH), and Broadband (BB) ADCPs. The thickness of the materials depends on the frequency you intend to use. Table 1 will help to choose the maximum thickness you should use. Note, one concern with window selection is that it be able to support the weight of the water inside the well once the ship is dry-docked. RDI recommends that you always fill/drain the well at the same time that you are either filling/draining the dry dock area.

Table 1: Window Thickness

Frequency	Recommended Thickness	Maximum Thickness
38	1.5	3 inches
75	1	2 inches
150		1 inch

Spacing between window and transducer. The primary geometrical factor in design of windows is the reflection of a beam into another beam, causing crosstalk between the beams. The distance of the Ocean Surveyor transducer from the window should be at least 0.25 to 0.5 inches. If installed farther than 0.25 to 0.5 inches, then be sure your window aperture is large enough to clear the OD convex beams.

The optimum distance for the bottom of the transducer assembly from the window is 0.25 inches ±0.125 inches. Never allow the transducer to touch the window. The farther away the transducer is from the window, the more the sound is reflected off of one beam and then reflected into another beam.

Example

Our Japanese representative uses 0.25-inch thick window. He then drills two 30mm holes in the window along the edges. The inside walls are painted with anti-fouling paint. This allows the water to be full of anti-foulant during the time the ship is docked, which is when the barnacle growth occurs. The holes allow the water to exchange when the ship is in motion and allows for draining when the ship is dry-docked (a 0.25" window will not support the weight of the water). He has never had a failure with the window, and has seen only a minimal loss in range (5-30 meters).

It is best if the window is parallel to the bottom edge of the transducer. If the window is at an angle to the transducer, it will change the absorption. We do not have experience with different angles, but we have had customers use domes or have the window follow the contour of the ship bottom without noticeable degradation of the data.

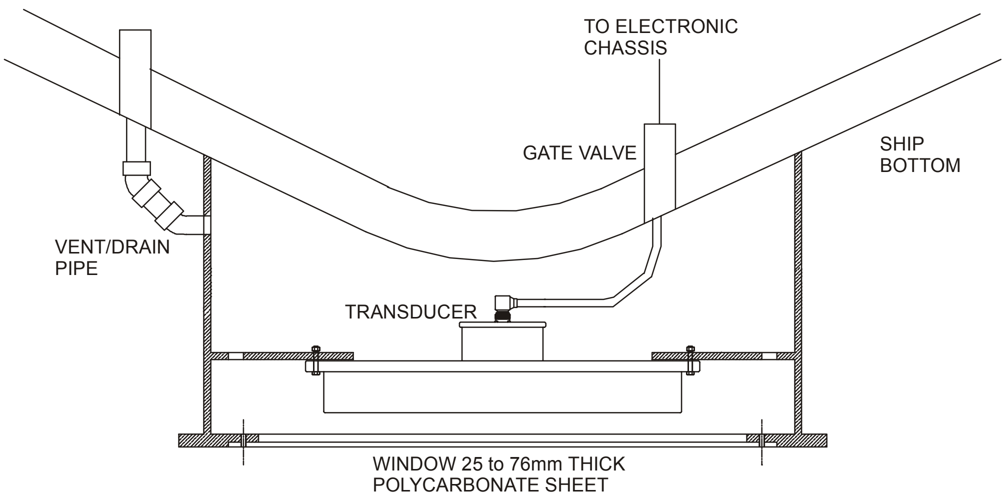


Figure 4. Acoustic Window Example

Acoustically-absorbing sea chest liner. A sound absorbing material should be used inside the sea chest to minimize the effects of sound ringing within the sea chest. The material should be a minimum of one wavelength thick (include the sound speed of the absorbing material when calculating the size of a wavelength). Approximate wavelengths of sound in seawater are given below in Table 2. Using standard neoprene wet suit material has been found to work well with 75 and 150hKz frequency ADCPs.

Table 2: Wavelength of sound in seawater (1500 m/s sound speed)

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

Fluid in the sea chest. The sea chest should be filled with fresh water. Seawater can be used, but at the cost of increased corrosion. Seawater should not be circulated through the sea chest unless the sea chest has been painted with anti-fouling paint. The pressure within the sea chest should be adjusted to keep the window from bowing in and out, and thereafter, the volume should be kept constant.

3.4 Air Bubbles

Design your installation to minimize the volume of air bubbles in the path of the acoustic beams. Air bubbles attenuate (weaken) the signal strength and reduce the ADCP profiling range. Ships with a deep draft or a non-flat bottom have fewer problems with bubbles. Ways to reduce bubble flow vary with ship characteristics, but two options are available. Mount the transducers below or away from the bubble layer.

- The flow layer is usually within the first two feet below the hull. Bubbles can be trapped in this layer. Mounting the transducer head amidship on the fore-to-aft centerline may help. For ships with propulsion systems that make large amounts of bubbles, use a mounting technique that lets you lower the transducer head below the hull while underway.

> **NOTE.** If you use locally made or existing extension hardware instead of the hardware available from RDI, you may need to make an adapter plate to connect your hardware to our transducer head. See "Outline Installation Drawings," page 35 for the bolt hole locations.

- Divert the bubble layer so it flows around the transducers - You can use fairings to alter the bubble flow (see "Fairing," page 4). An acoustic window (see "Acoustic Window," page 5) may help reduce the bubble problem, but can cause ringing (see "Acoustic Isolation," page 10) and attenuation problems.

3.5 Flow Noise

Water flowing over the transducer faces increases the acoustic noise level, which decreases the profiling range of the ADCP. You can reduce the flow across the transducer faces with a sea chest, fairing, or acoustic window.

3.6 Corrosion and Cathodic Disbondment

Never attach anodes directly to the transducer head. Additional anodes or impressed voltage systems can cause the urethane to separate from the transducer (cathodic disbondment) or cause the material of the transducer to break down. Standard anode protection used for the ship should be installed outside of the well of the transducer head. Mounting of ship's standard anode protection outside of the transducer well will typically not cause any problems. Our transducers are made of a material that has shown to corrode very little over time when the above precautions are met. The corrosion can be further reduced if the well is covered with a window and then filled with fresh water.

3.7 Ringing

The ADCP transmits an acoustic pulse into the water. The main lobe of this pulse bounces off particles in the water and the signals returned from these particles are used to calculate the velocity of the water.

As stated, the main lobe of the transmitted pulse is what we are using to process and calculate a velocity. The transmitted pulse, however, is made up of many side lobes off the main lobe. These side lobes will come in contact with metal of the transducer beam itself and other items in either the water or the well.

The energy from the side lobes will excite the metal of the transducer and anything bolted to the transducer. This causes the transducer and anything attached to it to resonate at the system's transmit frequency. We refer to this as "ringing."

If the ADCP is in its receive mode while the transducer is ringing then it will receive both the return signals from the water and the "ringing." Both of these signals are then processed by the ADCP. The ringing causes bias to the velocity data.

All ADCPs "ring" for some amount of time. Therefore, each ADCP requires a blanking period (time of no data processing) to keep from processing the ringing energy. Each ADCP frequency has a different typical ringing duration. The typical ringing period for each ADCP frequency is as follows; 38kHz is 16 meters, 75kHz is 8 meters, and 150kHz ADCPs is 4 meters. These typical ringing values are recommended as the minimum setting for all ADCPs using default setups.

It should be noted, on some installations the effects of ringing will last longer than the recommended settings above. For example, the effects of ringing will last longer if the transmit signal becomes trapped inside the transducer well. This can occur because the well itself is ringing with the transducer or when windows covering the opening of the well reflect the signal back inside the well.

The window causes the transmit signal to reflect back into the well due to the difference in impedance between the window and the water. When the transmit signal is reflected in the well it becomes trapped and this results in longer ringing periods. To keep from processing this signal, the blanking period must be increased. Lining the inside walls of the well with a sound absorbing material aid in dampening the ringing effect.

3.8 Acoustic Isolation

Try to minimize the acoustic coupling between the transducer head and the ship. Without adequate acoustic isolation, the transducer output will “ring” throughout the ship and feeds back into the ADCP receive circuits. Ringing causes bias errors in water-track velocities and results in the loss of data in the closest depth cells (bins). Reflections inside a sea chest with an acoustic window also can cause ringing.

You can attain acoustic isolation several ways. At a minimum, use gaskets to isolate all contact points between the ship and the transducer head. Design your installation for:

- A minimum number of contact points between the transducer head and the ship.
- Minimal contact area.
- Single points of contact for positioning and support (when possible).

You also should try to separate the transducer head from the ship using intermediate connections. This is because direct connections transfer the most acoustic energy. Texas A & M used the following installation technique and had minimal ringing problems.

- Transducer head mounted to a thin steel plate
- Steel plate positioned with three pins set into mounting holes on the hull; pins isolated with gaskets
- Steel plate held in place with four I-beams welded to a frame
- Frame bolted to another frame and separated by gaskets
- Second frame bolted to the ship and separated by gaskets

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

- Mount the other acoustic devices as far apart as possible.
- Make sure neither the main lobes nor the side lobes of the acoustic devices point at the transducers, including acoustic reflections.
- Do not to operate devices that use the same frequency or a harmonic of the ADCP’s frequency.

3.9 Maintenance

The Maintenance guide explains routine maintenance procedures. You rarely need access to the electronics inside the transducer head. However, one external maintenance item is important enough to mention here as it may affect how you install the transducer head.

Objects deployed within about 100 meters (328 feet) of the surface are subject to the buildup of organic sea life (biofouling). This means Ocean Surveyors are subject to biofouling. Soft-bodied organisms usually cause no problems, but hard barnacle shells can cut through the urethane transducer face causing transducer failure and leakage into the ADCP.

The best-known way to control biofouling is cleaning the ADCP transducer faces often. However, in many cases this is not possible. The other alternatives include the use of a window or some sort of anti-foulant protection.

Some of our users have had success applying a thin coat (≈4 mm; ≈0.16 in.) of either a 50:50 mix of chili powder and Vaseline or chili powder and silicone grease to the transducer faces. The chili powder should be the hottest that can be found. Water flowing across the transducers will wash this mix away over time. The silicone mixture tends to last longer.

Some organizations may decide to use antifouling grease. However, most antifouling greases are toxic and may cause problems. Recent tests suggest antifouling grease may cause the urethane on the transducer faces to develop cracks. Warmer temperatures accelerate this effect.

The other method is to use antifoulant paint. At present, we recommend the following antifouling paint manufacturer and paint brand: Courtalds Finishes Interlux brand paints, US Telephone: 908-686-1300, Web Page: www.interlux.com. Contact the antifouling paint manufacturer for preparation and application procedures for this and other antifoulant paints.

CAUTION.

1. Read the Material Safety Date Sheet before using any of the listed solvents and paints.
2. Some antifouling coatings may not be legal for use in all areas. Check with your local environmental agency before using the antifouling paint.
3. Do not arbitrarily use antifouling paints. Be aware that antifouling paints can accelerate the dezincification corrosion of brass. Once initiated, dezincificatioin will rapidly destroy the transducer.
4. RDI no longer recommends the use of Nopcocide for the prevention of biofouling. If using antifouling grease, remove it immediately after recovering the ADCP.
5. Antifouling grease is toxic. Read the product safety data sheet before using the grease. Wear gloves and a face shield when applying the grease. If the skin comes in contact with the grease, immediately wash the affected area with warm, soapy water.
6. When possible, do not coat the transducer faces with cuprous oxide or related paints that contain chemicals such as copper, chrome, or arsenic. These paints advance the corrosion of the transducer assembly and will cause the urethane to separate from the transducer cups.
7. All US Coastal States prohibit the use of tributyl-tins on boat hulls. The European Economic Commission has released a draft directive that would prohibit the use of many organo-tins after July 1989. We strongly recommend you obey your local laws.

3.10 Electronics Chassis Mounting Considerations

Place the electronics chassis (see "Outline Installation Drawings," page 35) where there is access to the I/O cable, host computer, gyro interface cable, and navigation interface cable. You can place the rack-mountable chassis in a standard 19-inch cabinet. The chassis needs 90 to 260 VAC to operate (see "Power Considerations," page 28). Allow enough room around the chassis for access, ventilation, and isolation from electronic and magnetic interference.

CAUTION. Do not place the electronic chassis within 3 feet of a computer monitor. Monitors are a major source of electronic interference.

3.11 Cabling Considerations

Several cables connect to the Ocean Surveyor system (Figure 6, page 14 and Figure 7, page 14). Use care when routing these cables through bulkheads, deck plates, cable runs, and watertight spaces. Make allowances in cable length and engineering design plans for cable routing. When necessary, use strain reliefs on the cables.

The input/output (I/O) cable (Figure 5 and Figure 8, page 15) connecting the transducer assembly to the electronics chassis has the following specifications.

- Minimum bend radius = 203 mm (8.0 in.)
- Typical cable OD = 19.8 mm (0.78 in.)
- Maximum pull load = 1132 N (250 lb.)
- Maximum length = 100 m (328 ft.)
- Available with either ends having straight or angled connectors or a combination thereof. The transducer-end connector is molded on, so you can use it below the waterline.

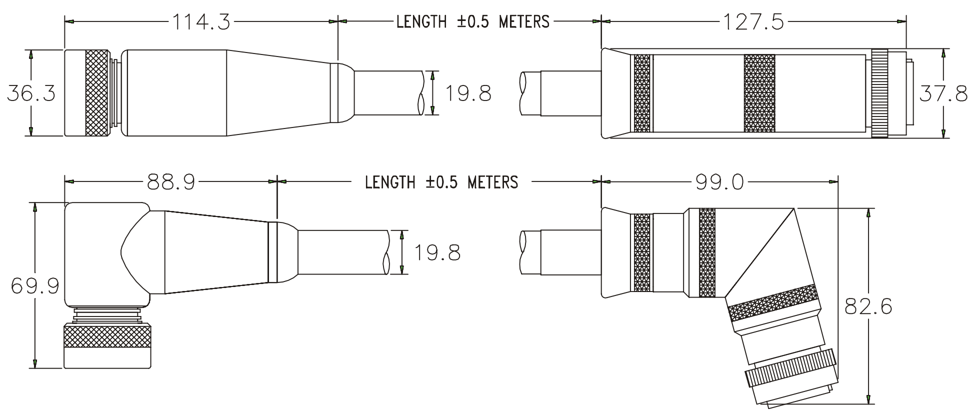


Figure 5. I/O Cable

Route this cable so:

- You can install it with the connectors attached.
- It does not have kinks or sharp bends.
- You can easily replace it if it fails.

> **NOTE.** You can order the cable with the chassis-end connector removed. This allows easier cable routing, but requires you to solder the cable connections at your installation site. This is a difficult task.

Other cables that may need routing to the chassis include the computer interface and the gyro interface. Other cables that may need routing to the computer include the navigation interface and the remote display interface.

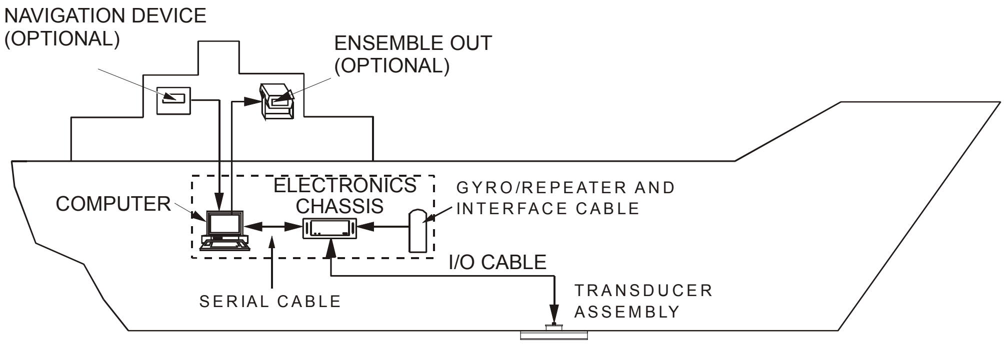


Figure 6. Typical Ocean Surveyor Interface Cable Layout (Overview)

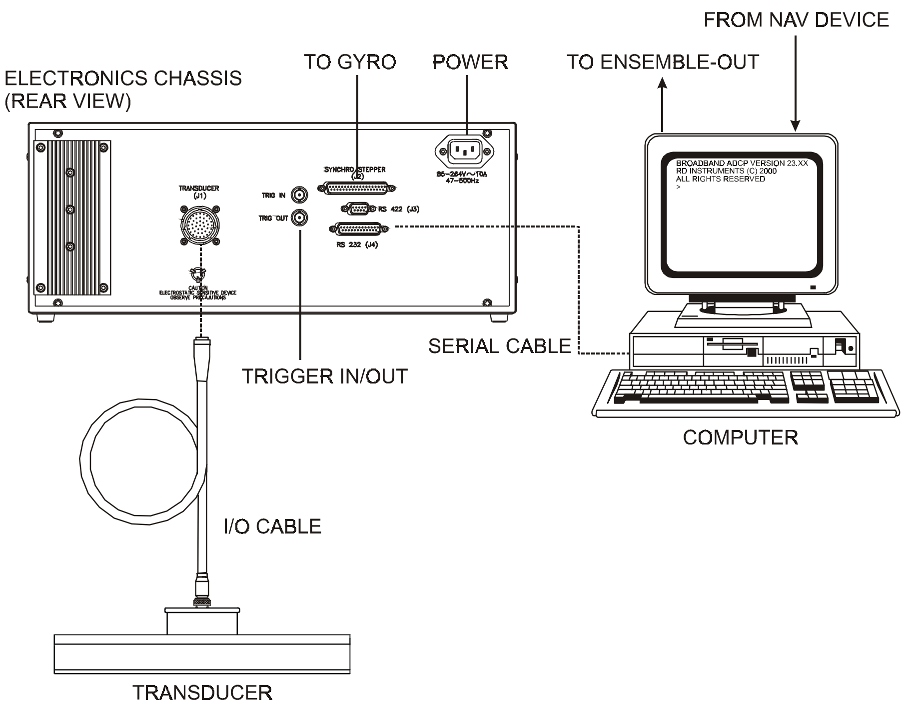


Figure 7. Typical Ocean Surveyor Interface Cable Layout (Detail View)

3.12 I/O Cable

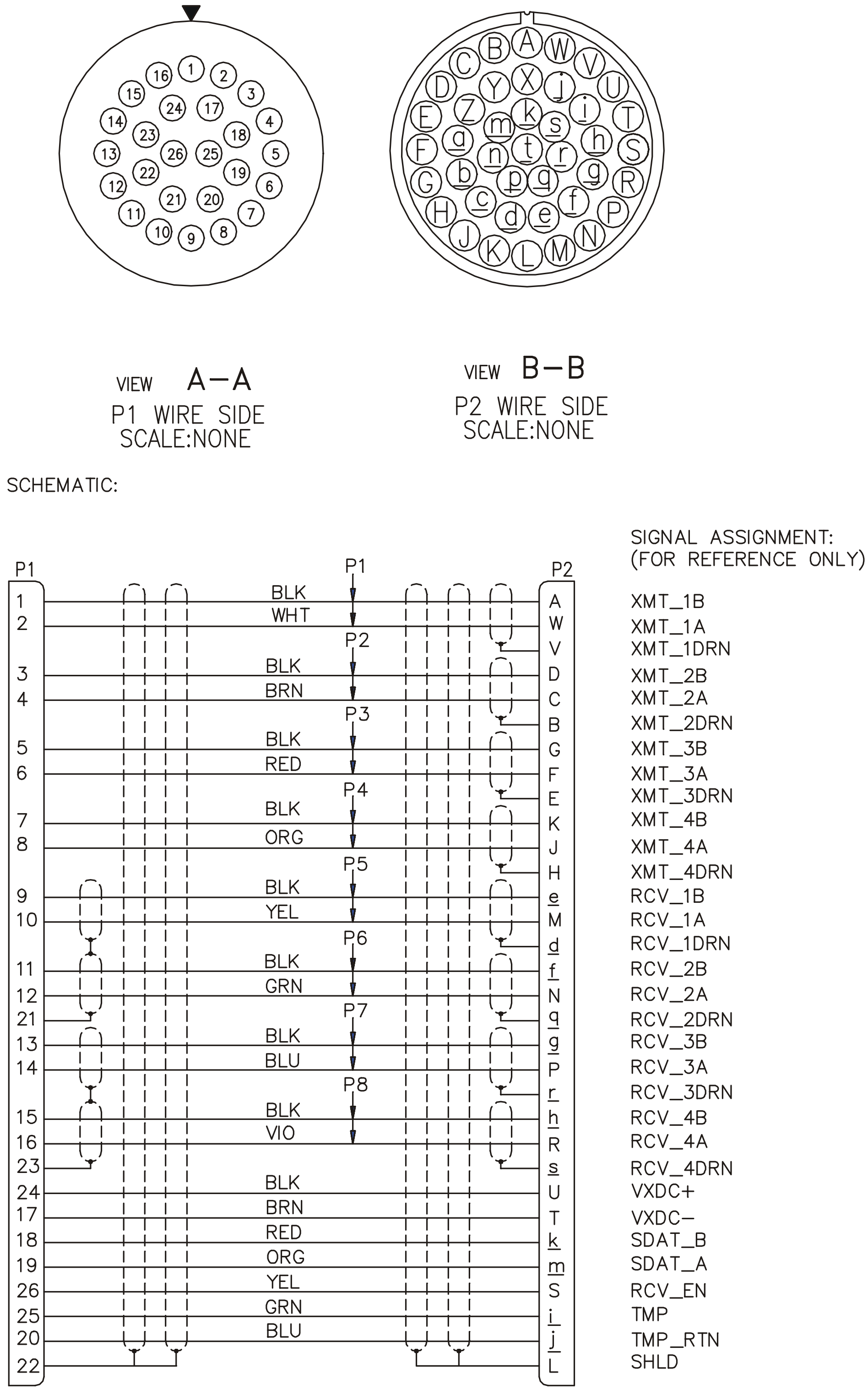


Figure 8. I/O Cable Wiring

3.13 Using Trigger-In and Trigger-Out

The Trigger Input allows the Ocean Surveyor to be synchronized by an external +5Vlogic level signal. The minimum duration for the Trigger Input is 1ms. The Input resistance is at least 2.7 kOhm. The Trigger Output is a +5V logic level signal as well. The nominal source resistance of the Trigger Output is 50 Ohms.

The Trigger Output and Input is controlled by the *CX a,b* command, where *a* controls the Trigger Input mode, and *b* the Trigger Output mode. For flexibility, several modes for the Trigger Input and Output operation have been implemented. See Table 3, page 17 for a description of the command.

NOTE. Trigger-In is available only for systems using firmware version 23.xx or later and using the new electronics chassis back panel.

The Trigger In and Trigger Out B-N-C connectors use the center post as the signal input. The outside of the B-N-C connector is used for ground.

The ADCP performs a cycle of reading sensors (known as overhead), transmitting, blanking, processing, and sleep for each ping. When the CX command is enabled (by any setting of CX other than CX0,0), the ADCP will enter a transmit trigger wait state just before the transmitting portion of the cycle. It is during this wait state that the *Trigger In* input is read by the ADCP. This results in the following caution:

CAUTION. The ADCP does not store trigger in inputs. This means that the ADCP will only acknowledge pulses it sees during the transmit trigger wait state. For example, if 3 trigger in pulses were sent to the ADCP in quick succession only the pulse that occurred during the transmit trigger wait state would be used. The other pulses would be ignored and lost.

The setting of the CX command tells the ADCP what type of input signal (either pulse or a DC level) will be sent as the trigger. The following are the available inputs:

Table 3: Trigger-In Input/Output Signals

Command	Action:	Description
CX 0,b	Trigger Input off	Normal operating mode.
CX 1,b	Positive edge Trigger Input	Used if Ocean Surveyor is to be Triggered by other equipment. One ping is executed on every rising edge of the Trigger signal. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%.
CX 2,b	Negative edge Trigger Input	Used if Ocean Surveyor to be Triggered by other equipment. One ping is executed on every falling edge of the Trigger signal. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%.
CX 3,b	Any edge Trigger Input	Used if Ocean Surveyor to be Triggered by other equipment. One ping is executed on every rising and falling edge of the Trigger signal. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%.
CX 4,b	High level Trigger Input	Used if Ocean Surveyor to be Triggered by other equipment. The OS transmits pings as long as the positive level of the Trigger signal is present. In this way, a single ping or multiple pings can be transmitted depending on the duration of the positive level. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%. A time between pings has to be set for cases where multiple pings should be transmitted.
CX 5,b	Low level Trigger Input	Same as CX 4,b except the Trigger is active at the low-level of the Trigger signal. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%. A time between pings has to be set for cases where multiple pings should be transmitted.
CX a,0	Trigger Output off	Normal operating mode.
CX a,1	Trigger Output – XMT	The Trigger Output is at a high level during the time the Ocean Surveyor transmits.
CX a,2	Trigger Output – RCV	The Trigger Output is at a high level during the time the Ocean Surveyor receives.
CX a,3	Trigger Output – X/R	The Trigger Output is at a high level during the time the Ocean Surveyor transmits and receives.
CX a,4	Trigger Output – inverted X/R Trigger	Identical to CX a,3, except the signal is inverted. The Trigger Output is at a high level while the OS is *not* transmitting or receiving.

4 Computer Considerations

We designed the Ocean Surveyor system to use a Windows® compatible computer. The computer controls the ADCP and displays its data, usually through our *VmDas* program. Table 4, page 18 lists the minimum computer requirements.

NOTE. It is highly recommended that you download and install all of the critical updates, recommended updates, and the service releases for the version of Windows® that you are using prior to installing any RDI software.

Table 4: Minimum Computer Hardware Requirements

Windows® 95 (see note), Windows® 98, or Windows® NT 4.0 with Service Pack 4 installed
Pentium class PC 233MHz (350 MHz or higher recommended)
32 megabytes of RAM (64 MB RAM recommended)
6 MB Free Disk Space (20MB recommended)
Two Serial Comports (two High Speed UART Serial Comports recommended)
Minimum display resolution of 800 x 600, 256 color (1024 x 768 or higher recommended)

NOTE. VmDas has special system requirements when using Windows® 95. See the *VmDas* User's Guide for details.

CAUTION. Do not place the computer monitor within 3 feet of the electronic chassis. Monitors are a major source of electronic interference.

5 Gyrocompass Interface Considerations

Vessel Mounted ADCPs do not contain any sensors for measuring heading, pitch, and roll. The vessel must provide this information. There are two ways to interface sensor data such as heading, pitch, and roll information with the ADCP data, either by an analog signal input or by a serial ASCII input. Further details of these interfaces are as follows.

1. Single or multi-turn synchro heading outputs and single-turn synchro tilt sensor outputs for pitch and roll or
2. Stepper heading outputs and single-turn synchro tilt sensor outputs for pitch and roll.
3. Serial ASCII data input to the host computer running the RDI ADCP software that conforms to one of the following NMEA standards.
    - $_ _ HDT (NMEA 0183 standard of true heading only)
    - $_ _ HDM (NMEA 0183 standard of magnetic heading only)
    - $PRDID (RDI proprietary NMEA string supporting heading, pitch, and roll)

5.1 Overview of the ADCP Gyro Interface

A Gyro Interface board (Figure 9, page 20) is installed in the Electronic Chassis to provide attitude data for the ADCP. ADCPs can use gyro analog outputs to obtain heading, roll, and pitch data. The advantage to these options is that gyro outputs can be used on vessels where flux-gate heading sensors and pendulums cannot. This is due to effects from the hull on a flux gate compass and the acceleration of the ship on pendulum pitch and roll sensors. Table 5 lists the gyro interface options.

Use the RD-SIC-0 option when only *stepper* heading is available. Use the RD-SIC-1 option when either *synchro* or *stepper* heading is available. This option supports single-turn (1:1), multi-turn (36:1, 90:1, 360:1), and stepper voltage outputs from a ship's gyro or portable gyro. Use the RD-SIC-3 option with a gyro capable of resolving motion across the vertical plane (i.e., tilt synchro gyro). With the RD-SIC-3 option, you can use one of the following:

- Single or multi-turn synchro heading outputs and single-turn synchro tilt sensor outputs for pitch and roll
- Stepper heading outputs and single-turn synchro tilt sensor outputs for pitch and roll.

The Gyro Interface board uses up to three synchro-to-digital (S/D) converter chips. A resistor network is used to configure the board for the input synchro stator voltages, and a DIPswitch is used to configure the board for the turns ratio of a specific gyro. The S/D chip supports a wide range of input synchro frequencies (50, 60, and 400 Hz).

We usually configure the Gyro Interface board at the factory to customer specifications for synchro stator voltage and gyro turns ratio. Table 6, page 20 lists the acceptable standard configurations. Sometimes, though, the customer chooses to use a gyro other than the one originally specified. Because of the need to change the gyro interface configuration "in the field," we provide technical information in this chapter.

Table 5: Gyro Interface Options by Model

Inputs Allowed	Natel chips	Typical Use
1 (RD-SIC-0)	0	Stepper heading only
1 (RD-SIC-1)	1	Synchro or Stepper heading only
3 (RD-SIC-3)	3	Synchro or Stepper heading, AND Synchro-only pitch and roll

Table 6: Acceptable Gyro Interface Configurations

Gyro Heading Input (Synchro)	
Frequency Input	50Hz, 60Hz, or 400Hz
Stator Voltages	Through a variable scaling resistor package, the stator voltage can vary. Starting with a minimum voltage of 11.6 volts RMS, the most common voltages are 11.8, 26, 50, and 90 volts RMS.
Reference Voltages	20 to 150 VAC
Turns Ratios supported	Through a selectable DIP switch, the turns ratio can be 1:1, 36:1, 90:1, and 360:1
Gyro Heading Input (Stepper)	
Input Voltages	Most common ranges are from 35 to 70 VDC, with a positive or negative common. On special request, other voltages may be possible.
Stepper Ratio	Only a 6-step gyro can be used, where each step stands for 1/6 of a degree. See table below. ST0 ST1 ST2 DEGREE 1 1 0 (0/6) 0.000 1 0 0 (1/6) 0.167 1 0 1 (2/6) 0.333 0 0 1 (3/6) 0.500 0 1 1 (4/6) 0.667 0 1 0 (5/6) 0.833
Gyro Tilt Input (Synchro Only)	
Input Frequency	50Hz, 60Hz, or 400Hz
Stator Voltages	Through a variable scaling resistor package, the stator voltage can vary. Starting with a minimum voltage of 11.6 volts RMS, the most common voltages are 11.8, 26, 50, and 90 volts RMS.
Reference Voltages	20 to 150 VAC
Turns Ratio	1:1 only

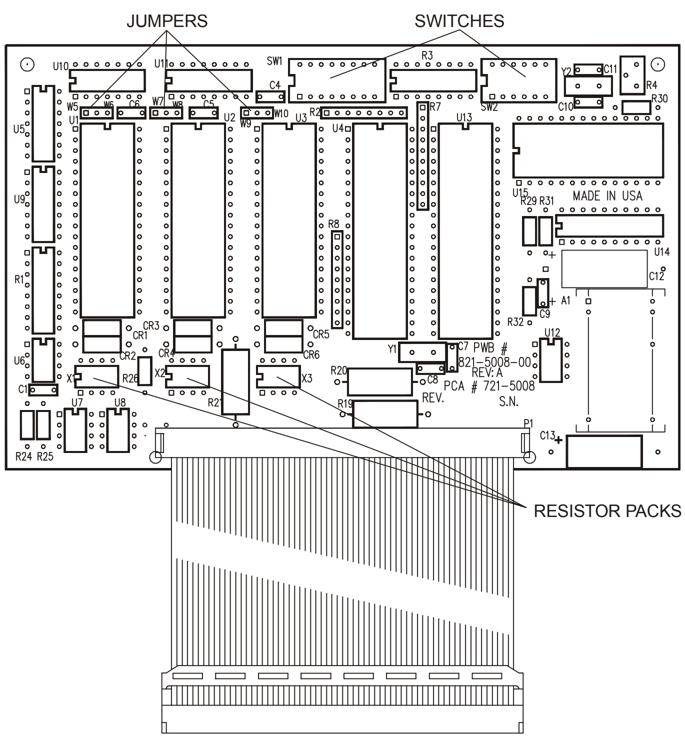


Figure 9. Gyro Interface Board

5.1.1 Determining the Synchro Stator Voltage

The best way to find the synchro stator voltage is to use the value listed in the gyro manual. If the manual does not list this value, you can determine the stator voltage by using an AC voltmeter and doing some calculations. After finding the stator voltage requirements, you will install one or more scaling-resistor packs on the Gyro Interface board. If you already know the stator voltage requirements, skip the rest of this section and go to "Determining the Size of the Scaling-Resistor Pack," page 22 to find the size of the scaling-resistor pack.

d. With the gyro synchro at a constant angle, measure the AC voltage across the following sets of leads. You must maintain this constant angle during your readings.

1. S1 to S2:______ VAC = S_{12}
2. S2 to S3:______ VAC = S_{23}
3. S3 to S1:______ VAC = S_{31}

e. Calculate the RMS stator voltage, V_S:

$$V_S = \left[\frac{S_{12}^2 + S_{23}^2 + S_{31}^2}{1.5} \right]^{1/2} = \text{RMS stator voltage}$$

Usually, V_S will be a common stator voltage (11.8, 26.0, 50.0, or 90.0). If V_S is about equal to one of these values, you can probably assume your gyro is using a common value. If you are unsure of your readings, retake them at a different gyro angle and re-compute V_S. If you know your gyro is using an *uncommon* stator voltage value, you can still modify the scaling-resistor pack value for use with the Gyro Interface board (see "Determining the Size of the Scaling-Resistor Pack," page 22).

Verify the synchro stator voltages are within acceptable limits.

Each stator-pair voltage (S_{12}, S_{23}, and S_{31}) must be less than or equal to V_S.

All pairs of synchro stator voltages must be within the limits given below. For example, the check for one such pair is

$$0.7071 \le \frac{(S_{12}^2 + S_{23}^2)^{1/2}}{V_S} \le 1.2247$$

If these voltage checks are not within acceptable limits, then the synchro output is bad, the voltage measurements were incorrect, or the synchro angle was not constant during readings.

5.1.2 Determining the Size of the Scaling-Resistor Pack

As explained earlier, most synchros use one of the standard synchro stator voltages (V_S) listed in Table 7. The Gyro Interface board will work with any of these voltages by using the associated scaling-resistor pack to adjust the stator voltage input rating to 11.8 VAC.

Table 7: Standard Synchro Stator Voltages and Scaling Resistance

Common synchro stator reference voltages	Scaling resistance
11.8 VAC	0.0 kΩ (jumper)
26.0 VAC	39.2 kΩ, 1/8 W
50.0 VAC	100.0 kΩ, 1/8 W
90.0 VAC	221.0 kΩ, 1/8 W

If the gyro is using non-standard stator voltages, you can find the scaling resistance with the following equation.

$$R = (V_S - 11.8\ VAC)\ x\ (2.76\ k\Omega)$$

The tolerance for this can be as large as 10%, but the four resistors in the scaling-resistor pack must be within 0.1% *of one another*. For example, the exact scaling-resistance value for a V_S of 50.0 VAC is 105.4 kΩ. However, resistor values of 100 kΩ are more common. Because this value is within 10% of the calculated value, you can use four 100-kΩ resistors for the scaling-resistor pack if they are within 0.1% of one another.

CAUTION. If you configure the gyro interface board for a lower voltage than the actual synchro stator voltage, you could damage the board or the ADCP.

5.1.3 Installing the Scaling-Resistor Pack and W-Jumpers

After calculating the size of the scaling-resistor pack, you are ready to install the pack on the Gyro Interface board (Figure 9, page 20). Before you can install the scaling-resistor pack, you may have to change the resistors now in the pack. To do so, pull the resistor pack out of its socket on the Gyro Interface board, unsolder the old resistors, and install the new resistors. When the scaling-resistor pack has the correct resistors soldered in place, re-install the pack in its socket. Also, make sure the appropriate W-jumpers are installed. Table 8, page 23 lists the associated resistor sockets and W-jumpers.

Table 8: Natel Chip, Resistor Pack, and W-jumper Sockets

Function	Natel chip socket	Resistor pack socket	W-jumper socket
Pitch	U1	X1	W5
Roll	U2	X2	W7
Heading	U3	X3	W9

5.1.4 Determining and Setting the Synchro Turns Ratio

The best way to find the synchro turns ratio is to use the value listed in the gyro manual. If the manual does not list this value, you may have to experiment by trying the various settings on the Gyro Interface board. Table 9 lists the available turns ratios and their switch settings. To set the turns ratio, set the poles of switch S1 on the Gyro Interface board (Figure 9, page 20) to the appropriate position.

If you are guessing, try a 1:1 turns ratio first. The reason you want to use a 1:1 turns ratio is so you do not have to enter a heading bias (or initialization) value in any software program you are using or adjustment on the front panel. That is, whenever you use a *non-1:1 turns ratio* or a *stepper* voltage, it is possible for the Gyro Interface board to be out of alignment with the heading synchro. For example, if the ship's heading is 027° when you initialize the ADCP, the misalignment between the gyro and the Gyro Interface board will be 27°. When a misalignment condition occurs, you must account for the misalignment by either the front panel set **Up**/**Down** button, or in the software program you are using. You can use the Ocean Surveyor ADCP EV-command (Heading Bias) to align the Gyro Interface board to the gyro if you do not have the ability to initialize the Ocean Surveyor ADCP through the front panel or in the software. Once set, the heading bias value is valid until you turn off the ADCP or gyro.

Table 9: Gyro Interface Switch 1 Settings

Turns ratio	P1	P2	P3	P4	P5	P6	P7	P8
1:1	C	O	C	O	O	C	C	C
36:1	C	O	C	O	O	O	C	C
90:1	C	O	C	O	O	C	O	C
360:1	C	O	C	O	O	O	O	C
Stepper enable	O	C	O	C	O	O	O	O

C = CLOSED O = OPEN

Table 10: Gyro Interface Switch 2 Settings

Pole	Setting	Function		
P1	C	Enables pitch and roll on the synchro board		
	O	Disabled pitch and roll on the synchro board		
P2-3	Baud rate	Baud rate	P2	P3
		2400	O	O
		4800	O	C
		9600	C	O
		19200	C	C
P4-5	Display rate	Display rate	P4	P5
		Continuous	O	O
		10 times per second	O	C
		2 times per second	C	O
		Once per second	C	C
P6	Not used			

5.2 Stepper Interface

If you are using a *stepper* voltage instead of a synchro voltage, remove the Synchro-to-Digital chip in socket U3 on the Gyro Interface board. Be sure to protect the S/D chip from static discharge.

CAUTION. Synchro-to-Digital converter chips are **expensive**, so handle them with care.

Remember the following items when using the stepper interface

- Only a 6-step gyro can be used, where each step stands for 1/6 of a degree. See Table 6, page 20.
- If you are using roll and pitch inputs from a vertical gyro, the turns ratios for these inputs ***must*** be 1:1.
- Most common stepper voltage ranges are from 35 to 70 VDC, with a positive or negative common and this is what the gyro interface board is setup for from the factory. On special request, other voltages are possible. The gyro Interface board uses resistors R19, R20, and R21 to set the current for the opto isolators on the stepper interface. Use the following table to determine the correct value of these resistors.

Table 11: Stepper Voltage Range

Stepper Voltage	Resistor Value	Watt
35 to 70 VDC	8.2kΩ	1
20 to 35 VDC	4.0kΩ	1
70 to 110 VDC	16.0KΩ	2

5.3 Testing the Gyro Interface

You can use the front LCD display on the Electronic Chassis to test the gyro interface. Turn on the Electronic Chassis. If the LCD heading readout agrees with the gyro at several angles, you can assume the settings are correct. You also should have the gyro make a complete turn through 360°. Some lag may appear, but the LCD readout should change smoothly and in the same direction as the gyro.

If you do *not* have a 1:1 turns-ratio synchro input, and the LCD readout follows in the same direction but with a constant offset from the gyro value, you must use the initializing **Up**, **Down**, and **SET** buttons on the front of the Electronic Chassis. This entry will align the two values when properly set or one of two problems can exist.

NOTE. If you do not have the initializing buttons on the electronic chassis, then you can set the offset in the *VmDas* **Transforms** tab (see the *VmDas* User's Guide). If you are not using RDI's *VmDas* program you can set the offset through the EV command (see the Ocean Surveyor Commands and Output Data Format guide).

- Incorrect turns-ratio value - If you are *not* sure of the turns ratio, try selecting the other turns-ratio values and retest the configuration.

CAUTION. Be sure to power down the Electronic Chassis *before* changing the switch settings. You also should secure the gyro signals to the Electronic Chassis, as these signals are still "live" at the Gyro Interface board terminals.

- Incorrect wiring hookup to gyro - If you *are* sure of the turns-ratio (i.e., found in gyro manual), the problem must be incorrect wiring. That is, the stator lines (S1, S2, S3) or reference lines (RH, RL) may be connected to the wrong gyro terminals. Use Table 12, page 26 or systematically swap pairs of stator or reference leads to correct wiring problems.

Table 12: Gyro Interface Troubleshooting Guide

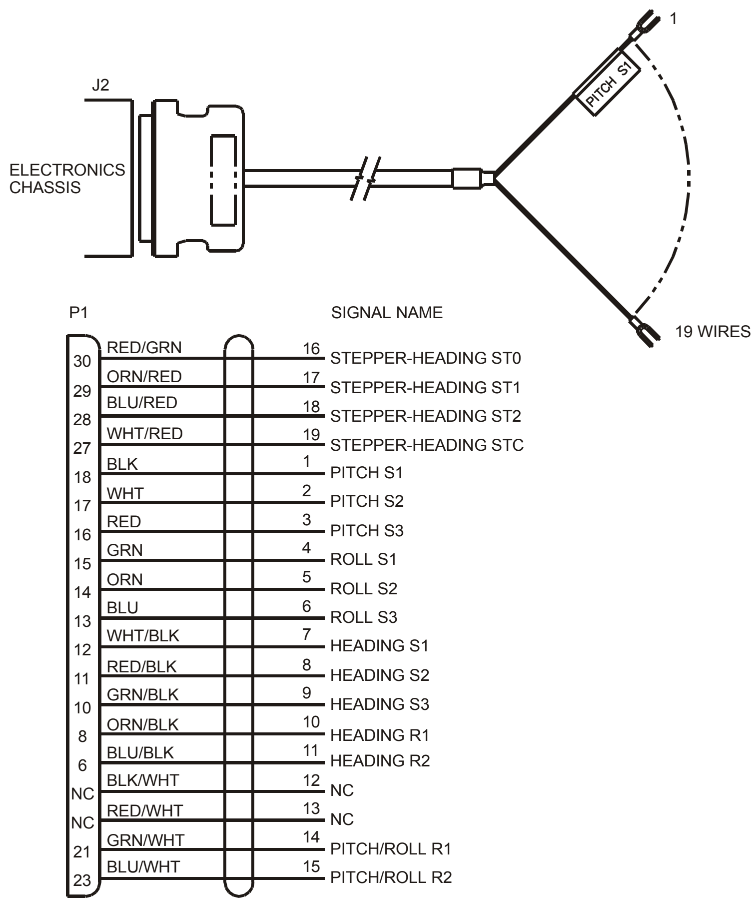
"A" Gyro angle	"B" Angle displayed by heading readout (Shaded areas indicate reverse rotation)											
000	000	120	240	240	000	120	180	300	060	060	180	300
060	060	180	300	180	300	060	240	000	120	000	120	240
120	120	240	000	120	240	000	300	060	180	300	060	180
180	180	300	060	060	180	300	000	120	240	240	000	120
240	240	000	120	000	120	240	060	180	300	180	300	060
300	300	060	180	300	060	180	120	240	000	120	240	000
Gyro conn.	"C" Possible ADCP Connector Configurations											
	1	2	3	4	5	6	7	8	9	10	11	12
RH	RH	RH	RH	RH	RH	RH	RL	RL	RL	RL	RL	RL
RL	RL	RL	RL	RL	RL	RL	RH	RH	RH	RH	RH	RH
S1	S1	S2	S3	S2	S3	S1	S1	S2	S3	S2	S3	S1
S2	S2	S3	S1	S1	S2	S3	S2	S3	S1	S1	S2	S3
S3	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2

NOTE

1. With a gyro angle of "a," the heading readout will show an angle of "b" if the gyro interface cable wires are connected as shown in "c." For example - if the gyro is at an angle of 120° ("a"), and the heading readout is showing a value of 300° ("b"), the interface is wired in either configuration #7 or #10 ("c"). If the heading readings rotate in the same direction as the gyro, the interface is wired as #7; if the rotation is in the reverse direction, the interface is wired as #10.
2. As shown above, only configuration #1 in "c" is correct for gyro interface wiring.
3. Configurations 7-12 occurs when reference wires RH and RL are reversed, producing errors of 180°.
4. Configurations 2, 3, 8, and 9 occur when the S1-S2-S3 wires are rotated, producing errors of 120°.
5. Switching any two of the S1-S2-S3 wires, as in configurations 4, 5, 6, 10, 11, and 12 (shaded in table), causes synchro rotation to be reversed, and results in errors of varying degrees.
6. Setting the gyro to 000° will produce an offset that is a multiple of 60° for all possible wiring configurations.
7. Leaving any of the S1-S2-S3 connections "open" will give unpredictable results.

5.4 Gyro Cable

This section has information on the gyro cable. Special user-requests may cause changes to the basic wiring system and may not be shown here. We provide this list only as a guide in troubleshooting the gyro interface. If you feel there is a conflict, contact RDI for specific information about your system.



NOTE: This cable provides synchro/stepper heading signals and/or synchro tilt from an external gyrocompass to the electronic chassis. This cable is provided with the instrument (length specified by user). Cable specifications: 26 conductors, cable OD = 8 mm (0.31 in.), terminated at one end with a 37-pin connector (electronic chassis side), terminated at the other end (gyro side) with 19 spade (or forked) lugs for connecting to the gyro

Figure 10. Cable, Gyro Synchro/Stepper to Electronic Chassis (J2)

6 Navigation Interface Considerations

VmDas can read in, decode, and record ensembles from an ADCP and NMEA data from some specific (i.e. GPS and attitude sensors) external devices. *VmDas* stores this data in both raw data files (leaving all original data input in its original format) and in a combined, averaged data file. *VmDas* uses all of this data to create different displays for the user.

VmDas looks for, and utilizes the following strings if transmitted: standard GGA (position), HDG/HDT (Heading), VTG (speed and track) messages, and a proprietary PRDID (pitch and roll) message.

As well as being able to input NMEA strings to *VmDas*, it can produce NMEA output strings of speed log information. The speed log contains VDVBW (ground/water speed) and VDDBT (depth).

NOTE. For more information about NMEA data, see the *VmDas* User's Guide.

7 Power Considerations

The Ocean Surveyor system uses an input power level of 90 to 250 VAC, 47 to 63 Hz. The system draws about 1600 watts peak with a inrush current of 17 Amps @ 115 VAC, 34 Amps @ 230 VAC (see "System Power Specifications," page 35). To operate properly, the Ocean Surveyor system must have "clean" power from regulated or spike-free source. Additionally, you can avoid many random or hard-to-define problems by connecting both the electronics chassis and the computer to the same power source.

8 Installation Procedures (Overview)

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

a. On receipt of the system, read the Read Me First guide.

b. Before installing the system, test the transducer and electronics chassis right out of the shipping container. Do the following.

   1. All power to the system DISCONNECTED.
   2. Review "Power Considerations," page 28.
   3. Connect the I/O cable from the electronics chassis to the transducer.
   4. Connect the serial I/O cable from the computer to the electronics chassis.

    5. Connect the power cable to the electronics chassis and apply power to the system (the Ocean Surveyor User's Guide shows all cable connections).
    6. Follow testing procedures in the Test Guide. Test the system. If errors occur, use the Troubleshooting Guide.

c. Prepare the system for shipboard installation. Disconnect all power to the system. Disconnect all interface cables.

d. Review “Transducer Mounting Considerations,” page 2. Install the transducer head. Mechanically align the system (see “Alignment Procedures (Overview),” page 30).

> **CAUTION.** Take steps to prevent leaks through the hull and gate valves.

e. Review section “Electronics Chassis Mounting Considerations,” page 12. As necessary, do the following.

    1. Check all switch settings on the gyro board (shown in “Determining and Setting the Synchro Turns Ratio,” page 23).
    2. Install the electronics chassis.

f. Review “Computer Considerations,” page 17. Install the computer.

g. Review “Cabling Considerations,” page 13. As necessary, route and connect the following cables:

- Transducer to chassis (J1) interface cable.
- Gyro to chassis (J2) cable.

> **CAUTION.** Signals may be present from the gyro.

- Navigation to computer cable.

> **CAUTION.** Signals may be present from the navigation device.

h. As necessary, load the software on the computer’s hard drive. See the software User's Guides and the Readme.txt files for each program.

i. Configure *VmDas*. See the VmDas User's Guide, *VmDas* help file, and the Ocean Surveyor User's Guide for help on configuring *VmDas*.

j. Do the Dock Side Tests (see the Test Guide). If errors occur, use the Troubleshooting Guide.

k. Do the Sea Acceptance testing (see the Test Guide). The Sea Acceptance tests include the following checks.

- Interference
- Water Profile Range
- Ringing and (cross-coupling, other pingers, noise)
- Water Profile Reasonableness (transducer alignment)
- Bottom-track (range, accuracy)

9 Alignment Procedures (Overview)

NOTE. This section does not apply to stationary systems (such as Oil Rig platforms). These systems use an internal compass by default.

The mechanical alignment of the transducer head is important to ADCP data accuracy. Mechanically mount the head as close as possible to your reference point. This is usually with the Beam 3 mark at 0° or 45° relative to the ship's fore-to-aft centerline. You also must mount the transducer head as level as possible using the ship's roll and pitch references. Review the "Transducer Mounting Considerations," page 2 for alignment considerations.

VmDas uses the **Heading Correction Parameters** on the **Transforms** tab to align the ADCP's north reference (Beam 3 mark) to the north reference of an external gyro/compass. Ships use the bow as the north reference.

NOTE. Ocean Surveyor 38kHz oval transducers are always mounted with the Beam 3 mark forward.

When the Ocean Surveyor is aboard a vessel, the mechanical alignment of the transducer head (Beam 3 mark) is usually aligned with the ship's fore-to-aft centerline (0°) or rotated 45° clockwise. To conceptually determine the misalignment angle, visually hold the ADCP still and turn the ship gyro's north reference to match the ADCP's north reference. For example, if the Beam 3 mark is pointing at the bow (Figure 11), the misalignment angle is zero. If the Beam 3 mark is pointing 45° to starboard (Figure 11), you must turn the ship a +45° to align the two north reference points. Conversely, if the Beam 3 mark is pointing 45° to port, you must turn the ship a -45° to align the two reference points.

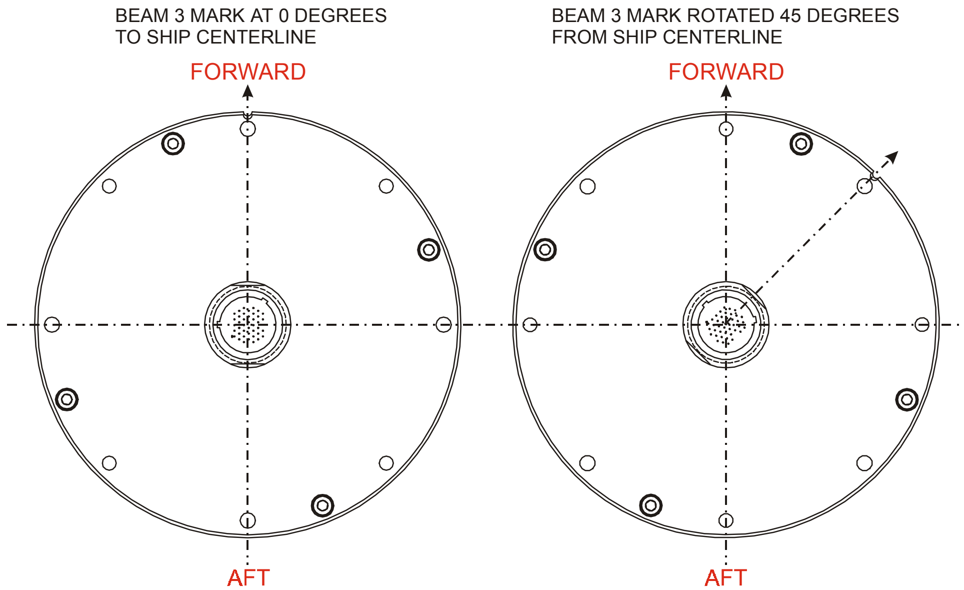


Figure 11. Transducer Misalignment Reference Points

10 Specifications

A brief review of ADCP operation may help you understand the specifications listed in this section.

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

The ADCP emits an acoustic pulse called a PING. Scatterers that float ambiently with the water currents reflect some of the energy from the ping back to the ADCP. The ADCP uses the return signal to calculate a velocity. The energy in this signal is the *echo intensity*. Echo intensity is sometimes used to determine information about the scatterers.

The velocity calculated from each ping has a *statistical uncertainty*; however, each ping is an independent sample. The ADCP reduces this statistical uncertainty by averaging a collection of pings. A collection of pings averaged together is an *ensemble*. The ADCP's maximum *ping rate* limits the time required to reduce the statistical uncertainty to acceptable levels.

The ADCP does not measure velocity at a single point; it measures velocities throughout the water column. The ADCP measures velocities from its transducer head to a specified range and divides this range into uniform segments called *depth cells* (or *bins*). The collection of depth cells yields a *profile*. The ADCP produces two profiles, one for velocity, and one for echo intensity.

The ADCP calculates velocity data relative to the ADCP. The velocity data has both speed and direction information. If the ADCP is moving, and is within range of the bottom, it can obtain a velocity from returns off the bottom. This is called *bottom tracking.* The bottom track information can be used to calculate the absolute velocity of the water. The ADCP can get absolute direction information from a heading sensor.

The following tables list the specifications for the Ocean Surveyor ADCP. About the specifications:

a. All these specifications assume minimal ADCP motion - pitch, roll, heave, rotation, and translation.

b. Except where noted, this specification table applies to typical setups and conditions. Typical setups use the default input values for each parameter (exceptions include Pings Per Ensemble and Number of Depth Cells). Typical conditions assume uniform seawater velocities at a given depth, moderate shear, moderate ADCP motion, and typical echo intensity levels.

c. The total measurement error of the ADCP is the sum of:

- Long-term instrument error (as limited by instrument accuracy).
- The remaining statistical uncertainty after averaging.
- Errors introduced by measurement of ADCP heading and motion.

d. Because individual pings are independent, the statistical uncertainty of the measurement can be reduced according to the equation:

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

10.1 Water Velocity Specifications

Table 13: Water Profiling – Long Range Mode

Frequency	Vertical Resolution Cell Size (m) [3]	Max Range (m) [1]	Precision (cm/s) [2]
38kHz	16	800-1000	30
	24	800-1000	23
75kHz	8	520-650	30
	16	560-700	17
150kHz	4	360-400	30
	8	380-425	17

Table 14: Water Profiling – High Precision Mode

Frequency	Vertical Resolution Cell Size (m) [3]	Max Range (m) [1]	Precision (cm/s) [2]
38kHz	16	520-730	12
	24	600-730	9
75kHz	8	310-430	12
	16	350-450	9
150kHz	4	200-250	12
	8	220-275	9

(1) Ranges at 1 to 5 knots ship speed are typical and vary with situation; (2) single-ping standard deviation; (3) user's choice of depth cell size is not limited to the typical values specified.

10.2 Profile Parameters

Velocity Long Term Accuracy: ±1.0% ±0.5 cm/s

Velocity Range: -Default setup 22 knots (combined water and vessel speed)

Number of Depth Cells: 1 to 128

Table 15: Water Profile Maximum Ping Rate

Frequency (kHz)	Ping Rate (Hz)[1]
38	0.5
75	0.7
150	1.1

Note – Ping rates specified for maximum range in Long Range mode. Shorter ranges allow faster ping rates.

10.3 Bottom Track Specifications

Table 16: Nominal Bottom Track Altitude

Frequency (kHz)	Altitude (m)
38	1,500
75	950
150	600

Bottom Track Precision: <2 cm/s

10.4 Echo Intensity Profile

Dynamic Range: 80dB

Precision: ±1.5dB

Relative Accuracy: 2.5 dB RMS

Scale Factor: 0.46 dB/count

10.5 Transducer and Hardware Specifications

Beam angle: 30°

Configuration: 4 beam, Janus

Communications: RS-422 or RS-232 Hex-ASCII or binary at 1200 to 115,200 baud

10.6 Internal Sensors

Temperature (mounted on transducer)

- Range: -5 to 45°C
- Precision: <0.1°C
- Resolution: 0.027°C
- Accuracy: ±0.4°C

Tilt

- Range: ±20°
- Accuracy: ±1.0°
- Precision: <0.1°
- Resolution: 0.1°

Compass (fluxgate type)

- Accuracy: ±5°
- Precision: <0.1°
- Resolution: 0.1°
- Maximum tilt: ±15°

10.7 System Power Specifications

AC Input: 90 to 250 VAC, 47 to 63 Hz

Power: 1600W peak

Inrush Current: 17A @ 115VAC, 34A @230VAC

Transmit Power: 1100W typical

Standby Power: 60W

10.8 Environmental Specifications

Operating Temperature: -5 to +40°C

Storage Temperature: -50 to +80°C

Standard Depth Rating: 100m

11 Outline Installation Drawings

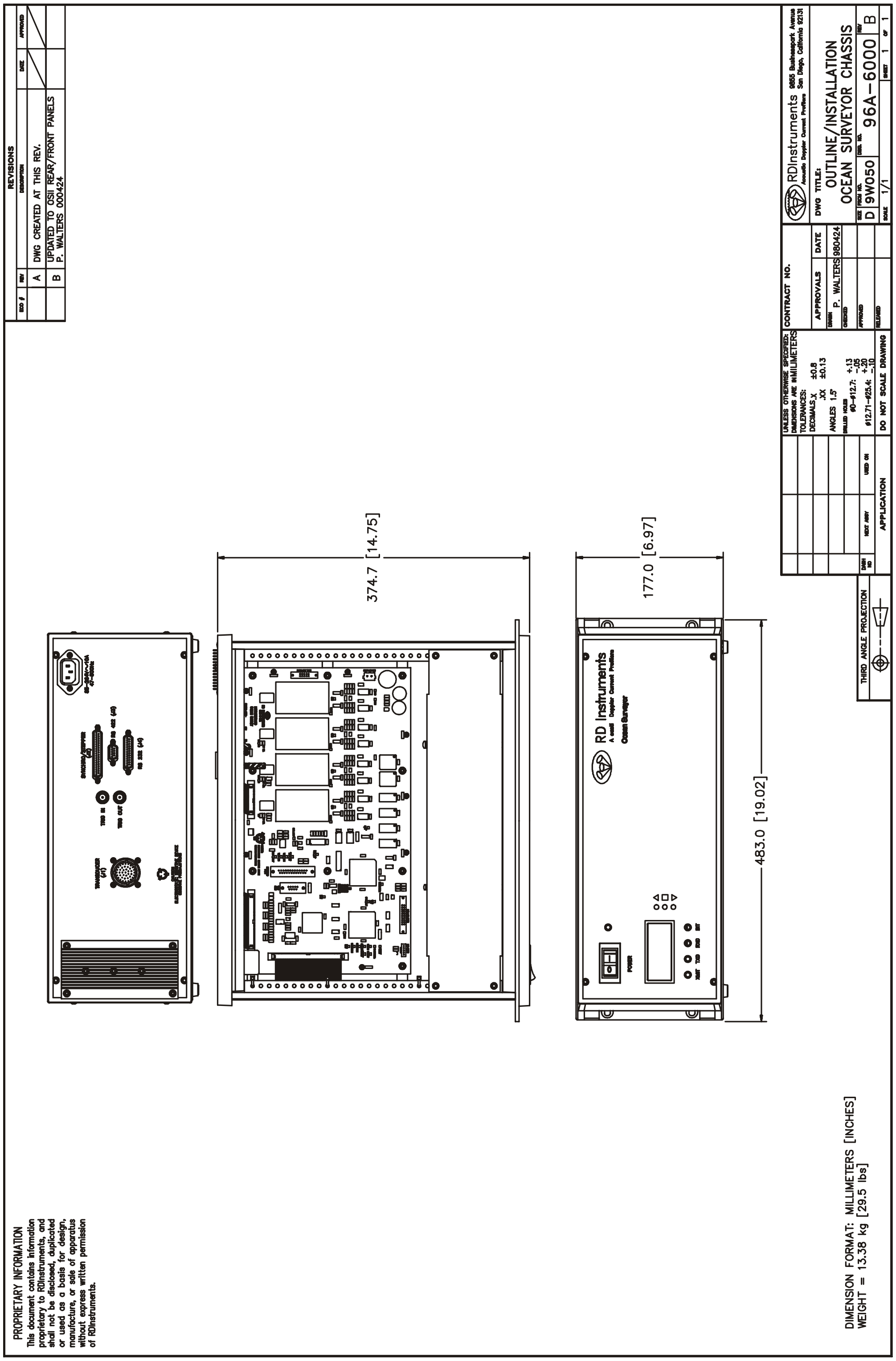
The following drawings show the standard Ocean Surveyor dimensions and weights.

Table 17: Outline Installation Drawings

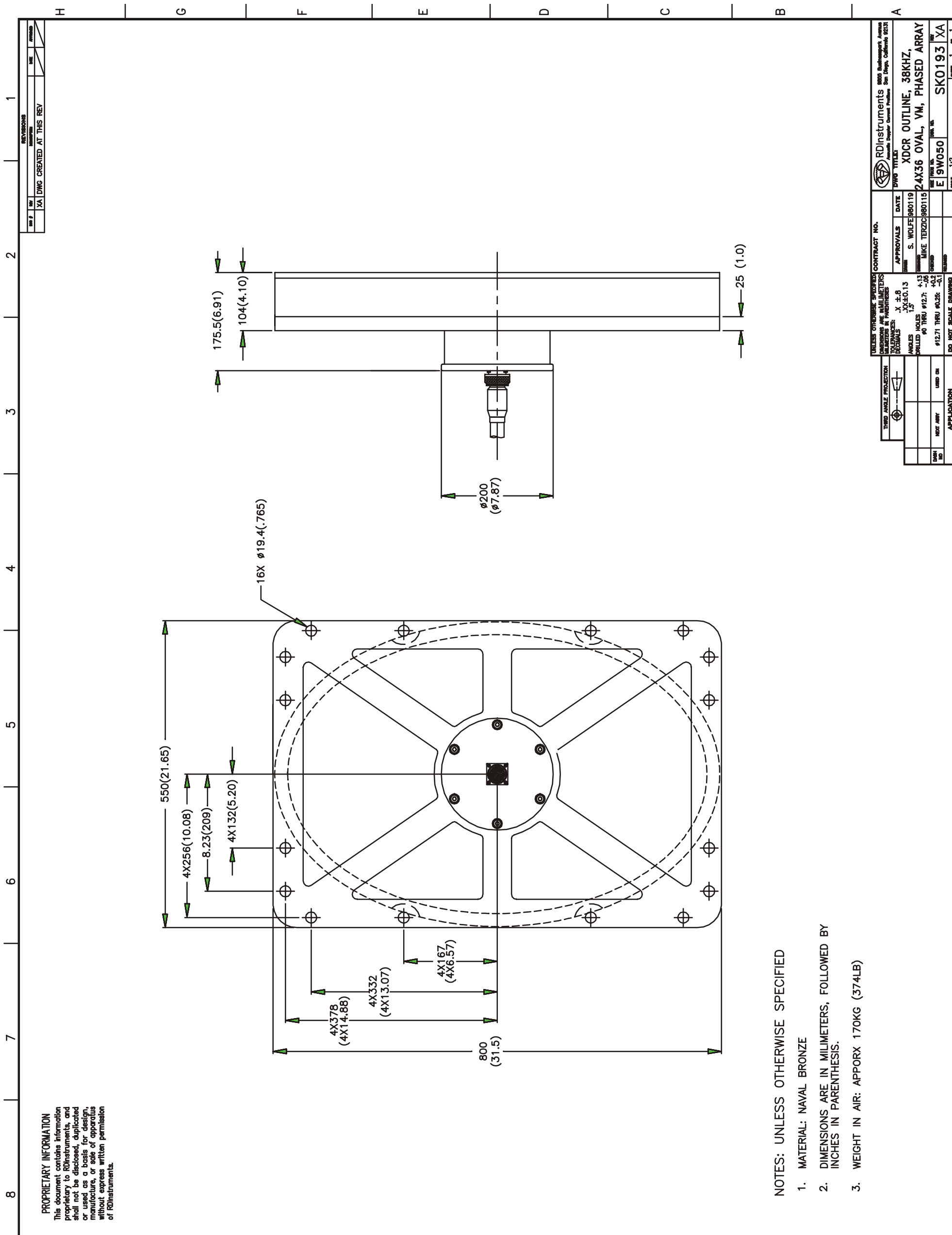
Description	Drawing #
Ocean Surveyor Electronics Chassis	96A-6000
Ocean Surveyor 38kHz Oval	SK0193
Ocean Surveyor 38kHz	SK0195
Ocean Surveyor 75kHz	SK0197
Ocean Surveyor 150kHz	SK0201

NOTE. If you are having difficulty reading the small text on the Outline Installation drawings, please use the electronic documentation. The documentation CD allows you to zoom in on graphics.

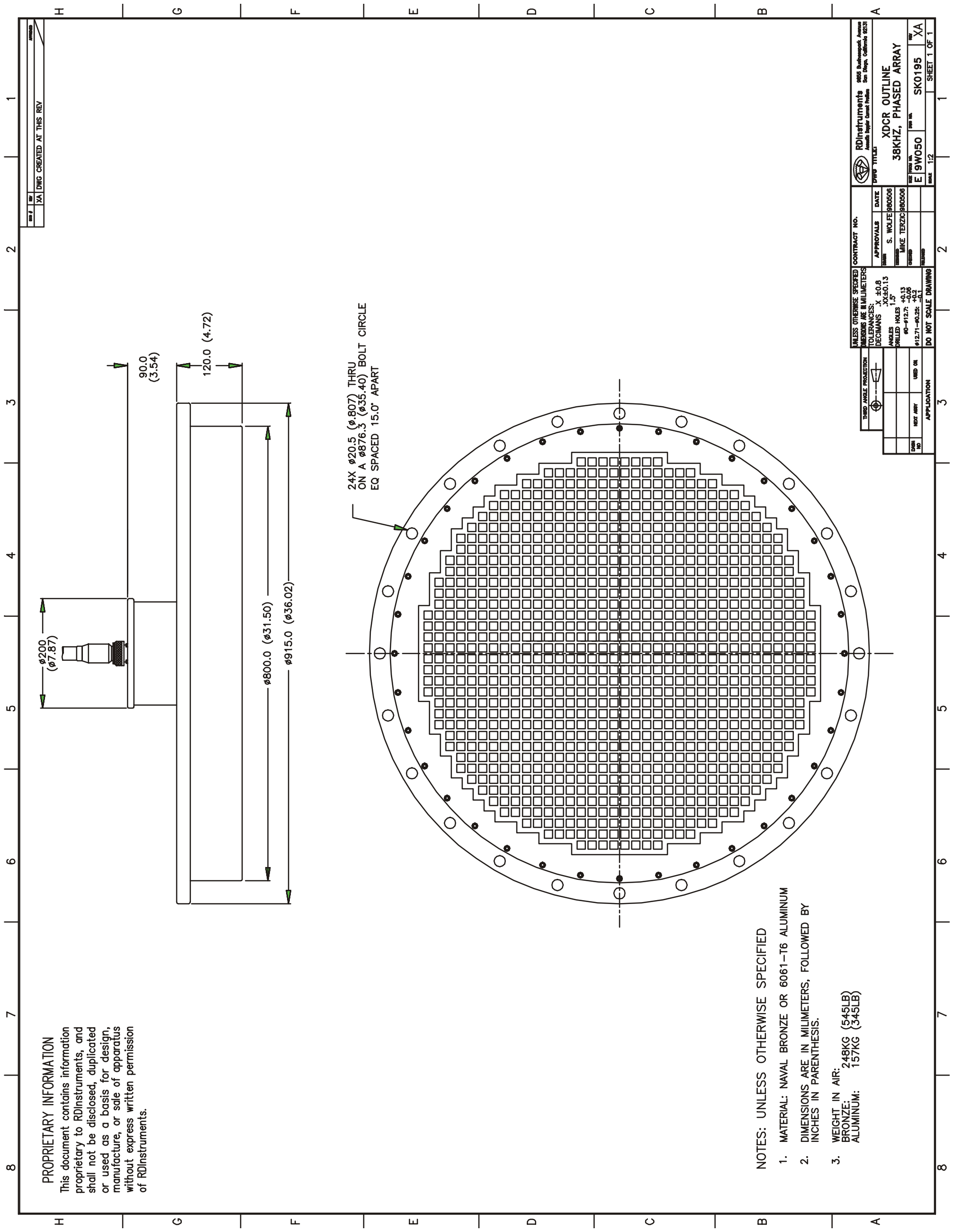
Ocean Surveyor Electronics Chassis - 96A-6000



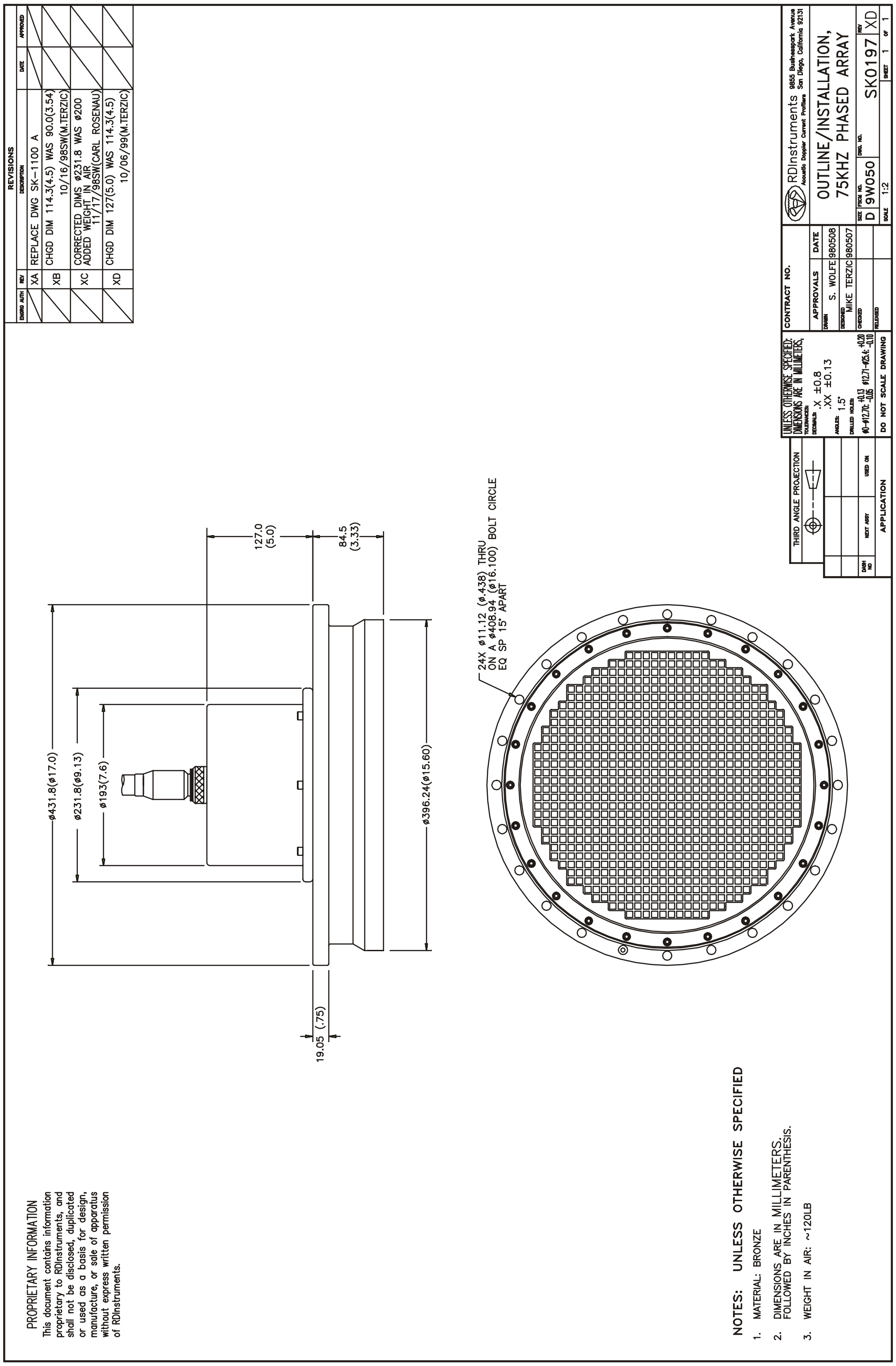
Ocean Surveyor 38kHz Oval - SK0193



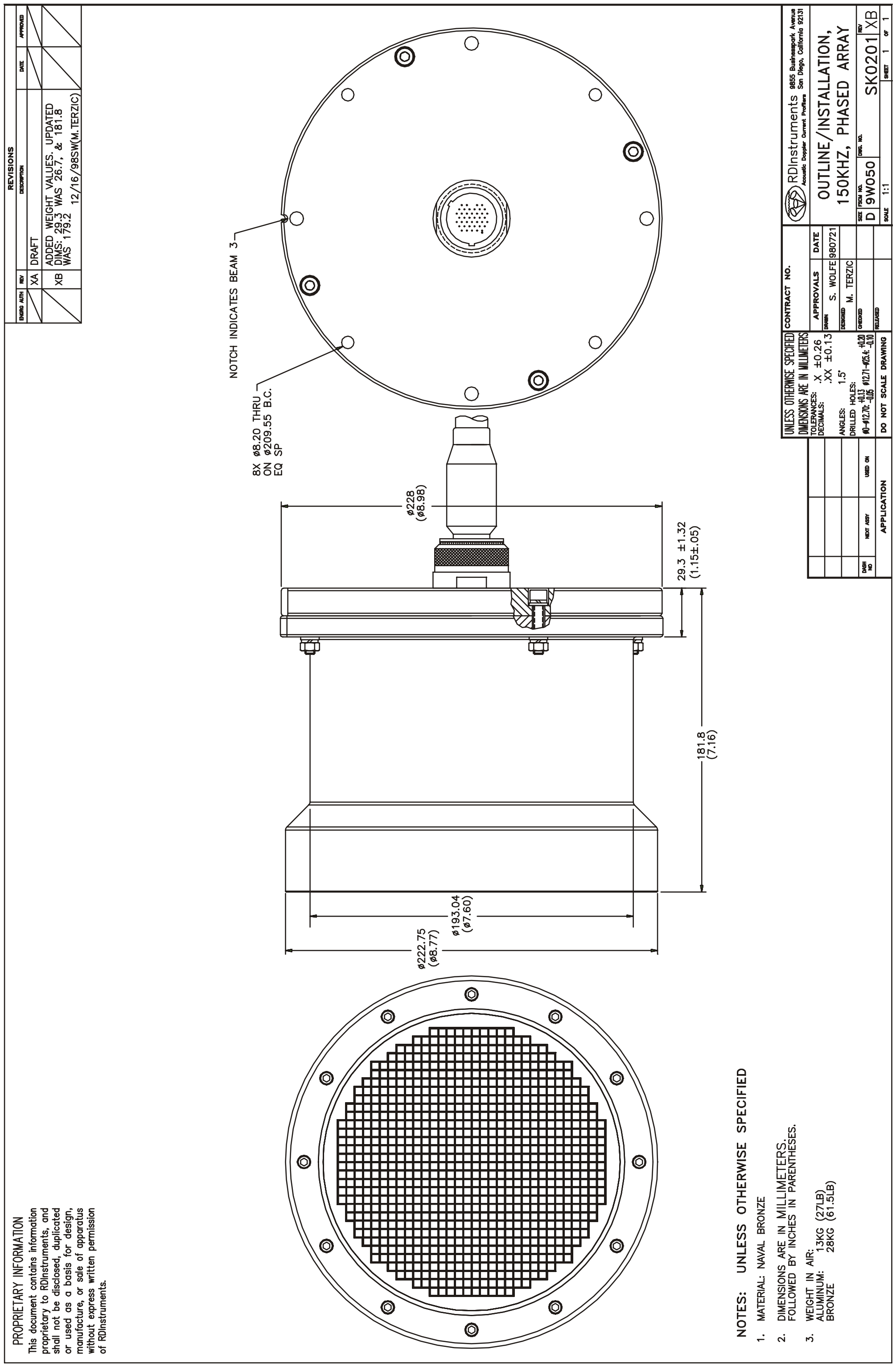
Ocean Surveyor 38kHz - SK0195



Ocean Surveyor 75kHz - SK0197



Ocean Surveyor 150kHz - SK0201



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NOTES

RD Instruments
Acoustic Doppler Solutions

Ocean Surveyor Read This First

1 Introduction

Thank you for purchasing the RD Instruments (RDI) Ocean Surveyor Acoustic Doppler Current Profiler (ADCP). This book is designed to help first time ADCP users to get familiar with their system.

2 Getting Started

You are probably eager to get started, but take a moment to read a few words of guidance. We have tried to make the Ocean Surveyor and its manual/s easy to use. However, the Ocean Surveyor *is* a complex instrument. You must take time to read the manuals.

The Documentation CD includes:

- The Documentation CD has electronic versions of all the user documentation. Use the electronic documentation to quickly search for information. The Read This First guide explains how to use the documentation CD.

The Ocean Surveyor User's Guide includes:

- This book contains an overview of the Ocean Surveyor hardware and software.

The Reference Guides includes:

- **Read Me First.** Use this guide to help unpack, inspect, and do a simple communication test with the Ocean Surveyor.
- **Installation Guide**. Use this guide to plan your installation requirements. This guide includes how to setup the optional gyro interface, and specifications and dimensions for the Ocean Surveyor (including outline installation drawings).
- **Maintenance Guide**. This guide covers Ocean Surveyor maintenance procedures. Use this guide to make sure the Ocean Surveyor is ready for a deployment.
- **Test Guide.** Use this guide to test the Ocean Surveyor.
- **Troubleshooting Guide**. This guide includes a system overview and how to troubleshoot the Ocean Surveyor. If the Ocean Surveyor fails a built-in test or you cannot communicate with the system, use this guide to help locate the problem.

The Commands and Output Data Format Guide includes:

- This book contains a reference for all commands and output data formats used by the Ocean Surveyor. Use the *Command Quick Reference Card* to help remember the direct commands used by the Ocean Surveyor.

The Reference Cards includes:

- **Command Quick Reference Card**. The *Command Quick Reference Card* is designed for *experienced* users to help remember the direct commands used by the Ocean Surveyor.
- **Quick Reference Card**. The *Quick Reference Card* is designed to help *experienced* users remember the proper steps needed to deploy the Ocean Surveyor for a deployment. First time users should read the User's Guide before deploying the Ocean Surveyor.

3 What's New

This section describes features added to the Ocean Surveyor II as compared to the Ocean Surveyor model I.

Real Time Clock (RTC) – A RTC has been added. The TS-command sets the system time (see the Command and Output Data Format guide). Contrary to earlier behavior in the Ocean Surveyor I, the RTC now keeps its own time, and does not depend on the PC time. Thus, a BREAK will not reset the time; rather the time is maintained until it is reset using the TS command.

LCD Display and Gyro Offset control – A LCD Display and Gyro Offset control for systems with Synchro-to-Digital converters for interfacing with a vessel's Gyro has been added. The Offset Control buttons are Up, Set, and Down, as depicted by the upward arrow, the square box, and the downward arrow respectively.

To set a heading offset for a multi-rate gyro for example, the user depresses the up or down button and set button simultaneously, using two small aids such as a pencil. When the desired offset is obtained, release the buttons. To prevent accidental re-adjustment, the bottoms have been recessed.

Trigger Input/Output – The Trigger Input allows the Ocean Surveyor II to be pinged by an external +5Vlogic level signal. The minimum duration for the Trigger Input is 1ms. The Input resistance is at least 2.7 k Ohm. The Trigger Output is a +5V logic level signal as well. The nominal source resistance of the Trigger Output is 50 Ohms.

The command that controls the Trigger Output and Input is *CXab*, where *a* controls the Trigger Input mode, and *b* the Trigger Output mode. For flexibility, several modes for the Trigger Input and Output operation have been implemented. See the Command and Output Data Format guide for a description of the command.

4 Upgrading an OS-I to an OS-II

To upgrade an Ocean Surveyor model I to an Ocean Surveyor model II, the following components must be replaced.

- Chassis
- Transducer Cable
- Transducer Top Hat Assembly
- Beamformer PCB

If you are interested in upgrading, please call our sales department at 858-693-1178.

5 Conventions Used in Manuals

Conventions used in the Ocean Surveyor manuals have been established to help you learn how to use the Ocean Surveyor quickly and easily.

Windows menu items are printed in bold: **File** menu, **Collect Data**. Items that need to be typed by the user or keys to press will be shown as **<F1>**. If a key combination were joined with a plus sign (**<ALT+F>**), you would press and hold the first key while you press the second key.

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

```
Ocean Surveyor Broadband/Narrowband ADCP
RD INSTRUMENTS (c) 1997-2000
ALL RIGHTS RESERVED
Firmware Version 23.xx
>
```

You will find two other visual aids that help you: Notes and Cautions.

> **NOTE.** This paragraph format indicates additional information that may help you avoid problems or that should be considered in using the described features.

> **CAUTION.** This paragraph format warns the reader of hazardous procedures (for example, activities that may cause loss of data or damage to the ADCP).

6 Ocean Surveyor Care

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

6.1 General Handling Guidelines

- Never set the transducer on a hard or rough surface. The urethane face may be damaged.
- Do not expose the transducer to prolonged sunlight. The urethane face may develop cracks. Cover the transducer face on the Ocean Surveyor if it will be exposed to sunlight.
- Do not scratch or damage the O-ring surfaces or grooves. All O-ring grooves and surfaces must be inspected for scratches or damages on every re-assembly. If scratches or damage exist, they must be sanded out using 400 to 600 grit sandpaper. If the damage cannot be re-paired, contact RDI. Do not risk a deployment with damaged O-ring surfaces.
- Do not lift or support an Ocean Surveyor by the external I/O cable. The connector or cable will break.

6.2 Assembly Guidelines

- Always check that the I/O cable (wet end) O-rings are in place when connecting the I/O cable to the transducer. These O-rings have a tendency to fall out if the cable connector is dropped.
- Read the Maintenance guide for details on Ocean Surveyor re-assembly. Make sure the top hat assembly O-rings stay in their groove when you re-assemble the Ocean Surveyor. Tighten the Top Hat hardware as specified. Loose, missing, or stripped Top Hat mounting hardware or damaged O-rings can cause the Ocean Surveyor transducer to flood.

6.3 Deployment Guidelines

- Read the Ocean Surveyor User's Guide and the *VmDas* User's Guide. These guides have tutorials to help you learn how to use the ADCP.
- Use the default Command Files (included on the *VmDas* CD) to help setup the ADCP.

7 Unpacking

When unpacking, use care to prevent physical damage to the transducer face and connector. Use a soft pad to protect the transducer. When handling any electronics modules, follow electrostatic discharge (ESD) prevention measures.

7.1 Inventory

You should have the following items.

- ADCP transducer
- I/O cable
- Ship Kit (includes manuals, software (*VmDas*, *WinADCP*, *RDI Tools*, and Documentation CD), and power cords)
- Electronics Chassis
- Shipping crates (please save all foam and crates for reshipping use)

7.2 Visual Inspection of the Ocean Surveyor

Inspect the Ocean Surveyor using the following table and Figure 1. If you find any discrepancies, call RDI for instructions.

Table 1: Visual Inspection Criteria

Item	Inspection Criteria
Transducer	Check the urethane face. There should be no gouges, dents, scrapes, or peeling.
I/O connector	Check the I/O connector for cracks or bent pins.
Electronic Chassis	Check the connectors on the rear panel for cracks or bent pins.
I/O Cable	Check the cable connectors for cracks or bent pins. Check the cable (wet end) has the O-rings installed.

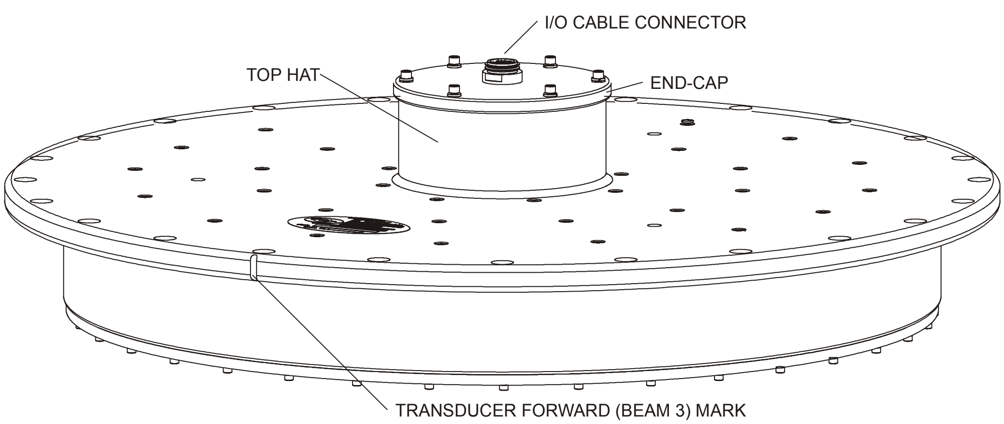


Figure 1. Ocean Surveyor Transducer Overview (38kHz Oval System Shown)

8 Set Up the Ocean Surveyor

Use Figure 2, page 7 to connect the Ocean Surveyor to a computer for a bench test. Read and follow the cautions listed below *before* applying power to the Ocean Surveyor.

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

CAUTION. If the instrument power is supplied via an auto-transformer, make sure the common terminal is connected to the earth terminal of the power source.

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

CAUTION. Do not operate the Ocean Surveyor Electronics Chassis in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

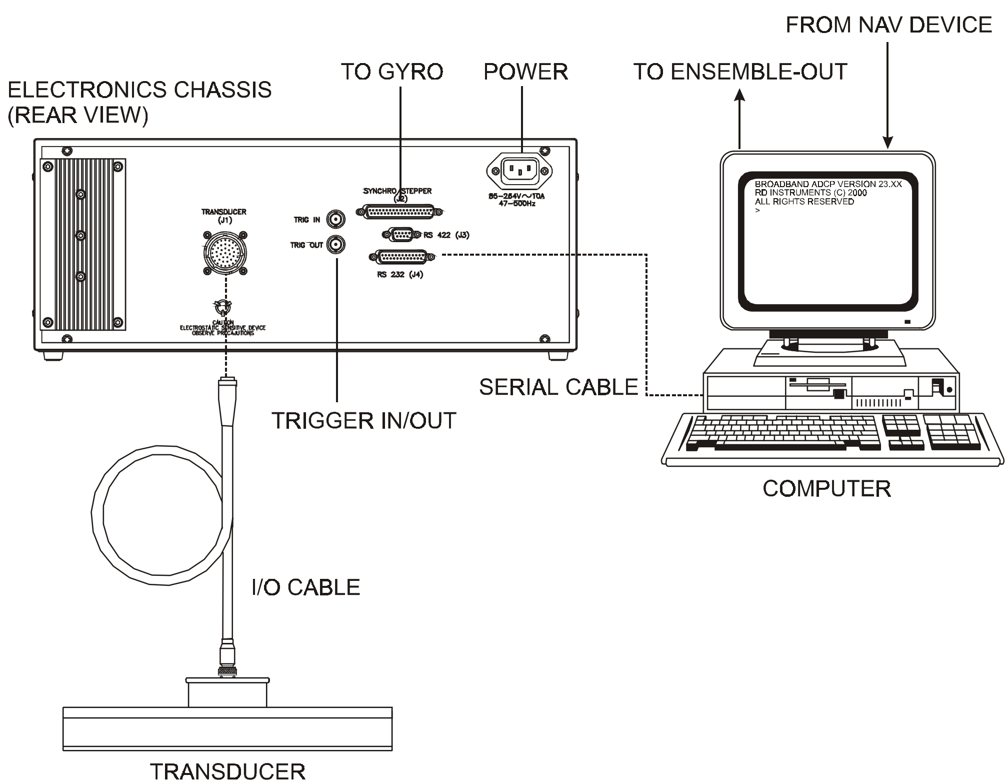


Figure 2. Ocean Surveyor Connections

NOTE. For complete instructions on how to install the Ocean Surveyor, see the Installation Guide.

8.1 Establish Communications

Before you can establish communications with the Ocean Surveyor, you must configure *DumbTerm*.

a. Connect and power up the ADCP as shown in Figure 2, page 7.

b. Start *DumbTerm* (for complete instructions on how to use this program see the RDI Tools User's Guide).

c. At the **Connect To** screen, select **Broadband** from the list. Select the COM port the Ocean Surveyor is connected to. Click **Next**.

d. On the **Port Settings** screen, select the baud rate, parity, and stop bits. Click **Next**.

e. On the **Options** screen, select the desired settings. Click **Finish**.

> **NOTE.** If the **Connect To Last Open Port On Startup** box is selected, *DumbTerm* will immediately start without going through the configuration screens.

f. On the **File** menu, click **Break** (you can also press the **End** key to send a break). You should see the wakeup message appear on the log file window.

```
Ocean Surveyor Broadband/Narrowband ADCP
RD INSTRUMENTS (c) 1997-2000
ALL RIGHTS RESERVED
Firmware Version 23.xx
>
```

> **NOTE.** A delay of up to three seconds before the message appears is normal.

8.2 What to do if the Ocean Surveyor Will Not Wake-up

Wakeup is the process by which the Ocean Surveyor sets up communication with a computer. Sending a BREAK signal to the Ocean Surveyor on the serial communication line begins the wake-up process. Pressing **End** while using *DumbTerm* sends the BREAK. Each time you press **End**, you should see a message similar to the following.

```
Ocean Surveyor Broadband/Narrowband ADCP
RD INSTRUMENTS (c) 1997-2000
ALL RIGHTS RESERVED
Firmware Version xx.xx
>
```

If the wake-up message does not appear, check the following items.

a. Is the I/O cable connected from your computer's COM port to the Ocean Surveyor electronic chassis?

b. Is power connected to the electronic chassis?

c. Check the communication setup using *DumbTerm*. See the RDI Tools User's Guide for detailed help on using *DumbTerm*. The computer and the Ocean Surveyor must be using the same baud rate and COM port.

d. If wakeup still does not occur, use the Troubleshooting book to locate the problem.

9 How to Contact RD Instruments

If you have technical problems with your instrument, contact our field service group in any of the following ways:

RD Instruments	**RD Instruments Europe**
9855 Businesspark Ave.	5 Avenue Hector Pintus
San Diego, California 92131	06610 La Gaude, France
(858) 693-1178	+33(0) 492-110-930
FAX (858) 695-1459	+33(0) 492-110-931
Sales - rdi@rdinstruments.com	rdi@rdieurope.com
Field Service - rdifs@rdinstruments.com	rdifs@rdieurope.com

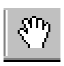
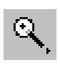
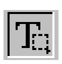
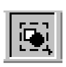
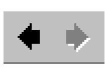
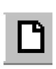
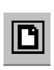
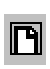
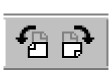
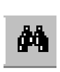
Web: www.rdinstruments.com

10 Using the Documentation CD

The documentation CD contains an electronic version of the Ocean Surveyor Technical Manual. All of the files are in Adobe® Portable Document Format (*.pdf). To use these files, you must install the Acrobat version 4.0 Reader. This program is included on the documentation CD.

NOTE. If you have an earlier version of Acrobat Reader installed on your computer, please uninstall it prior to installing the version 4.0 Reader.

Table 2: Acrobat Reader Toolbar

Tool	Description
	Use these tools to visit Adobe's website.
	Use these tools to open or print a pdf file.
	Use the navigation pane button to turn on or off the table of contents or thumbnail pane.
	Use the hand tool to move the page around so that you can view all the areas on it.
	Zoom In/Out tool
	Text select tool. Use this button to highlight text to be copied into another document.
	Select the Graphics Select tool by holding down the mouse button on the text select tool and dragging to the graphics select tool. Use this button to select a graphic to be copied into another document.
	Use these buttons to page through a document.
	Use these buttons to return to a previous or next view.
	Actual size tool.
	Fit in window tool.
	Fit width tool.
	Rotates page 90 degrees.
	Find tool. Find will search only the current open document.
	Search tools. Use search to find information located in the Ocean Surveyor Technical Manual.

10.1 Opening PDF Documents

Do one of the following:

- Start Acrobat Reader. Choose **File**, **Open**. In the Open dialog box, select the filename, and click **Open**. Acrobat Reader documents have the extension *.pdf.
- Double-click the file icon in your file system.

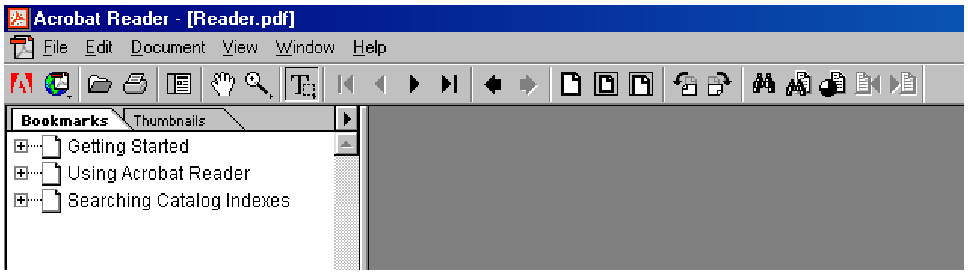


Figure 3. Adobe Acrobat Reader Screen

10.2 Viewing Documents

The minimum and maximum zoom levels available depend on the current page size. If you magnify a page to a size larger than the window, use the hand tool to move the page around so that you can view all the areas on it. Moving a PDF page with the hand tool is like moving a piece of paper on a desk with your hand.

To Resize a Page to Fit the Window:

Do one of the following:

- To resize the page to fit entirely in the window, click the **Fit in Window** button, or choose **View**, **Fit in Window**.
- To resize the page to fit the width of the window, click the **Fit Width** button, or choose **View**, **Fit Width**. Part of the page may be out of view.
- To resize the page so that its text and graphics fit the width of the window, choose **View**, **Fit Visible**. Part of the page may be out of view.

To Increase Magnification:

Do one of the following:

- Select the **Zoom-In** tool, and click the page.
- Select the **Zoom-In** tool, and drag to draw a rectangle, called a marquee, around the area to magnify.

- Click the **Magnification** button in the status bar, and choose a magnification level.

To Decrease Magnification:

Do one of the following:

- Select the **Zoom-Out** tool, and click the page.
- Select the **Zoom-Out** tool, and drag to draw a marquee the size you want the reduced page to be.
- Click the **Magnification** button in the status bar, and choose a magnification level.

> **NOTE.** When the **Zoom-In** tool is selected, you can press **Ctrl** while clicking or dragging to **Zoom Out** instead of in. When the **Zoom-Out** tool is selected, press **Ctrl** to zoom in.

To Return a Page to Its Actual Size:

Click the **Actual Size** button, or choose **View**, **Actual Size**.

10.3 Paging Through a Document

Acrobat Reader provides buttons, keyboard shortcuts, and menu commands for paging through PDF documents.

To Go to Another Page:

Do one of the following:

- To go to the next page, click the **Next Page** button in the command bar or status bar, press the **Right Arrow key**, press **Ctrl + Down Arrow** key, or choose **Document**, **Next Page**.
- To go to the previous page, click the **Previous Page** button in the command bar or status bar, press the **Left Arrow** key, press **Ctrl + Up Arrow** key, or choose **Document**, **Previous Page**.
- To move down one line, press the **Down** Arrow key.
- To move up one line, press the **Up** Arrow key.

> **NOTE.** The **Down** and **Up** Arrow keys move you one line at a time when you are not in Fit in Window view. In Single Page mode, these keys move you one page at a time if the page fills the entire screen.

- To move down one screen, press **Page Down** or **Return**.
- To move up one screen, press **Page Up** or **Shift + Return**.

- To go to the first page, click the **First Page** button in the command bar or status bar, press the **Home** key, or choose **Document**, **First Page**.
- To go to the last page, click the **Last Page** button in the command bar or the status bar, press the **End** key, or choose **Document**, **Last Page**.

To Retrace Your Viewing Path:

Do one or more of the following:

- To retrace your path within a PDF document, click the **Go to Previous View** button in the command bar, or choose **Document**, **Go Back** for each step back. Alternatively, click the **Go to Next View** button, or choose **Document**, **Go Forward** for each step forward.
- To retrace your viewing path through other PDF documents, choose **Document**, **Go Back Doc** for each step back or **Document**, **Go Forward Doc** for each step forward. Alternatively, hold down **Shift**, and click the **Go Back** or **Go Forward** button. This command opens the other PDF documents if the documents are closed.

10.4 Using Find

You can use the Find command to find a complete word or part of a word in the *current* PDF document. Acrobat Reader looks for the word by reading every word on every page in the file, including text in graphics.

To Find a Word Using the Find Command:

a. Click the **Find** button, or choose **Edit**, **Find**.

b. Enter the text to find in the text box.

c. Select search options if necessary:

- **Match Whole Word** Only finds only occurrences of the complete word you enter in the text box. For example, if you search for the word stick, the words tick and sticky will not be highlighted.
- **Match Case** finds only words that contain exactly the same capitalization you enter in the text box.
- **Find Backwards** starts the search from the current page and goes backwards through the document.

d. Click **Find**. Acrobat Reader finds the next occurrence of the word.

To Find the Next Occurrence of the Word:

Do one of the following:

- Choose Edit, Find Again.
- Reopen the **Find** dialog box, and click **Find Again** (the word must already be in the **Find** text box).

10.5 Using Search

The Acrobat **Search** command allows you to perform full-text searches of PDF document collections (i.e. the Ocean Surveyor Technical Manual), whereas the Acrobat **Find** command allows you to search only a single document. The **Search** command also provides powerful tools for limiting and expanding a search. Opening a PDF document associated with an index automatically makes the index searchable.

NOTE. The documentation CD version of the Adobe® Acrobat Reader has the Search plug-in included.

To Select an Index:

Choose **Edit**, **Search**, **Select Indexes** to list the currently available indexes and to add or delete indexes, and then do one of the following in the **Index Selection** dialog box:

- To add an index to the available indexes list, click **Add**, navigate to the index, and double-click on the index file.

NOTE. The documentation CD has an index file in the same directory as the pdf files.

- To remove an index, select the index name, click **Remove**, and then click **OK**.
- To select or deselect an index, select the box for the index, and then click **OK**. Indexes that are grayed out are currently unavailable for searching.

Using the Search Command

The **Search** command allows you to perform a search on PDF documents. You can search for a simple word or phrase, or you can expand your search query by using wild-card characters and operators. You can use the search options to further refine your search.

To Perform a Full-Text Search:

a. Choose **Edit**, **Search**, **Query**.

b. Type the text you want to search for in the **Find Results Containing Text** box: The text that you type in can be a single word, a number, a term, or a phrase.

c. To clear the search dialog box and redefine the search, click **Clear**.

To View a Document Returned From a Search:

a. Double-click the document name to open the document.

b. Use the **Search** buttons on the tool bar to view all the matches for your query.

c. Review the search results that automatically appear in the text box: To highlight the next occurrence of a match in the document, click **Next Highlight**. To highlight the previous occurrence of a match in a document, click **Previous Highlight**.

d. To highlight the first occurrence of a match in the next document listed or previous document listed, **Shift-click Next Highlight** or **Previous Highlight**.

e. To view any other document listed, select **Search Results** to redisplay the list, and then double-click the document name.

10.6 Copying Text and Graphics

You can select text or a graphic in a PDF document, copy it to the Clipboard, and paste it into a document in another application such as a word processor.

> **NOTE.** If a font copied from a PDF document is not available on the system displaying the copied text, the font cannot be preserved. A default font is substituted.

To Select Text and Copy It to the Clipboard:

Select the **Text Select** tool, and do one of the following:

- To select a line of text, select the first letter of the sentence or phrase and drag to the last letter.
- To select all the text on the page, choose **Edit**, **Select All**. To deselect the text and start over, click anywhere outside the selected text.

Choose **Edit**, **Copy** to copy the selected text to the Clipboard.

To Copy Graphics to the Clipboard:

Select the **Graphics Select** tool by holding down the mouse button on the text select tool and dragging to the graphics select tool, or press **Shift-V** as necessary to cycle through the group of tools. The cursor changes to the cross-hair icon.

Drag a rectangle around the graphic you want to copy. To deselect the graphic and start over, click anywhere outside the selected graphic.

Choose **Edit**, **Copy** to copy the graphic to the Clipboard.

NOTE. The graphic is copied using the *.wmf file format.

11 Warranty

Solely for the benefit of the original buyer, RD Instruments (RDI) warrants all new products of its manufacture to be free from defects in material and workmanship. RDI will replace or repair free of charge, F.O.B. at its factory in San Diego, California or other location designated by RDI, any part or parts returned to it within one year of original delivery, which RDI's examination shall show to have failed under normal use and service.

For those parts or components of a product which RDI does not manufacture itself but which are acquired from other vendors, the duration on times of this warranty given above shall not exceed those of the vendor's warranties for such parts or components.

This warranty applies to all goods manufactured by RDI and is included in the Terms and Conditions contained in sales documents of RDI which Terms and Conditions set forth the provisions that govern all sales made by RDI. This warranty also applies to all other activities performed by research, design, design and development, joint development, field engineering, field testing and operation training and is the ONLY WARRANTY GIVEN FOR THE SALE OF PRODUCTS OR SERVICES. NO WARRANTIES IMPLIED IN LAW, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE SHALL APPLY. IN NO EVENT WILL RDI BE LIABLE FOR CONSEQUENTIAL DAMAGES RESULTING FROM THE PURCHASE OR USE OF RDI PRODUCTS, OR RESULTING FROM ANY DELAYS OR FAILURE OF PERFORMANCE OR RDI UNDER ANY AGREEMENT, OR RESULTING FROM ANY SERVICES FURNISHED BY RDI.

This warranty may not be modified, amended, or otherwise changed except in writing and properly executed by an officer of RDI.

Ocean Surveyor

Maintenance Guide

RD Instruments

Acoustic Doppler Solutions

P/N 95A-6020-00 (January 2001)

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RD Instruments
Acoustic Doppler Solutions

Ocean Surveyor Maintenance Guide

1 Introduction

This guide explains how to do certain maintenance/repair, and how to prepare the Ocean Surveyor for storage or shipment.

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

2 Spare Parts

The following parts are included in the spare parts kit.

Table 1: Spare Parts

Item ID	Description	Where Used
2-020-70SH-EP	O-ring	End-Cap/Top Hat connector
2-022-70SH-EP	O-ring	I/O Cable
DC-111	Lubricant, silicone	O-ring lubricant
314025	Fuse, 25A Fast blow, 3AB	Power Interface PCB
M4x0.7x6PH	Screw, pan head, SST	Electronic Chassis cover

3 Electronics Chassis Board Replacement

Printed Circuit Board (PCB) removal and replacement may occur during system upgrades. Damage to the board or its components can occur if you do not follow the guidelines in this section. Refer to Figure 1, page 3 through Figure 4, page 4.

> **CAUTION.** Static electricity can damage board components. RDI recommends using an earth-grounded wrist strap to help prevent such damage. You must have the wrist strap on whenever you handle a board.

a. Turn off power to the electronic chassis. Disconnect the power and gyro interface cables to ensure that no power is applied.

b. Remove the Electronics Chassis top cover. The cover is held in place with four screws on the corners of the cover. Remove all screws and lift the cover slowly.

c. A grounding wire is attached to the underside of the top cover. Unplug the ground wire from the tab on the top cover and lift off the cover. You now have access to the electronic chassis circuit boards.

d. Attach an earth-grounded wrist strap. Locate the board needing removal. Disconnect all cables going to the board. Remove the board.

> **NOTE.** Save all hardware.

e. Before replacing a board, be sure you have the correct one. Reconnect all cables.

> **NOTE.** Replace all hardware that was removed (i.e. flat washers, split-lock washers, screws, etc.).

> **NOTE.** Removing and replacing the Power Interface Board is not easy. **RDI does not recommend replacing this board in the field.**

> **CAUTION.** The LCD Display is part of the Front Panel Interface PCB. Removing this board requires removing the front cover and unplugging the AC power wires to the power switch. It is critical that the wires to the power switch be plugged back in correctly. **RDI does not recommend replacing this board in the field.**

f. Plug the ground wire to the tab on the top cover. Replace the chassis top cover.

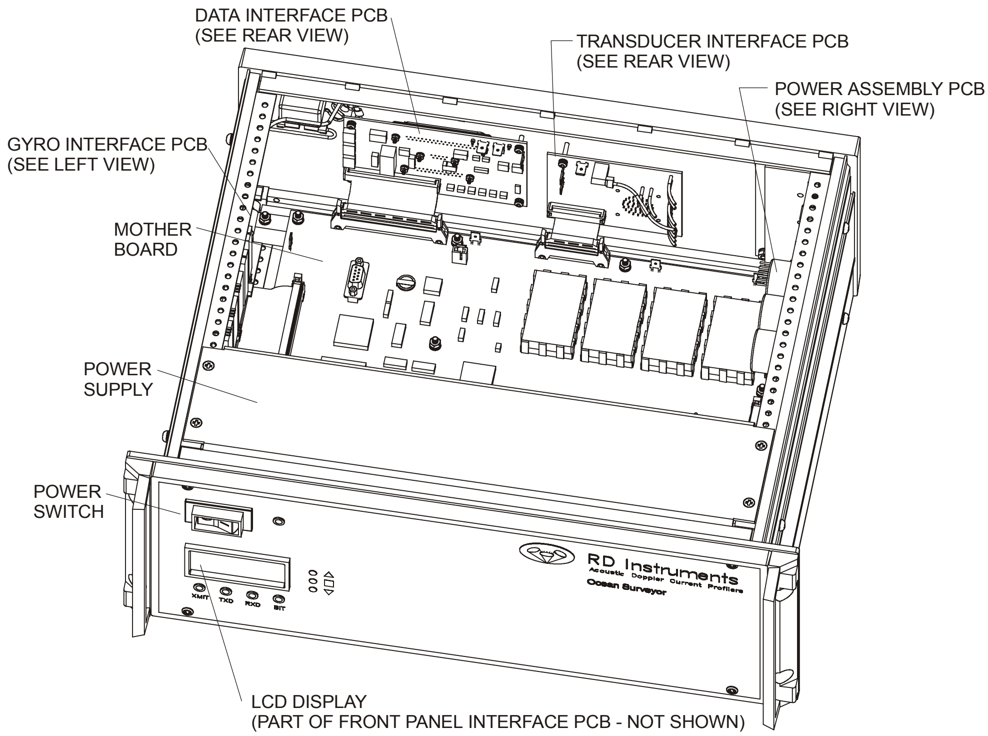

Figure 1. Electronic Chassis (Top View)

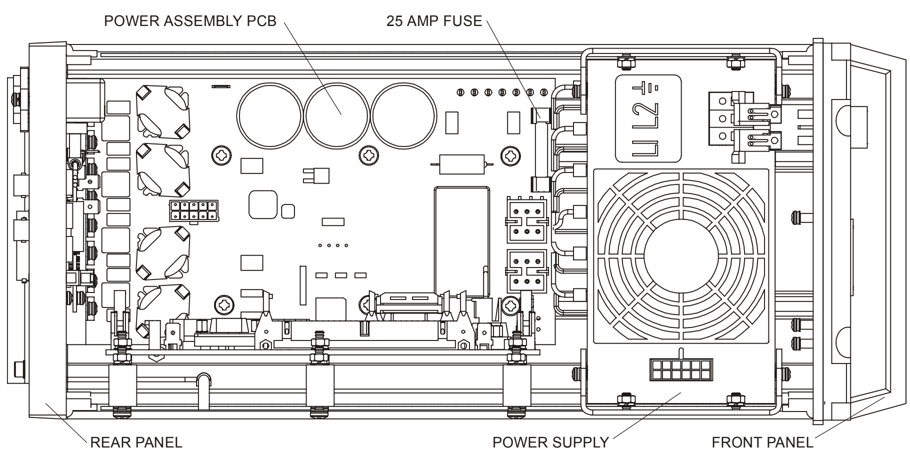

Figure 2. Electronic Chassis (Right View - Looking Toward the Power Interface PCB)

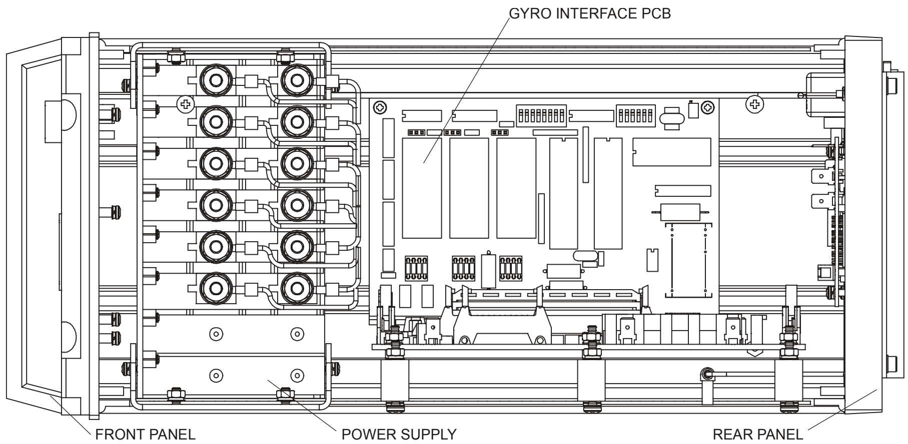

Figure 3. Electronic Chassis (Left View - Looking Toward the Gyro Interface PCB)

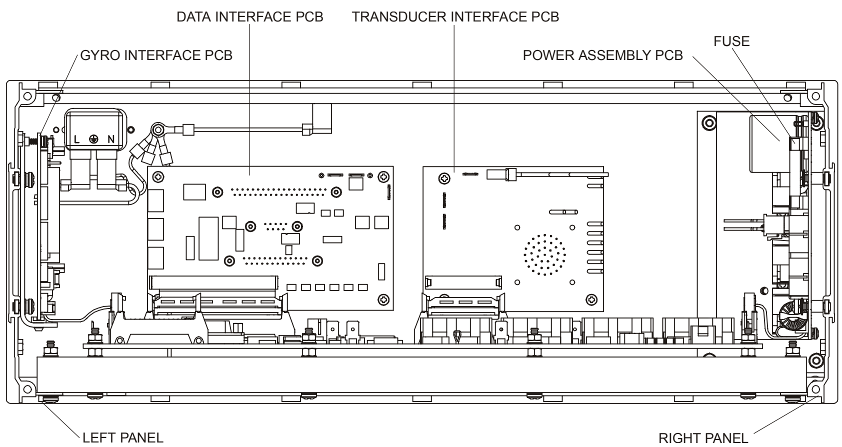

Figure 4. Electronic Chassis (Rear View - Looking Toward the Data Interface PCB)

4 Transducer Board Replacement

Access to the Printed Circuit Boards (PCB) in the transducer is not normally required for routine maintenance. RDI does not recommend opening the transducer housing unless necessary. Damage to the board or its components can occur if you do not follow the guidelines in this section.

CAUTION. Static electricity can damage board components. RDI recommends using an earth-grounded wrist strap to help prevent such damage. You must have the wrist strap on whenever you handle a board.

NOTE. Spare O-rings and desiccant must be ordered to properly seal the transducer. Ensure you have these parts **before** you open the transducer.

a. Attach an earth-grounded wrist strap.

b. Remove the end-cap/Top Hat assembly on the transducer. The end cap is attached to the beam former and optional TCM2 compass by a cable (see Figure 5, page 7 and Figure 6, page 8). The end-cap cannot be removed until the cable has been disconnected.

NOTE. Use a marker pen on the end cap/Top Hat assembly to note the transducer forward mark. When you reassemble the transducer, you need to put the end cap/Top Hat assembly back in the same position.

NOTE. The 75 kHz transducer uses a one-piece Top Hat assembly (see Figure 6, page 8)

c. Remove the beam former board before disconnecting the cable on the compass (if installed). The beam former connector unplugs from the transducer connector by turning the knobs to release the locking mechanism, then pulling the two apart.

   If there is a compass installed, the small connector from the end-cap is plugged into it. The top cover of the compass box must be removed in order to unplug the connector from the TCM2 PCB.

d. Before installing the end-cap or Top Hat (75 kHz), check that all cables have been reconnected and all hardware are tight.

e. Replace the desiccant (see "Desiccant Bags," page 9).

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

NOTE. RDI recommends you use new O-rings if you are preparing for a deployment.

CAUTION. If the O-ring appears compressed from prior use, replace it. **Weak or damaged O-rings will cause the ADCP to flood.**

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

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

h. Lubricate the O-ring with a thin coat of DC-111 lubricant. Apply the lubricant using latex gloves. Do not let loose fibers or lint stick to the O-ring. Fibers can provide a leakage path.

NOTE. RDI uses Dow Corning's silicone lube model number 111 but any equivalent silicone O-ring lube can be used.

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

i. Place the end-cap on the transducer housing, aligning the mating holes and the Transducer Forward mark for orientation. When mating the end-cap with the housing, apply equal pressure to all parts of the O-rings. Make sure the face and bore O-rings remain in their retaining grooves.

j. Examine the end-cap assembly bolts and washers for corrosion; replace if necessary. *All* the hardware items are needed to seal the Ocean Surveyor properly.

k. Install all six sets of hardware until "finger-tight."

l. Tighten the bolts in small increments in a "cross" pattern until the split washer flattens out, and then tighten each bolt ¼ turn more to compress the face seal O-ring evenly. Tighten the bolts to the recommended torque value of 5.6 Newton-meters (50 pound-inches).

CAUTION. Apply equal pressure to the O-rings as you tighten the bolts. If one bolt is tightened more then the others, the O-rings can become pinched or torn. **Damaged O-rings will cause the system to flood.**

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

CAUTION. Do not over tighten the bolts that hold the transducer housing and end-cap together. If you over tighten, you can strip the bolts. On the other hand, **leaving the bolts too loose can cause the system to flood**. Tighten the hardware to the recommended torque value.

NOTE. The recommended torque value for the end-cap bolts is 5.6 Newton-meters (50 pound-inches).

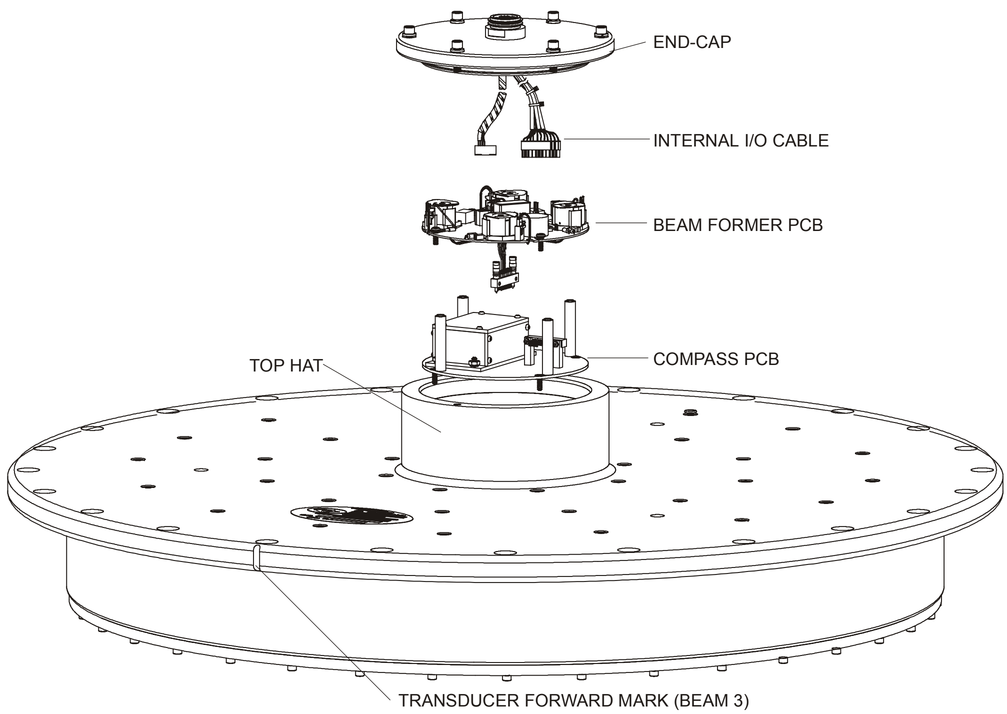

Figure 5. Transducer PCB Layout (38 kHz Round Transducer Shown)

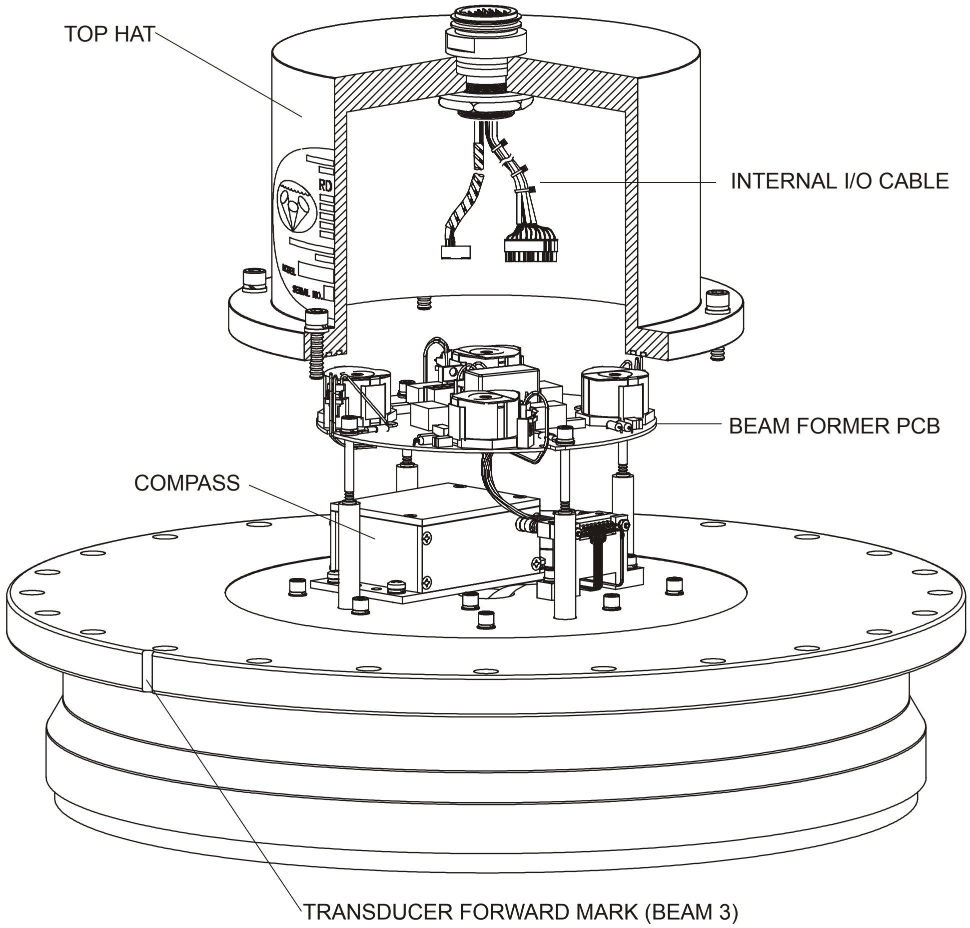

Figure 6. Transducer PCB Layout (75 kHz Transducer Shown)

5 Desiccant Bags

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

> **NOTE.** If the transducer housing has been opened, the desiccant should be replaced.

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

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

> **NOTE.** Desiccant bags are shipped in an airtight aluminum bag to ensure maximum effectiveness. There is a moisture indicator inside the bag. If the moisture indicator is pink, do not use the desiccant bag until it has been dried.

a. Remove the End-Cap/Top Hat assembly (see Figure 5, page 7 and Figure 6, page 8).

b. Remove the new desiccant bags from the airtight aluminum bag.

c. Remove the old desiccant bags and install two new ones. Place the desiccant bags on top of the Beam Former board.

d. Install the End-Cap/Top Hat assembly (see Figure 5, page 7 and Figure 6, page 8).

> **NOTE.** RDI recommends that the desiccant and Top Hat O-rings be replaced every three years. These parts are not included in the spare parts kit. Make sure you have replacement parts **before** opening the transducer.

6 O-Ring Inspection and Replacement

This section explains how to inspect/replace the Ocean Surveyor O-rings. A successful deployment may depend on the condition of these O-rings and their retaining grooves (see Figure 7). Read all instructions before doing the required actions.

- Transducer I/O connector (2-020)
- Transducer I/O cable (2-022)
- Top hat, bore (2-257)
- Top hat, face (2-164)

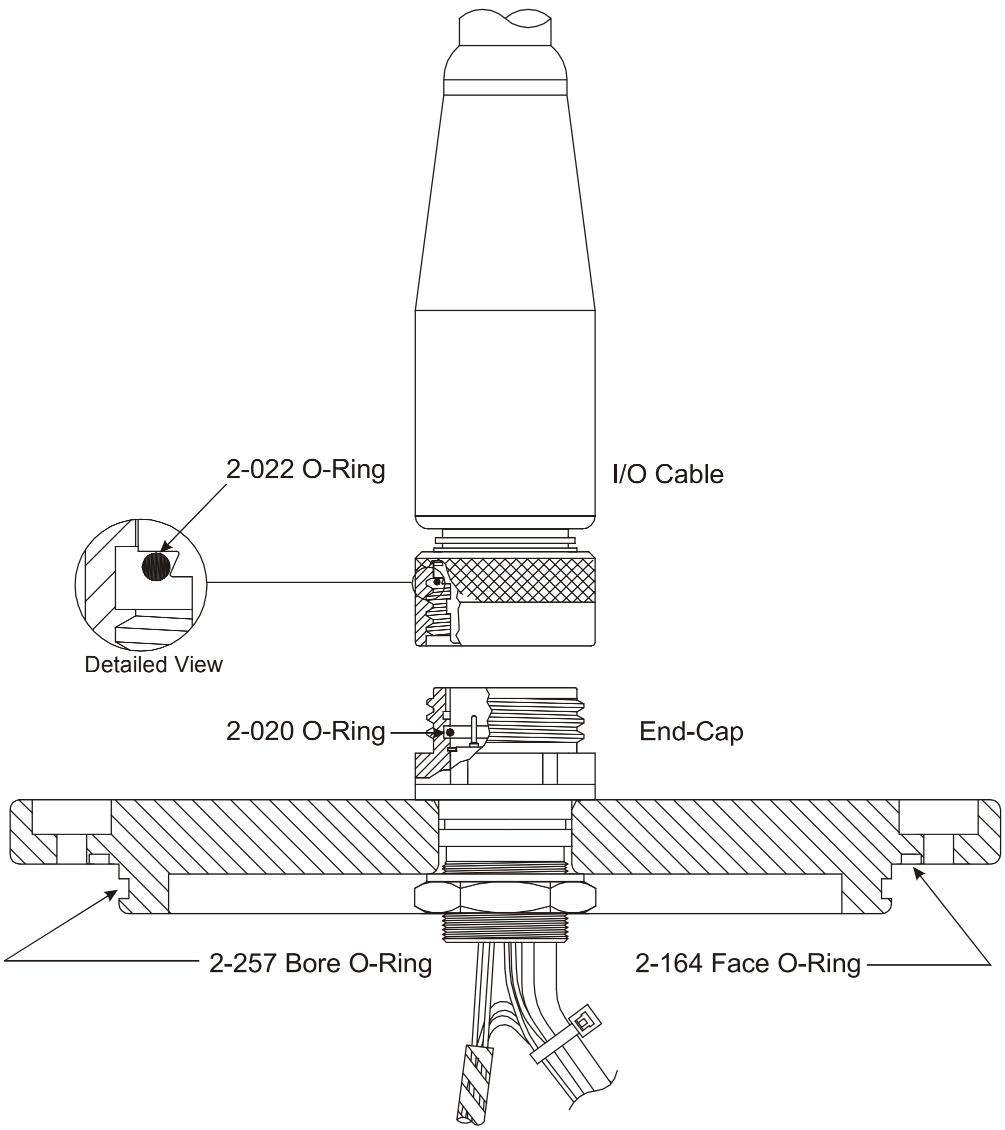

Figure 7. Ocean Surveyor O-ring Locations

We strongly recommend replacing these O-rings whenever you open the transducer assembly. Inspecting and replacing the O-rings should be the last maintenance task done before installing the transducer.

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

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

c. Lubricate the O-ring with a **thin** coat of lubricant. Apply the lubricant using latex gloves. Do not let loose fibers or lint stick to the O-ring. Fibers can provide a leakage path.

NOTE. RDI uses Dow Corning's silicone lube model number 111 but any equivalent silicone O-ring lube can be used.

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

NOTE. During installation, do not cut or twist the O-ring. Never force O-rings over sharp corners, screw threads, keyways, slots, or other sharp edges.

d. Use tweezers to install the 2-020 O-ring into the transducer I/O connector. Do not bend the connector pins.

e. Install the I/O cable 2-022 O-ring by first lubricating the O-ring. Do not let lubricant enter the pinholes.

NOTE. Always check that the I/O cable (wet end) O-ring is in place when connecting the I/O cable to the transducer. The 2-022 O-ring has a tendency to fall out if the cable connector is dropped.

7 Fuse Replacement

A fuse on the Power Assembly board (see Figure 2, page 3) protects the Ocean Surveyor from excessive incoming power. If this fuse continues to blow, check your input power before applying power again.

a. Turn off the power.

b. Remove the top cover of the electronic chassis (see "Electronics Chassis Board Replacement," page 2). The fuse is located on the Power Assembly board (Figure 2, page 3).

c. Gently pull the fuse from the clips.

d. Replace the fuse with the correct voltage and amperage fuse (250 volt 25 amp, fast blow).

CAUTION. Only fuses with the required rated current, voltage, and specified type must be used. Do not repair fuses or short circuit fuse-holders. To do so could cause a shock or fire hazard.

e. Install the top cover of the electronic chassis.

f. Test the system (see the Test Guide).

8 Transducer Head Inspection

The seal on the transducer face is important to ADCP watertight integrity. Mishandling, chemicals, abrasive cleaners, and excessive depth pressures can damage the transducer ceramics. Inspect the transducer face for dents, chipping, peeling, urethane shrinkage, hairline cracks, and damage that may affect watertight integrity or transducer operation. Repair of the transducer face should only be done by RDI.

CAUTION. Never set the transducer on a rough surface; always use soft padding no thicker than 1/4" to protect the transducers. Thicker padding may allow the transducer face to flex, causing the ceramics to crack.

9 Prevention of Biofouling

This section explains how to prevent the buildup of organic sea life (biofouling) on the transducer faces. Objects deployed within about 100 meters (≈328 feet) of the surface are subject to biofouling, especially in warm water. This means all vessel-mounted deployments are subject to biofouling. Soft-bodied organisms usually cause no problems, but barnacles can cut through the urethane transducer face causing failure to the transducer and leakage into the ADCP. Therefore, you should take steps to prevent biofouling during shallow water deployments.

Some organizations may decide to use antifouling grease. However, most antifouling greases are toxic and may cause problems. Recent tests suggest antifouling grease may cause the urethane on the transducer faces to develop cracks. Warmer temperatures accelerate this effect. If using antifouling grease, remove the grease immediately after recovering the ADCP from its deployment. Remove the grease with soapy water because cleaning solvents may also cause the urethane to crack. Be sure to wear protective gloves and a face shield.

The best-known way to control biofouling is cleaning the ADCP transducer faces often. However, in many cases this is not possible. The following options can help reduce biofouling.

a. Cover the transducer face using the recommended antifouling paint.

b. Apply a thin coat (≈4 mm, ≈0.16 in.) of either a 50:50 mix of chili powder and Vaseline or chili powder and silicone grease to the transducer faces. The chili powder should be the hottest that can be found. Water flowing across the transducers will wash this mix away over time. The silicone mixture tends to last longer.

c. Using an acoustic window over a sea chest filled with fresh water (see the Installation Guide). The drawback to this method is that it reduces the range of the ADCP.

CAUTION. If using antifouling grease, remove it immediately after recovering the ADCP.

Antifouling grease is toxic. Read the product safety data sheet before using the grease. Wear gloves and a face shield when applying the grease. If the skin comes in contact with the grease, immediately wash the affected area with warm, soapy water.

Do not coat the transducer face with paints such as copper, chrome, or arsenic. These paints advance the corrosion of the aluminum case and transducer assembly.

All US coastal states prohibit the use of tributyl-tins (TBT) paint. The European economic commission has released a draft directive that would prohibit the use of many organo-tins after July 1989. We strongly recommend you obey your local laws.

Never use anti-foulant paints containing copper. They will cause the urethane to separate from the transducer.

9.1 Antifouling Paint Recommendations

RDI no longer recommends the use of Nopcocide for the prevention of biofouling. At present, we recommend the following antifouling paint manufacturer, paint brand, and preparation procedures for all ADCPs.

Manufacturer	Contact
Courtalds Finishes	Telephone: 908-686-1300
Interlux brand paints	Web Page: www.interlux.com

9.2 Brass and Bronze Instruments

Use the following procedure on instruments with brass and bronze cases.

Metal Surfaces

a. Metal Surface Preparation

1. Sand metal surfaces with 60-grit paper to expose clean metal.
2. Clean surface with 353/354 Vinylux solvent (thin with 355 as needed). Perform the Metal Surface Application (Step (b), below) between 1 and 24 hours.

b. Metal Surface Application

1. Apply a barrier coat of 360R Underwater Metal Primer to all exposed brass. Allow the primer to dry for 5 to 8 hours before proceeding.
2. Mask as necessary to avoid having the cuprous oxide antifouling paint come in contact with any bare metal surfaces.
3. Apply cuprous oxide 669 antifouling paint as desired. If more than one coat is used, allow each coat to dry for 16 hours.

Transducer Face

a. Surface Preparation - Lightly sand by hand with 120-grit paper.

b. Surface Application

1. Mask as necessary to avoid having the cuprous oxide antifouling paint come in contact with any bare metal surfaces.
2. Apply a thin barrier coat of 360R Underwater Metal Primer. Allow the primer to dry for 5 to 8 hours before proceeding.
3. Apply cuprous oxide 669 antifouling paint. Do not exceed the maximum thickness specified in Table 2, page 15. If more than one coat is needed to reach the maximum thickness, allow each coat to dry for 16 hours.

Table 2: Recommended Maximum Thickness Of Cuprous Oxide 669 Paint

System Frequency	Maximum Paint Thickness*
38 kHz	1.00 mm (0.040 in.)
75 kHz	1.00 mm (0.040 in.)
150 kHz	0.50 mm (0.020 in.)

NOTE. Cuprous oxide 669 is a high-density paint. As such, using it will slightly degrade ADCP performance. Exceeding these recommended maximum thickness would further degrade performance.

CAUTION. Read the Material Safety Data Sheet before using any of the listed solvents and paints.

Do not arbitrarily use antifouling paints for deep-water applications. For shallow-water applications, using antifouling paints may be appropriate if you cannot clean the ADCP regularly (weekly). Be aware that antifouling paints can accelerate the corrosion of aluminum housings, and can initiate dezincification corrosion of brass. Once initiated, dezincification will rapidly destroy the transducer.

Some antifouling coatings may not be legal for use in all areas. Check with your local environmental agency before using the antifouling paint.

10 Storage and Shipping Maintenance

This section lists the maintenance items to do before storing the ADCP. These maintenance items include

- Cleaning the ADCP with fresh, soapy water and rinse thoroughly.
- Removing biofouling
- Inspecting the transducer head
- Inspecting/replacing the O-rings
- Preparing the ADCP for final storage or shipping

10.1 Removal of Biofouling

Before storing or shipping the ADCP, remove all foreign matter and biofouling. Remove soft-bodied marine growth or foreign matter with soapy water. Waterless hand cleaners remove most petroleum-based fouling. Rinse with fresh water to remove soap residue. Dry the transducer faces with low-pressure compressed air or soft lint-free towels.

> ⚠ **CAUTION.** The soft, thin urethane coating on the transducer faces is easily damaged. Do not use power scrubbers, abrasive cleansers, scouring pads, high-pressure marine cleaning systems, or brushes stiffer than hand cleaning brushes on the transducer faces.

If there is heavy fouling or marine growth, the transducer faces may need a thorough cleaning to restore acoustic performance. We do recommend removal of the barnacles to prevent water leakage through the transducer face, and to keep the shells from trapping air, which will block the signal. Lime dissolving liquids such as Lime-Away™ break down the shell-like parts. Scrubbing with a medium stiffness brush usually removes the soft-bodied parts. Scrubbing, alternated with soaking in Lime-Away™, effectively removes large barnacles. After using Lime-Away™, rinse the ADCP with fresh water to remove all residues. If barnacles have entered more than 1.0-1.5 mm (0.04-0.06 in.) into the transducer face, you should send the ADCP to us for repair. If you do not think you can remove barnacles without damaging the transducer faces, contact RDI.

10.2 Final Storage or Shipping Preparation

This section explains how to store or ship the ADCP.

Clean and inspect the I/O connector and dummy plug for water or salt residue. Clean the I/O cable O-rings (bore and face). Install the dummy plug to protect the I/O connector from damage and dust.

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

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

11 Returning ADCPs to RDI for Service

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

11.1 Domestic Shipments

Step 1 - Get a Return Authorization

The best way to make sure RDI is aware of your intentions to ship equipment is to obtain a Return Authorization (RA) before sending the shipment. Return Authorizations are issued by Sales Administration or Customer Service and are used to notify us of your needs in advance of arrival so we can provide a faster turnaround. When requesting a Return Authorization, please give us the following information.

- What is being shipped (include the serial number)
- When you plan to send the shipment
- What problem(s) need correction
- When you need the instrument returned

When the Return Authorization is issued, we will tell you the RA number. Please include this number on all packages and correspondence.

Step 2 - Ship via air freight, prepaid

CAUTION. Never ship the Workhorse with lithium batteries inside. Lithium batteries must be packaged and shipped according to the hazardous materials regulations of the International Air Traffic Association (IATA) via Air Cargo only.

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

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

Mark the Package(s)

To: RD Instruments, Inc. (RA Number)
9855 Businesspark Avenue
San Diego, CA 92131-1101

Step 3 - Urgent shipments

Send the following information by fax or telephone to RDI.

Attention: Sales Administration
Fax: (858) 695-1459
Phone: (858) 693-1178

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

11.2 International Shipments

Step 1 - Get a Return Authorization

The best way to make sure RDI is aware of your intentions to ship equipment is to obtain a Return Authorization (RA) before sending the shipment. Return Authorizations are issued by Sales Administration or Customer Service and are used to notify us of your needs in advance of arrival so we can provide a faster turnaround. When requesting a Return Authorization, please give us the following information.

- What is being shipped (include the serial number)
- When you plan to send the shipment
- What problem(s) need correction
- When you need the instrument returned

When the Return Authorization is issued, we will tell you the RA number. Please include this number on all packages and correspondence.

Step 2 - Ship Via Air Freight, Prepaid

CAUTION. Never ship the Workhorse with lithium batteries inside. Lithium batteries must be packaged and shipped according to the hazardous materials regulations of the International Air Traffic Association (IATA) via Air Cargo only.

Urgent Shipments should be shipped direct. Do not send urgent airfreight as part of a consolidated shipment. If you ship consolidated, you will save money, but may lose up to five days in transit time.

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

Mark the package(s) as follows:

To: **RD Instruments, Inc. (RA Number)**
9855 Businesspark Avenue
San Diego, CA 92131-1101 USA
C/O: **Paxton, Shreve & Hays**
Lindbergh Field, San Diego Airport
2361 Airlane Drive, #D
San Diego, CA 92101

Notify upon arrival
Phone: 858-692-3113
Fax:858-692-0539

Step 3 - Include Proper Customs Documentation

The Customs statement should be completed very carefully. It should accurately and truthfully contain the following information.

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

Step 4 - Send the Following Information by Fax or Telephone to RDI

Attention: Sales Administration
Fax: (858) 695-1459
Phone: (858) 693-1178

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

NOTES

Ocean Surveyor

Test Guide

P/N 95A-6027-00 (January 2001)

RD Instruments
Acoustic Doppler Solutions

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Ocean Surveyor Test Guide

1 Introduction

This guide explains how to test the Ocean Surveyor. *DumbTerm* thoroughly checks the Ocean Surveyor in a laboratory environment, but is no substitute for the Sea Acceptance Tests. You should do the Dock Side tests:

- When you first receive the ADCP.
- Before and after each deployment or every six months.
- When you suspect instrument problems.

These test procedures assume all equipment is working. The tests can help you isolate problems to a major functional area of the ADCP. For trouble-shooting information, see the Troubleshooting Guide.

2 Dock Side Tests

The following checks should occur at Dock Side prior to performing the Sea Acceptance Tests. These tests will verify the Ocean Surveyor ADCP is ready for the Sea Acceptance Tests and confirm the peripherals attached to the ADCP.

NOTE. Compare future tests to the Dock Side test results. If large changes have occurred, check to see if changes have been made to the installation (i.e. a new sonar device installed, the Ocean Surveyor transducer cable or electronic chassis was moved). **Changes in the test results do not necessarily mean that the system is failing, but do require further investigation.** Perform the Sea Acceptance tests (see "Sea Acceptance Tests," page 7) to fully evaluate the system performance.

2.1 Dock Side Diagnostic Tests

The Ocean Surveyor ADCP interfaces directly to the computer and to external gyros. The following tests will confirm the connection of the Ocean Surveyor Electronics Chassis to the Transducer.

Table 1: Dock Side Test Setup

Setup	Description
Platform/Vessel	The vessel should be tied to the dock or at anchor. The transducer should be in water. All other sonar devices and equipment should be turned off.
Ocean Surveyor	The Ocean Surveyor ADCP electronics chassis should be connected to the transducer, and AC Power connected to the electronics chassis. The Gyro connection may or may not be connected at this point.
Computer	The RDI *DumbTerm* program should be running, communications port setting (F5) to match the connection to the PC and Ocean Surveyor ADCP baud rate requirements (default 9600,N,8,1).

Use the following steps to interconnect the Ocean Surveyor system and to place the ADCP in a known state.

a. Interconnect and apply power to the system as shown in Figure 1, page 3.

b. Start the *DumbTerm* program.

c. Press **<F2>** and run the script file TestOS.txt. The results of the tests will be printed to the screen and saved to the log file OS_RSLTS.txt. The OS_RSLTS.txt file will be created in the same directory that *DumbTerm* is running from. See “DumbTerm Test Results,” page 3 for information on the test results.

NOTE. Print and save a copy of the OS_RSLTS.txt file. Use these test results as a “baseline” value for future comparison of the PT test values.

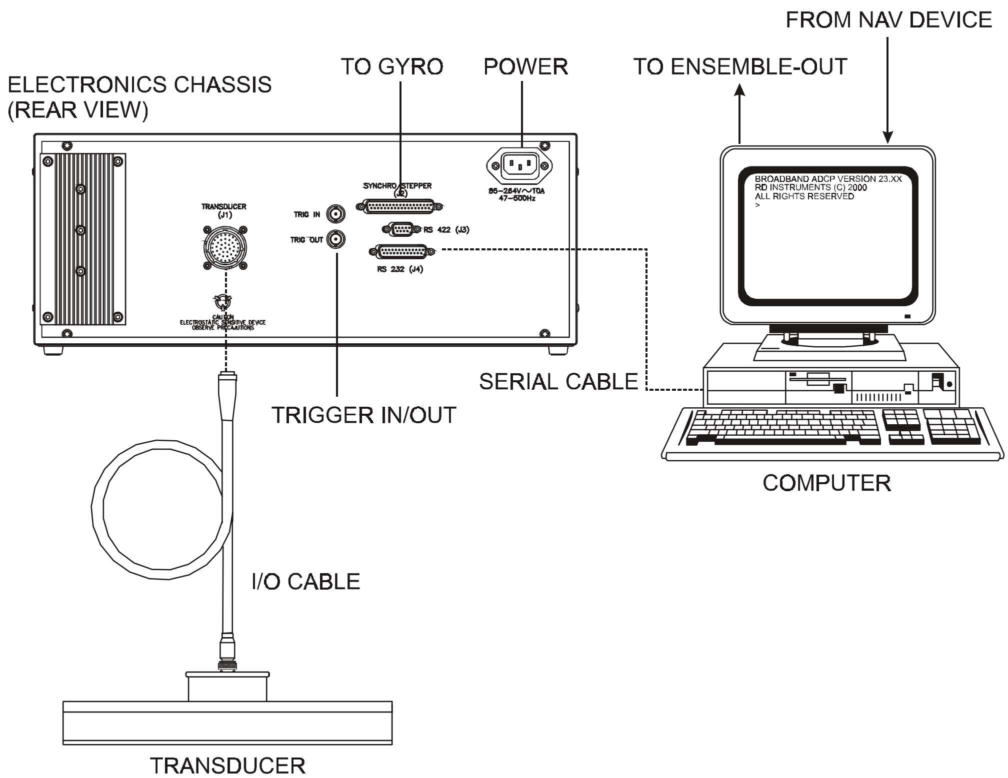

Figure 1. Ocean Surveyor Connections

2.2 DumbTerm Test Results

This section shows an example of the OS_RSLTS.txt printout after running the *DumbTerm* script file TestOS.txt.

NOTE. The built-in tests require you to immerse the transducer faces in water. If you do not, some of the tests may fail.

NOTE. Do not place the electronic chassis within 3 feet of a computer monitor. Monitors are a major source of electronic interference.

2.2.1 Display System Parameters

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

```
>PS0
Frequency:  38400 HZ
   Configuration:  4 BEAM, JANUS
 Transducer Type:  PHASED ARRAY
      Beam Angle:  30 DEGREES
    Beam Pattern:  CONVEX
     Orientation:  DOWN
    CPU Firmware:  14.04
     Temp Sensor:  STANDARD
 Attitude Sensor:  NONE
```

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

2.2.2 Interference Verification Test

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

NOTE. Compare these test results with the dockside tests done when the system was first installed.

```
>PT3
Correlation Magnitude:
      Lag     Bm1       Bm2       Bm3       Bm4
       0      1.00      1.00      1.00      1.00
       1      0.74      0.67      0.66      0.69
       2      0.31      0.36      0.36      0.30
       3      0.11      0.14      0.15      0.11
       4      0.12      0.09      0.11      0.11
       5      0.07      0.04      0.01      0.01
       6      0.03      0.07      0.05      0.02
       7      0.04      0.05      0.10      0.06

RSSI: 4 7 6 4
```

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

NOTE. PT3 Test is considered to have passed if the correlation values at lag 5 and greater are less than 0.50.

2.2.3 Bandwidth Verification Test

This test measures the receive bandwidth of the system.

NOTE. Compare these test results with the dockside tests done when the system was first installed.

A message similar to the following should appear.

```
>pt6
Receive Bandwidth:
........................................
  Expected      Bm1    Bm2    Bm3    Bm4
  --------     -----  -----  -----  -----
     3840       3922   3792   3766   3895
```

NOTE. The PT6 Test is considered to have passed if the received bandwidth for each beam is within ± 20% of the expected bandwidth.

2.3 Dock Side Peripheral Tests

The Ocean Surveyor requires (at minimum) input for heading (true north) and for position fixes (GPS). Additionally, the Ocean Surveyor can make use of pitch and roll data to correct for the tilt.

Heading can be input directly to the Ocean Surveyor electronics chassis through an external synchro gyro or stepper gyro. Heading can also (or instead of) be input and combined with Ocean Surveyor data in the computer software *VmDas*. This heading input is done through the communications port of the computer with the NMEA 0183 string $HDT or $HDG as specified in the **Transforms** tab in *VmDas*.

If the gyro connection is used for the heading input, then the Gyro Interface Board must be first configured to match the platform's gyro output. Follow the instructions in the Installation Guide on how to setup the Gyro Interface Board.

Pitch and Roll data can be input directly to the Ocean Surveyor electronics chassis through an external synchro gyro. Pitch and Roll can also (or instead of) be input and combined with Ocean Surveyor data in the computer software *VmDas*. This pitch/roll input is done through the communications port of the computer with the RDI proprietary NMEA string $PRDID.

Navigation data can only be combined with Ocean Surveyor data in the computer software *VmDas*. This navigation input is done through the communications port of the computer with the NMEA proprietary strings $GGA and $VTG.

Table 2: Dock Side Peripheral Tests Setup

Setup	Description
Platform/Vessel	The Gyro, Navigation, and Pitch/Roll sensors should be attached to the appropriate place on either the Ocean Surveyor electronics chassis or the computer communication port. The devices should be on and should be stable (in the case of gyros this may require a spin up time of up to 12 hours).
Ocean Surveyor	The Ocean Surveyor electronics chassis should be connected to the transducer, AC Power connected to the electronics chassis, and the power switch turned on.
Computer	The RDI *DumbTerm* program should be running, communications port setting (F5) to match the connection to the PC and Ocean Surveyor ADCP baud rate requirements (default 9600,N,8,1).

Testing the Gyro Connections to the Electronic Chassis

The following sequence of commands should be sent after powering up the Ocean Surveyor electronics chassis. These commands will wake up the ADCP (<BREAK>), initialize the Ocean Surveyor (CR1), and save the initialization (CK).

```
<BREAK> press the end key
CR1
CK
```

The following command should be sent to test the gyro input to the Ocean Surveyor electronics chassis.

```
PC2
```

The response from the ADCP should be as follows:

```
>PC2
Heading          Pitch      Roll        Temperature
 (ext)           (ext)      (ext)       cts     degs
 000.0           +00.0      +00.0       243E    23.9
```

Testing the Navigation Connections to the Computer

Start *VmDas* in the Data Collect mode (see the *VmDas* User's Guide). On the **View** menu, select **Nmea Communications**. Confirm that the Navigation Device NMEA string is viewable and the $GGA string is present.

The **Navigation Data** window (see Figure 2) shows a text box of the position and velocity data from a NMEA navigation device. You can use this to verify the navigation connections.

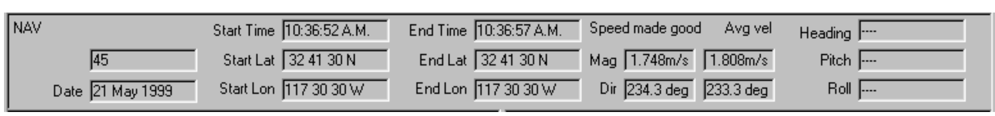

Figure 2. Testing the Navigation Connections

Testing $HDG Heading Connections to the Computer

Start *VmDas* in the Data Collect mode. On the **View** menu, select **Nmea Communications**. Confirm that the Navigation Device NMEA string is viewable and the $HDG string is present. Note that the data for this information may appear on the same communications port as the navigation data or on a separate input port.

Testing $PRDID Heading Connections to the Computer

Start *VmDas* in the Data Collect mode. On the **View** menu, select **Nmea Communications**. Confirm that the Navigation Device NMEA string is viewable and the $PRDID string is present. Note that the data for this information may appear on the same communications port as the navigation data or on a separate input port.

Table 3: Dock Side Peripheral Test Results

Test	Test Criterion
External Gyro Connection Test	Verify that the Gyro inputs for Heading, Pitch and Roll (if included) are reasonable for the platform's attitude. The Temperature reading should match the expected water temperature at the transducer.
External Heading NMEA Connection Test	Verify that the Navigation Device NMEA string is viewable and the $GGA string is present.
External Heading NMEA Connection Test	Verify that the Navigation Device NMEA string is viewable and the $HDT or $HDG string is present.
External Heading NMEA Connection Test	Confirm that the Navigation Device NMEA string is viewable and the $PRDID string is present.

3 Sea Acceptance Tests

This procedure is intended to test the Ocean Surveyor at sea. This procedure assumes that the Dock Side Testing (see "Dock Side Tests," page 1) procedure has been run and that all of the items have passed or been confirmed to be operational. The following tests will not obtain favorable results unless all of this work has been performed.

The reason for Sea Acceptance Testing is that although the Dock Side Tests confirm the Ocean Surveyor is operational, they do not confirm that the system is able to perform to its specifications. The performance of any ADCP relies greatly upon the installation into any platform. Therefore, the system must be tested at sea to understand the effects of the platform on the ADCP performance.

At sea testing includes tests for Acoustic Interference, Profiling Range, and Profiling Reasonableness testing. For each of these tests the following Equipment and ADCP setup requirements are recommended.

Equipment Required

- Ocean Surveyor 38kHz, 75kHz, or 150kHz ADCP with firmware 23.xx or greater
- Computer
- *VmDas* Program
- *WinADCP* Program
- Navigation Interface Connected
- Heading Interface Connected

VmDas Setup

a. Start *VmDas*. On the **File** menu, click **Collect Data**. On the **Options** menu, click **Load**. Select the Default.ini file and click **Open**.

b. On the **Options** menu, click **Edit Data Options**. Click the **ADCP Setup** tab. Set the **Ensemble Time** to the value shown in Table 4.

Table 4: Ensemble Time

Frequency (kHz)	With Bottom Track (sec)
38	6
75	3
150	2

c. On the **ADCP Setup** tab, select **Use File**. Use Table 5 to choose a command file for your ADCP, and load it into *VmDas* using the **Browse** button.

Table 5: Command Files

File Name	Description
OS38**NB**DEF	Default setup for an OS 38kHz ADCP in the lowest precision (narrow bandwidth) but extended range profiling mode.
OS75**NB**DEF	Default setup for an OS 75kHz ADCP in the lowest precision (narrow bandwidth) but extended range profiling mode.
OS150**NB**DEF	Default setup for an OS 150kHz ADCP in the lowest precision (narrow bandwidth) but extended range profiling mode.

NOTE. These files can also be used for stationary systems (such as Oil Rig platforms) but you must first open the file (right click on file and select open) and modify the EZ command from EZ1020001 to EZ1111111. This new setting will enable the use of the internal heading, pitch, and roll sensors.

d. On the **Options** menu, click **Edit Data Options**. Click the **Averaging** tab. Set the **Short Term Average** to 300 seconds (5 minutes). Set the **Long Term Average** to 600 seconds (10 minutes).

3.1 Interference Test

The Ocean Surveyor transmits and receives acoustic signals from the water. If other sonar devices are operating on the platform at the same time as the ADCP it is possible for those signals to bias the ADCP data. Therefore, all ADCPs must be tested to ensure that they are not receiving interference from other sonar equipment on board the vessel.

The following Interference Test will determine if there is interference from other devices on board the vessel.

3.1.1 Interference Test Platform Test Setup

This test requires that the platform be in water deeper than the ADCP's maximum expected profiling range. Use the following table to determine the minimum water depth required.

Table 6: Interference Test Minimum Water Depth Requirement

OS 38 ADCP	OS 75 ADCP	OS 150 ADCP
1200 meters	1000 meters	600 meters

The platform speed for this test is drifting. The motors may be running if required for platform safety. The test sequence starts with ALL sonar and non-essential electronic equipment turned off. Only the ADCP should be on for the first test. This test establishes a base line for the interference and is critical to the rest of the tests. After a 10-minute period the first sonar device is turned on, transmission started, and the data is reviewed for interference terms. At the end of this 10-minute period the first sonar device is turned off and than the next sonar device is turned on and started pinging for 10 minutes. This process repeats for each of the sonar devices.

3.1.2 Interference Test Computer Screen Display Setup

View the RAW data (*.ENR files) being collected by the *VmDas* program in the *WinADCP* program contour plots for echo intensity data. This data will show the single ping return levels.

3.1.3 How to Identify Interference

If there is an interference term, the echo intensity data will show spurious echo intensity spikes. An example of what an interference term may look like what is shown in Figure 3, page 10.

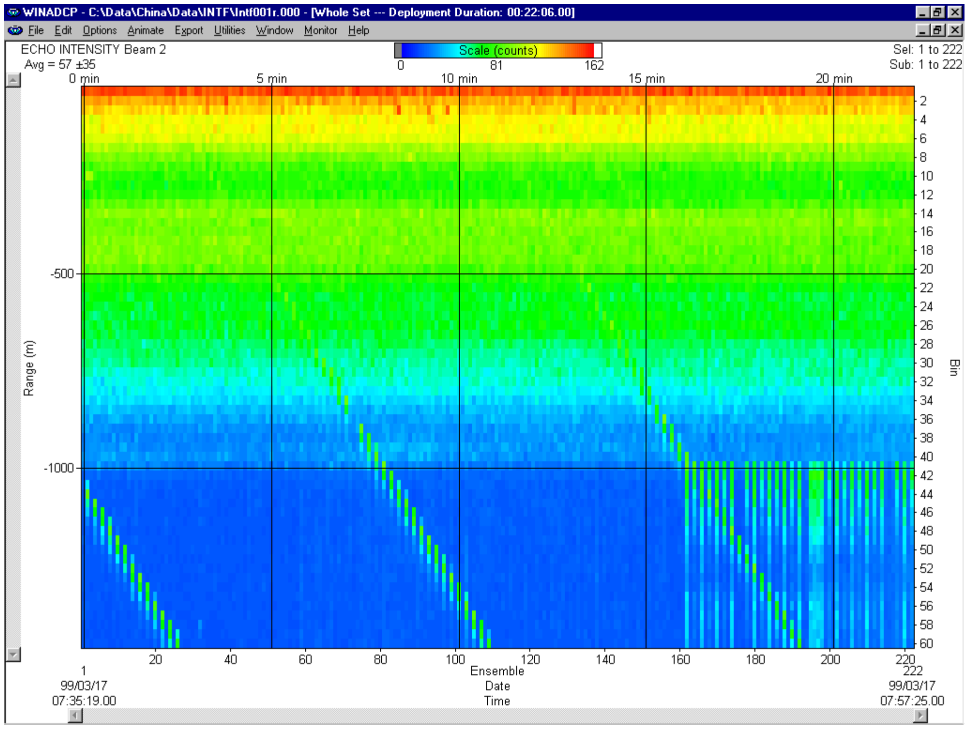

Figure 3. Interference Test

The interference term appears as the periodic green blocks in the data set. The interference is some what lost in the upper part of the profile however it can be clearly seen once the system reaches the noise floor (the point where signals are no longer being returned from the water).

NOTE. Interference terms such as above seen anywhere in the echo intensity profile data will result in a bias to the ADCP data.

NOTE. Figure 3 is shown in color in the electronic documentation.

3.2 Water Profile Range Test

The range of any ADCP is directly dependent on the level of backscattering material in the water, the transmit power into the water, the received sensitivity, and the level of the background noise. Each of these effects the range of the system in different ways, but in the end can result in reduced or extended range as follows.

- The ADCPs transmit power and receive sensitivity are fixed based on the transducer frequency. However, these may be affected by installation of an acoustic window in front of the transducer. A window will absorb both sound transmitted by the ADCP and the sound returned from backscatter in the water.

- The volume of the backscatter in the water will affect the range. All specifications for range assume that there is a certain amount of backscatter in the water. The backscatter volume is not controllable in any way.
- The background noise changes as the platform's speed increases or decreases. There are two types of noise created by the moving platform; first, there is the noise due to propeller and engines; and second, there is the noise created by the rushing water across the platform and ADCP transducer.

This test is used to determine the effects of the background noise on the range of the ADCP. This information can be used to determine the optimum speed of the platform to obtain the desired range required.

3.2.1 Water Profile Range Platform Test Setup

This test requires that the platform be in water deeper than the ADCP's maximum expected profiling range. Use the following table to determine the minimum water depth required.

Table 7: Water Profile Range Test Minimum Water Depth

OS 38 ADCP	OS 75 ADCP	OS 150 ADCP
1200 meters	1000 meters	600 meters

The platform course for this test is a continuous straight line. The speed of the platform will be varied during this test. At each speed, the system will be set to collect data for a minimum of 10 minutes. The following table lists the recommended speeds.

Table 8: Water Profile Range Test Platform Speed

Test #	Speed
Speed 1	Drifting
Speed 2	3 knots
Speed 3	6 knots
Speed 4	9 knots
Speed 5	12 knots
Speed 6	Maximum Speed

3.2.2 Water Profile Range Computer Screen Display Setup

View the Tabular Display of the Long Term Average data (10 minute averages) in the *VmDas* program.

3.2.3 How to Determine the Maximum Range of the ADCP

The data collected in the long-term average (10 minutes) tabular display will be used to determine the maximum range of the ADCP. The maximum profiling range of the system is determined by locating the last valid bin and then using that ping to determine the range. To determine the last valid bin the following criterion is used:

- The last bin must be above the bottom side lobe area
- The bin must have a percent good value above 25%
- The correlation value for at least 3 beams must be above the threshold of 120 counts

Locate the last valid bin for each of the speeds and fill in the table below.

Platform Speed	Last Valid Bin Number	Range to Last Bin	Average RSSI Value at Last Bin

Notes:

- Platform Speed must be input as a measurement from the Bottom Track (if in range) or the GPS speed.
- Range to Last Bin is found in the *VmDas* Tabular display or is calculated as follows: ((bin size) * (last bin number)) + (NF command)
- Average RSSI Value at Last Bin is the average of the 4 beams RSSI values in the last bin number

The results from the above test should be compared to the specified nominal range of the system. Assuming that there are sufficient scatterers in the water, the acoustic window is not attenuating the signal, and that that the platform background noise is variable there should be a speed at which the nominal range of the system is obtained.

3.2.4 Water Profile Range Test Results

Through the results of this test, determine the platform speed in which the range to the last valid bin obtained the specified nominal range of the ADCP frequency being used.

If it was not possible to reach the specified nominal range during the Water Profiling Range test, then determine the speed at which it allowed the best range possible. Calculate the percentage of the nominal range that was obtained by the system.

3.3 Ringing Test

The ADCP transmits an acoustic pulse into the water. The main lobe of this pulse bounces off particles in the water and the signals returned from these particles are used to calculate the velocity of the water. The main lobe of the transmitted pulse is what we are using to process and calculate a velocity. The transmitted pulse, however, is made up of many side lobes off the main lobe. These side lobes will come in contact with metal of the transducer beam itself and other items in the water.

The energy from the side lobes will excite the metal of the transducer and anything bolted to the transducer. This causes the transducer and anything attached to it to resonate at the system's transmit frequency. We refer to this as "ringing." If the ADCP is in its receive mode while the transducer is ringing then it will receive both the return signals from the water and the "ringing." Both of these signals are then processed by the ADCP. The ringing causes bias to the velocity data.

All ADCPs "ring" for some amount of time. Therefore, each ADCP requires a blanking period (time of no data processing) to keep from processing the ringing energy. Each ADCP frequency has a different typical ringing duration. A blanking period (time of not processing data) is required at the beginning of each profile. The blanking distances required for the typical ringing period for each Ocean Surveyor frequency is shown in the following table.

Table 9: Required Blanking Distance

Frequency	Typical Blank Period for Ringing
38kHz	16 meters
75kHz	8 meters
150kHz	4 meters

Ringing will bias the velocity estimation to a lower value than it should be. However, when the platform motion is removed from the water profile data it will appear as a large velocity, which is the opposite of what it is really doing. This effect is caused because the vessel motion portion of the water profile data has been biased low.

3.3.1 Ringing Test Platform Test Setup

The key to success on this test is that the water velocity and direction not change over the entire test period of 120 minutes. This may be difficult to adhere to in regions with large tidal effects. The test requires that the platform be within the ADCP bottom tracking range so that valid bottom track can be used. Use the following table to determine the optimum water depth range required.

Table 10: Ringing Test Water Depth Requirement

OS 38 ADCP	OS 75 ADCP	Ocean Surveyor 150 ADCP
300-600 meters	200-400 meters	100-200 meters

Platform speed should be held to as fast a speed as possible without loosing any bottom tracking data for a period of 30 minutes. Typically, this will be a speed of 6-9 knots. Some experimentation may be required to find the maximum bottom track speed for the given depths above.

3.3.2 Ringing Test Computer Screen Display Setup

The Magnitude and Direction Profile Display of the Long Term Average data (10 minute averages) will be viewed in the *VmDas* program.

3.3.3 How to Determine the Ringing Test Results

Viewing the Long Term average of the magnitude and direction profile data, look for unreasonable shears from bin 1 to bin 2 to bin 3 and so on. If an unreasonable shear is seen, this is most likely ringing and your blanking needs to be increased by the following formula:

(bin size) * (last bin number with ringing) * 0.80

*The total blanking period is typical blanking period plus the increased blanking period required. The above value should be used to change both the NF and WF commands in all configuration files for this ADCP.

3.4 Water Profile Reasonableness Test

The mounting alignment of the Ocean Surveyor transducer to the relative position of the heading input from the vessel is critical in the velocity estimates made by the ADCP. If either of these are not known and corrected for, it will result in both directional and velocity estimate errors in the water velocity data.

It is possible to confirm if the transducer alignment is correct by collecting data over the same water in several different directions. If the transducer is properly aligned, then both the magnitude and direction of the currents will appear the same in all directions that the platform travels.

3.4.1 Water Profile Reasonableness Platform Test Setup

The key to success on this test is that the water velocity and direction not change over the entire test period of 120 minutes. This may be difficult to adhere to in regions with large tidal effects. The test requires that the platform be within the ADCP bottom tracking range so that valid bottom track can be used. Use the following table to determine the optimum water depth range required.

Table 11: Water Profile Reasonableness Water Depth Requirement

OS 38 ADCP	OS 75 ADCP	OS 150 ADCP
300-600 meters	200-400 meters	100-200 meters

Platform speed is held at a constant 5 knots during the entire course. The course for this test contains 4 legs. Each leg must be approximately 4500 meters (except for leg 2 which will be one half the length of each of the other legs). The course will appear as shown in Figure 4. The actual starting direction is not critical as long as the course completes the pattern shown in Figure 4.

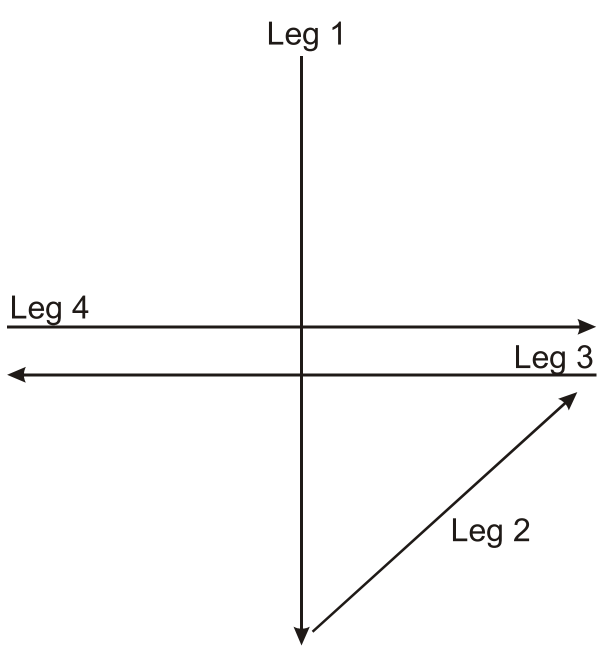

Figure 4. Water Profile Reasonableness Course

3.4.2 Water Profile Reasonableness Display Setup

View the *VmDas* Ship Track display of bin 3 with the bottom track reference. The Short Term Average (5 minute averages) data should be viewed.

3.4.3 How to Determine Water Profile Reasonableness

A pass condition is if the velocities in each of the ship track plotted directions has reasonably the same magnitude and direction. It is common to see some wild velocity magnitude and directions during turns. This happens as a result of the effects of the turn on the gyro heading device or the latency of the heading updates for a GPS heading input.

If the direction of the currents is not the same in each of the four directions, then it will be necessary to enter in a transducer misalignment angle. Changing the transducer alignment angle and playing back the same data file again allows you to determine the misalignment angle. The best way to perform this check out is to use incremental change of 1-5 degrees at a time.

Assuming that the misalignment angle was not required or could be determined, it is now possible to use the same data just collected to determine how reasonable the navigation data input is. Change the data display reference from bottom track to the navigation data in the *VmDas* program. There should be little to no change in the velocity magnitude and direction if the navigation data is a valid input for a reference.

3.5 Bottom Tracking Test

The bottom tracking capability of the ADCP varies depending on the type of bottom (hard, soft, rock, sand, etc.), the slope of the bottom, and the speed of the vessel (background noise).

Before testing the Bottom Track capabilities, the Water Profiling Range Test must be performed (see "Water Profile Range Test," page 10). Use the speed that allowed the nominal water profile range to be obtained or the maximum range if the nominal range was not obtained.

3.5.1 Bottom Tracking Platform Test Setup

The key to this test is to operate the system in an area where both the minimum and maximum bottom tracking range can be obtained. The platform will travel over water that is very shallow (<10 meters) to very deep (greater than the maximum bottom track range). It does not matter if the water starts deep and goes shallow or vice-versa.

The course of the platform should be a relatively straight line. The platform speed should be no greater than the velocity recorded in the Water Profiling Range Test.

3.5.2 Bottom Tracking Computer Screen Display Setup

View the raw data display of the *VmDas* bottom track display window.

3.5.3 How to Determine Bottom Tracking Reasonableness

Viewing the bottom track velocity data, record the maximum and minimum average of the bottom track depths in the table below.

Beam Number	Minimum Depth (meters)	Maximum Depth (meters)
Beam 1		
Beam 2		
Beam 3		
Beam 4		

A pass condition is if the maximum depth of the system is equal to the specification for the nominal bottom track range.

> **NOTE.** If the system was not able to water profile to the nominal range, then the bottom track range should be reduced to no more than the same percentage as the water profile loss.
>
> If the Bottom Track **did** obtain the complete range and the Water Profile **did not**, then it is likely that there is insufficient backscatter in the water to obtain the specified range.

4 How to Contact RD Instruments

If you have technical problems with your instrument, contact our field service group in any of the following ways:

RD Instruments

9855 Businesspark Ave.

San Diego, California 92131

(858) 693-1178

FAX (858) 695-1459

Sales - rdi@rdinstruments.com

Field Service - rdifs@rdinstruments.com

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06610 La Gaude, France

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rdi@rdieurope.com

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Web: www.rdinstruments.com

NOTES

Ocean Surveyor

Troubleshooting Guide

P/N 95A-6021-00 (January 2001)

RD Instruments

Acoustic Doppler Solutions

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Ocean Surveyor Troubleshooting Guide

1 Introduction

The provided information assumes that faults are isolated with a large degree of certainty to a least replaceable assembly (LRA) level only. Considering the complexity of the Ocean Surveyor, it is RD Instrument's intention to provide as much information as practical for field repair; fault location to the component level is beyond the scope of these instructions. The mean time to repair the system will be minimized if an entire replacement unit is available in the field. If time to repair is of essence, RD Instruments strongly advises the availability of the listed LRAs.

Table 1: List of Least Replaceable Assemblies

LRA	Description:
Electronics Chassis	The Electronics Chassis contains all electronics necessary to supply power, provide user communication and interface, transmit and receive signals, interfaces to sensors, and process data.
Transducer Cable	Connects the transducer with the Electronics Chassis.
Transducer	The entire transducer, includes the transducer electronics, transducer housing, transducer ceramic assemblies, and connector.

Since these LRAs are manufactured in different configurations, please contact RD Instruments (see "Technical Support," page 12 for contact information) to obtain the correct part number for your specific system configuration. When contacting RD Instruments about a replacement assembly, please provide the serial numbers of the Transducer and Electronics Unit. If you want to replace the Transducer Cable only, then please provide the cable length and connector style (straight or angled) for both the Underwater Transducer Connector and the Dry-side Electronics Chassis Connector.

1.1 Equipment Required

Special test equipment is not needed for trouble shooting and fault isolation. The required equipment is listed in Table 2. Any equipment satisfying the critical specification listed may be used.

Table 2: Required Test Equipment

Required Test Equipment	Critical Specification
DMM	Resolution: 3 ½ digit
	DC-Voltage Range: 200 mV, 2V, 20 V, 200V
	DC-Voltage Accuracy: ± 1%
	AC-Voltage Range: 200 V, 450 V
	AC-Voltage Accuracy: ± 2%
	Resistance Range: 200, 2 k, 20 k, 200 k, 20 MOhm
	Res.-Accuracy: ± 2% @ 200 Ohm to 200 kOhm
	Res.-Accuracy: ± 5% @ 20 MOhm
	Capacitance Range: 20 nF, 2 uF, 20 uF
	Capacitance Accuracy: ± 5%
Serial Data EIA Break-Out Box such as from International Data Sciences, Inc. 475 Jefferson Boulevard Warwick, RI 02886-1317 USA.	Model 60 or similar is recommended as it eases the troubleshooting of RS-232 communication problems significantly. Other manufacturers or models may be substituted.

NOTE. The EIA Break-out Panel is not absolutely necessary but eases RS-232 communication problems troubleshooting significantly.

1.2 Basic Steps in Troubleshooting the Ocean Surveyor

The first step in troubleshooting is determining what type of failure has occurred. In principal, there are four types of failure classes:

- Communication failure
- Built-In Test (BIT) or other electronics failure
- Beam failure
- Sensor failure

Communication failures involve the host computer, the Ocean Surveyor Electronics Chassis, and the serial communication cable. The symptoms may include that the system is not responding, or does not respond in a proper fashion (for example “garbled” text).

BIT failures will appear when the system diagnostics are run. Use RD Instruments software utility *DumbTerm* to identify the failing test.

Beam failures can be identified when collecting data or when the system diagnostics are run.

Sensor tests can also be identified when collecting data or during the user-interactive performance tests. The sensor may send incorrect data or is not identified by the system.

2 Troubleshooting

Although the Ocean Surveyor is designed for maximum reliability, it is possible for a fault to occur. This section explains how to troubleshoot and fault isolate problems to the LRA level. Before troubleshooting, review the procedures, figures, and tables in this book. Also, read the “System Overview,” page 18 to understand how the Ocean Surveyor processes data.

CAUTION. Under all circumstances, follow the safety rules listed in “Troubleshooting Safety,” page 4.

2.1 Troubleshooting Safety

Follow all safety rules while troubleshooting.

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

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

CAUTION. If this instrument is supplied via an auto-transformer, make sure the common terminal is connected to the earth terminal of the power source.

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

CAUTION. Only fuses with the required rated current, voltage, and specified type must be used. Do not repair fuses or short circuit fuse-holders. To do so could cause a shock or fire hazard.

CAUTION. Do not operate the Ocean Surveyor Electronics Chassis in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

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

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

CAUTION. Do not attempt to open or service the power supply.

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

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

2.2 Troubleshooting a Communication Failure

Ocean Surveyor ADCPs communicate by means of two serial communication channels. The user can choose between RS-232 and RS-422 types of asynchronous serial interfaces by connecting to either J4 (RS-232) or J3 (RS-422) on the rear panel of the Electronics Chassis.

The Ocean Surveyor selects the user communications port simply by detecting on which channel it received its *Break* signal. From this point on forward, it uses that channel until it receives a new *Break* signal on the other channel.

To successfully communicate, both the host computer and the Ocean Surveyor must communicate using the same type of serial interface. Standard serial interfaces in IBM compatible computers are also RS-232. RS-422 communication requires an appropriate communications board for the host computer.

NOTE. If you are using a high baud rate and a long serial cable (greater then 15 meters) RS-232 may not work properly. Change to RS-422 and try to wakeup the Ocean Surveyor again.

2.2.1 Communication Failure Quick Checks

If you cannot communicate with the Ocean Surveyor (i.e., no wakeup message), you need to isolate the problem to a computer fault, power, communication cable failure, or an Electronic Chassis problem. Verify the following.

a. Connect the Ocean Surveyor to a computer according to the Ocean Surveyor Read This First Guide. Check that all cable connections are tight.

b. Make sure that Mains power to the host computer and the Ocean Surveyor is connected and has the proper voltage. Verify that the Ocean Surveyor front panel circuit breaker switch is in the ON position and that the power status LED next to the circuit breaker is lit. If power is present but the power status LED is not lit then you should check the power supply voltages inside the Electronic Chassis (see "2.2.7Checking the Power Supply," page 9).

c. Make sure that your computer and *DumbTerm* program are set up to use the communication port the serial cable is connected to on the electronic chassis.

NOTE. Most communication problems are associated with incorrect cabeling (i.e. the serial cable is connected to the wrong port) or data protocols (i.e. the wrong baud rate is set between the Ocean Surveyor and computer).

2.2.2 Checking the Serial Communications Channels

The following procedure checks the serial communications channels using an EIA Break-Out Box. If you do not have an EIA Break-Out Box, use "Checking the Serial Cable," page 7 to verify the communications. If you are using RS-422 serial communications, you can not use an EIA Break-Out Box. Use the "RS-422 Communication," page 6 checks to verify the communications.

a. If you are using RS-232 for your communications port, connect a serial data EIA Break-Out Box between the serial cable and the Ocean Surveyor Electronics Chassis.

b. Send a Break and verify via the LEDs on the Break-Out Box that the Break signal arrives at the proper pin at the Ocean Surveyor (see Figure 3, page 17). If it does, verify that the front panel LED marked RXD lights up temporarily.

   If the Break signal does not arrive at the proper pin or not at all, disconnect the serial cable from the Ocean Surveyor Electronics Chassis, and troubleshoot the communication channel between the host computer and that end of the serial communications cable.

   If the Break signal does arrive at the proper pin but the front panel RXD LED does not light up then there may be a problem with the Ocean Surveyor Electronics Chassis (see "Electronics Chassis Checks," page 8).

c. If the Break signal does arrive at the proper pin and the front panel LED labeled RXD lights up temporarily, this indicates the Break signal does arrive at the Ocean Surveyor Electronics Chassis.

   The Ocean Surveyor must now respond with a 'Wake-up" message. The front panel TXD LED should intermittently light up. If it does not, then there is most likely a problem with the Ocean Surveyor Electronics Chassis (see "Electronics Chassis Checks," page 8).

   If the TXD LED does light up then the Break-out Panel should receive the signal at the proper pin. If this is the case, then the Ocean Surveyor Electronics Chassis's data path seems in principal to be operational. If the wakeup message is not readable, check for a communication mismatch (see "Communication Mismatch," page 7).

2.2.3 RS-422 Communication

If you use the RS-422 port as your communications port, you can not use the Break-Out Box. Do the following checks to verify the RS-422 communication port is functioning.

a. In addition of having transmit and receive pairs interchanged, you may have also the "A" and "B" lines of the transmit and/or receive pair interchanged. Verify the communications cable connections according to the schematics provided (see Figure 3, page 17).

b. Check that the differential “A”-“B” receive pair are not interchanged (as seen from your host computer). Verify the communications cable connections according to the schematics provided (see Figure 3, page 17).

> **NOTE.** For the Ocean Surveyor ADCP, Channel A represents signals that start high and transition low. Channel B represents signals that start low and transition high.

c. When you send a *Break* and the data is not the Wake-Up message, you may have a Baud rate or parity mismatch between the Ocean Surveyor and the computer (see “Communication Mismatch,” page 7).

2.2.4 Communication Mismatch

The following conditions may indicate a communications mismatch.

- Sending a *Break* causes non-alphanumeric characters to appear on the screen that may keep scrolling. This may happen when the computer is using RS-232 and the Electronics Chassis is connected to the RS-422 port or vice-versa.
- Sending a *Break* causes non-alphanumeric characters to appear on the screen. These characters do not keep scrolling. Check that the ADCP and computer are both using the same baud rate (CB-command). See the Command and Output Data Format guide for a description of the CB commands.

2.2.5 Checking the Serial Cable

This test will check the serial communication cable between the computer and Ocean Surveyor *without* using an EIA Break-Out Box.

a. Disconnect both ends of the serial cable and measure the continuity using a DMM (see Figure 3, page 17 for the wiring diagram). Correct any problems found.

b. Reconnect the serial cable to host computer. Start the RD Instruments software utility program *DumbTerm* on your computer. Make sure to select the proper communications port (see the RDI Tools User's Guide).

c. For testing a RS-232 cable, jumper pins 2 and 3 at the far end of the cable. To check a RS-422 cable, connect one jumper between pin 2 to 4, and one jumper between pins 7 to 8.

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

e. If you use cables that are **not** supplied by RD Instruments you must make sure that transmit and receive pairs are not interchanged. The above loop-back test does not show if transmit and receive pairs are interchanged. Thus, it is important that you check the wiring diagrams provided in Figure 3, page 17.

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

f. If the keys are echoed correctly on the screen, the computer and the communication cable are most likely good. Re-connect the serial cable to the Ocean Surveyor electronic chassis. If the Ocean Surveyor still does not wakeup, there could still be a problem with the Electronic Chassis.

2.2.6 Electronics Chassis Checks

Once you have eliminated possible problems with the Ocean Surveyor system power, the serial data communication cable, and the host computer, that may leave the Ocean Surveyor Electronics Chassis as the source of the problem. Check the following conditions.

CAUTION. The Ocean Surveyor contains Electro Static Sensitive Devices. You must take accepted ESD prevention measures **before** opening the Ocean Surveyor electronics chassis.

a. One of the interconnecting cables between the Motherboard inside the Electronic Chassis may not be fully seated. Turn off power. Remove the top cover of the Electronic Chassis and check that all of the cables are properly seated.

b. Make sure power to the Ocean Surveyor is connected and that the circuit breaker is in the ON position. Verify that the power status LED indicator located at the front panel next to the circuit breaker switch is lit. If the LED is not on, skip to "2.2.7 Checking the Power Supply," page 9.

c. Reset the system by locating the push button switch S2 on the Motherboard and temporarily depress the switch. Observe the TXD LED for lighting up, and the computer screen for displaying the Wake-Up message.

d. Switch Mains power to the Electronics Chassis off, and after a few seconds on again. Repeat the wakeup procedure from the beginning. If the system does not respond normally, it is malfunctioning and you should contact RD Instruments.

2.2.7 Checking the Power Supply

The following test is done with a voltmeter to verify the voltage levels inside the Electronic Chassis.

Use the test points on the Power Assembly board located in the top right corner of the Electronic Chassis. Use Table 3 to verify the system voltages. If the voltage at test point TP3 is not present, check and replace fuse F1 if necessary. Observe all safety precautions.

If after replacing fuse F1 the voltages listed in Table 3 are still not present with applied mains power or fuse F1 blows again, it may be necessary to replace the Ocean Surveyor Electronics Chassis.

CAUTION. Only fuses with the required rated current, voltage, and specified type must be used. Do not repair fuses, or short circuit fuse holders. To do so could cause a fire hazard. Disconnect the power cord before attempting to replace fuse F1.

Table 3: Electronic Chassis Voltage Checks

Test Point	Value	Description
TP0	0 VDC	GND, ground reference
TP1	$4.95 \leq Vdc \leq 5.05$	VCC, Electronics power
TP2	$11.5 \leq Vdc$ 12.5	VXDC, Transducer power
TP3	$47 \leq Vdc \leq 49$	VXMT, Transmitter supply
TP4	$9.0 \leq Vdc$ 11.5	VGG, Transmitter gate drive supply

NOTE. The voltage measured at test point TP3 is also the output voltage from the Electronic Chassis power supply.

2.3 Troubleshooting a Built-In Test Failure

The built-in diagnostic tests (BIT) check the major ADCP modules and signal paths for reasonableness. If any BIT test is outside what would normally be considered reasonable (see the Test Guide), than check the following items:

- Turn off all other acoustic devices.
- Ensure that all monitors are at least 1 meter (3 feet) from the electronic chassis.
- The vessel is stopped.
- The vessel is in at least 3 meters of water below the transducer.
- No air is in front of the transducer.

Please consult RD Instruments before replacing the system or parts thereof.

2.4 Troubleshooting a Beam Failure

If a beam fails, a defective Electronic Chassis, Transducer, or Transducer Cable may be the cause for the failure. We recommend you check the following items:

- No air in front of the transducer.
- Cable connection at the transducer and Electronic chassis.
- Cable pin-to-pin wiring (see "Checking the Transducer I/O Cable," page 15).
- Replace the electronic chassis.
- Replace the transducer.

Replacing one or more of these assemblies should eliminate the encountered problem. If the perceived problem still exists, then the Ocean Surveyor may not be the primary cause. In this case, please consult RD Instruments.

2.5 Troubleshooting a Sensor Failure

Run the PC2 test to isolate the problem. The temperature sensor is imbedded in the transducer head, and is used for water temperature reading. The displayed Heading, Pitch, and Roll sensor data source is set according to the selection via the EZ command. Please refer to the Command and Output Data Format guide for more details on using the EZ command.

An open temperature sensor connection would approximately indicate the counts and degrees as given in the example below. A shorted temperature sensor or connection would indicate approximately 92 °C.

```
>PC2
Heading      Pitch       Roll        Temperature
 (int)       (int)       (int)       cts    degs
 000.0       +00.0       +00.0       0FF6   -36.3
 000.0       +00.0       +00.0       0FF5   -36.2
>
```

NOTE. If the temperature sensor is bad, the data can still be collected without effecting the accuracy or quality. Contact RDI about scheduling the repair of the temperature sensor at your convenience.

For External Sensor verification, see the Test Guide and the Installation Guide. If the external gyro is not working, see the Installation guide for troubleshooting information.

If the internal Heading/Pitch/Roll sensors are not working properly, check the following items.

- Check the cable connections.
- Check the transducer pin-to-pin connections.
- Remove the transducer and open the end cap/top hat assembly. Check the cable connection to the TCM2 compass (see Figure 8, page 23 and the Maintenance Guide).
- Contact RDI for a replacement TCM2 Heading/Pitch/Roll assembly.

2.5.1 Fault Log

To determine why a sensor failed, view the fault log. To view the fault log, start *DumbTerm*. Press the **End** key to wakeup the ADCP. Send the following commands: **CR1**, **PC2**, **LD**. The LD-command displays the fault log.

```
[BREAK Wakeup A]

Ocean Surveyor Broadband/Narrowband ADCP
RD INSTRUMENTS (c) 1997-2000
ALL RIGHTS RESERVED
Firmware Version 23.xx
>
>CR1
>PC2
|          (PC2 test results (not shown))
|
>LD
Time of first fault:    2000/08/23,10:08:13
Overflow count:                 0

Fault Log:
     Code            Count            Time                  Parameter
506  TEMP RANGE          3       2000/08/23,10:08:22        FFFFF1D7h
203     RTC CAL          2       2000/08/23,10:08:19        00000001h

End of fault log.

>
```

NOTE. The LL command displays a list of different faults that can be recorded in the fault log.

2.6 Technical Support

If you have technical problems with your instrument, contact our field service group in any of the following ways:

RD Instruments
9855 Businesspark Ave.
San Diego, California 92131
(858) 693-1178
FAX (858) 695-1459
rdifs@rdinstruments.com

RD Instruments Europe
5 Avenue Hector Pintus
06610 La Gaude, France
+33(0) 492-110-930
+33(0) 492-110-931
rdifs@rdieurope.com

Web: http://www.rdinstruments.com

If your instrument works and you have questions involving a specific application, you may call either the field service group (above) or our sales/marketing staff.

3 Ocean Surveyor Cables

This section provides information on Ocean Surveyor cabling. Special user-requests may cause changes to the basic wiring system and may not be shown here. We provide these drawings only as a guide in troubleshooting the ADCP. If you feel there is a conflict, contact RDI for specific information about your system. Where shown, the color code is for reference only; your cable may be different. The following figures show various Ocean Surveyor cable locations, connectors, and pin-outs.

3.1 Transducer to Electronic Chassis I/O Cable

Cable specifications:

- Minimum bend radius = 203 mm (8.0 in.)
- Typical cable OD = 19.8 mm (0.78 in.)
- Maximum pull load = 1132 N (250 lb.)
- Maximum length = 100 m (328 ft.)
- Available with either ends having straight or angled connectors or a combination thereof.

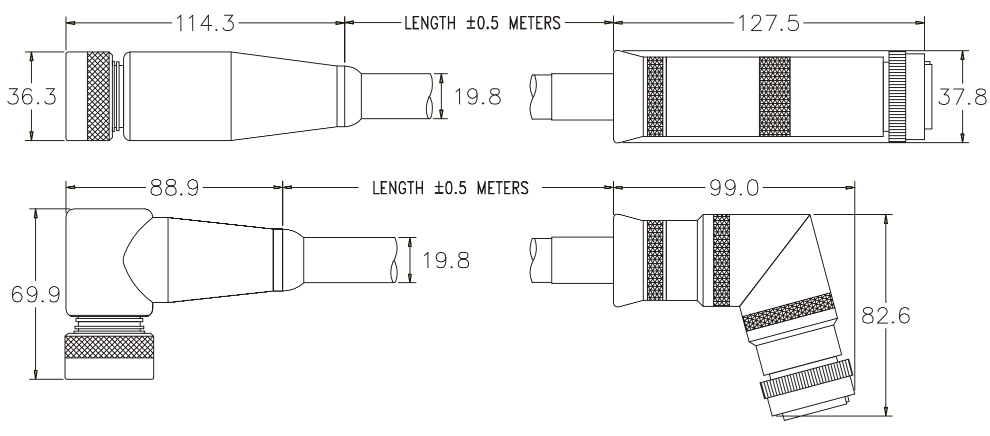


Figure 1. External I/O Cable

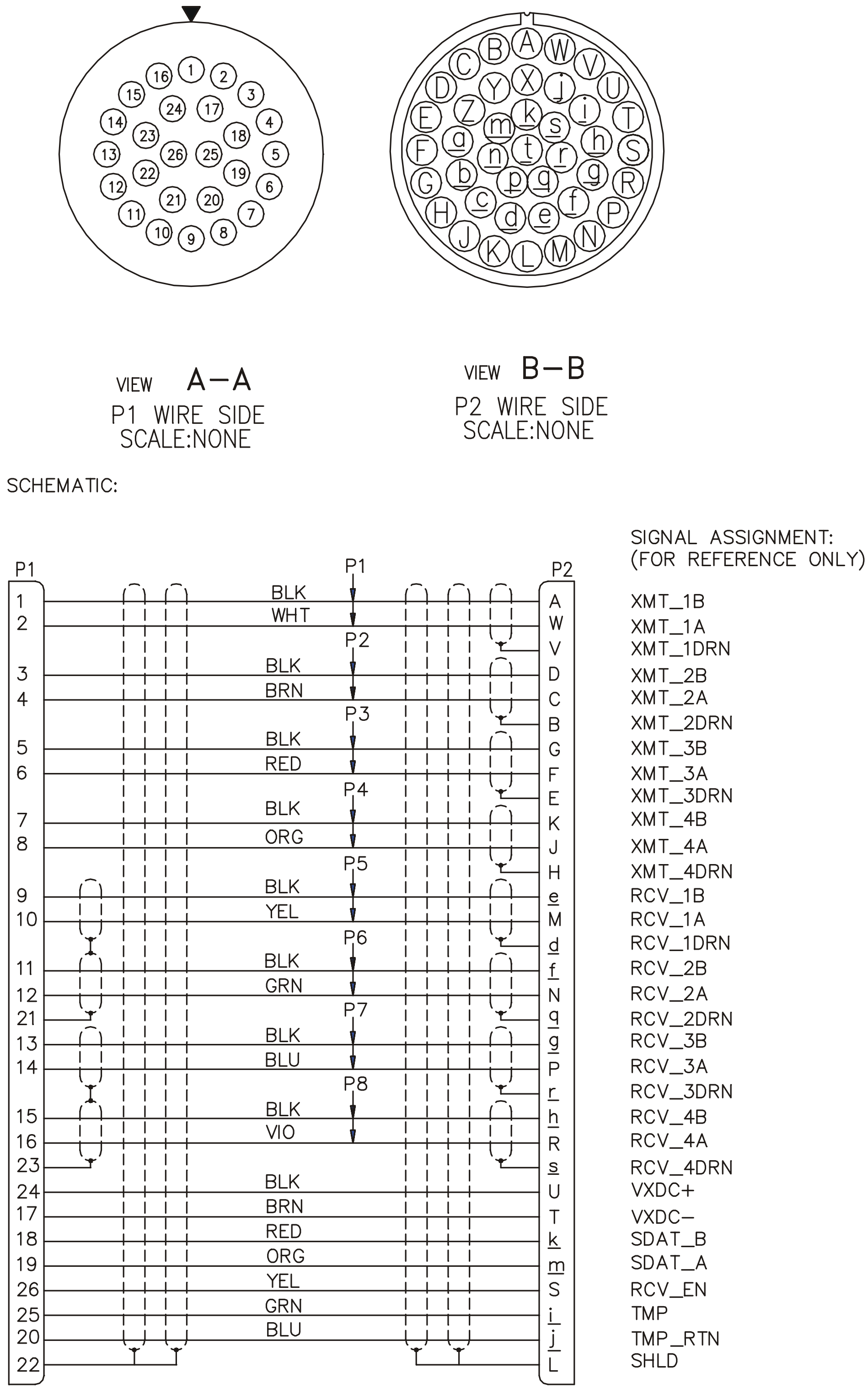


Figure 2. External I/O Cable Wiring

3.2 Checking the Transducer I/O Cable

For checking the Transducer cable, it is recommended that both ends of the cable are disconnected and accessible. You must take care not to bend or otherwise damage any pins or sockets. Do not allow debris or moisture to enter the contact or O-ring surfaces of the connectors. While performing the continuity check, it provides the opportunity to verify the integrity of the o-ring on the under-water mating connectors. Use silicon DC-111 O-ring grease for lubricating the O-ring and O-ring grooves.

Use the schematic diagram in Figure 2, page 14 to check the continuity of the transducer cable. Verify the pin-to-pin connections as indicated in the schematic; each connection should have continuity, where the resistance should nominally be 0.33 Ohms per meter of cable length at 20 °C (i.e., a 30 meter cable has a nominal conductor resistance of 1 Ohm at 20 °C). The isolation resistance between conductors, and conductors and shields should be at least 20 MOhm at 100 VDC. Note that if moisture is present you may not be able to obtain this isolation resistance.

When only the dry-side connector P2 (Electronics Chassis connector) is accessible and the transducer is connected to the underwater connector P1 (Transducer connector), use Table 4, page 16 for a coarse check of the transducer cable's integrity. Use a DMM for measuring the resistance.

CAUTION. Do **NOT** use a Hi-Pot Tester for measuring the resistance values, as serious damage to the transducer electronics will be the result.

NOTE. When the transducer cable is connected to the transducer, you are not able to differentiate between a problem that may exist in the cable or the transducer. That is, if you measure an open connection, the open may be in the cable or the transducer.

CAUTION. You must observe anti-static precautions for this test if the cable is connected to the transducer.

Table 4: Transducer I/O Cable Wiring Resistance Check.

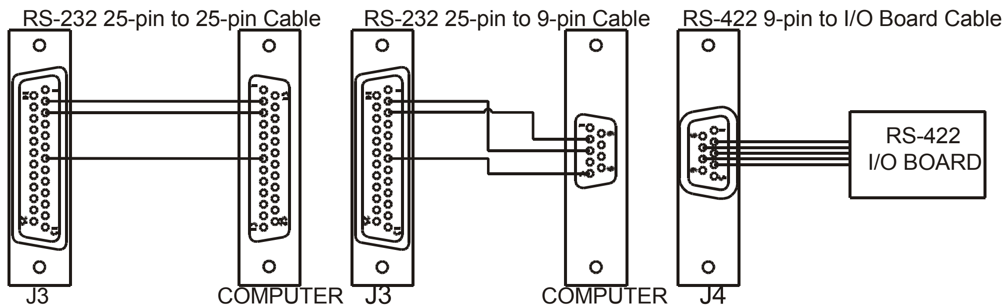
Pin	Pin	Value with cable connected to Transducer	Notes
A	W	2 – 4 Ohms	> 20 MOhms to all other
D	C	2 – 4 Ohms	> 20 MOhms to all other
G	F	2 – 4 Ohms	> 20 MOhms to all other
K	J	2 – 4 Ohms	> 20 MOhms to all other
e	M	3 – 15 Ohms	> 20 MOhms to all other
f	N	3 – 15 Ohms	> 20 MOhms to all other
g	P	3 – 15 Ohms	> 20 MOhms to all other
h	R	3 – 15 Ohms	> 20 MOhms to all other
d	q	1 – 4 Ohms	> 20 MOhms to all other
r	s	1 – 4 Ohms	> 20 MOhms to all other
S	T	4.75 kOhm	> 20 MOhms to all other
i	j	10 kOhm @20 °C transducer temperature 19.9 kOhm @10 °C transducer temperature	> 20 MOhms to all other
U	T	0.9 – 1.2 uFarad	No return connection; capacitance can not be interpolated for different cable length, but the capacitance shown is required.
B	--	> 20 Mohms to all other	No return connection
E	--	> 20 Mohms to all other	No return connection
H	--	> 20 Mohms to all other	No return connection
V	--	> 20 Mohms to all other	No return connection
k	T	Undetermined	Integrated circuit i/o; > 20 MOhms to all other
m	T	Undetermined	Integrated circuit i/o; > 20 MOhms to all other

NOTE: Table 4 is valid for a Phased Array Transducer connected and a 30 meter cable length. Other cable lengths may be interpolated. Resistance values are valid at 20 °C.

CAUTION. For testing the Transducer Cable with the transducer connected, do not use a Hi-Pot Tester, as serious damage to the transducer electronics may be the result.

3.1 Serial Data Communications Cables

The provided wiring diagrams and pin-out descriptions of Figure 3 provide the information necessary to connect your host computer to the Ocean Surveyor Electronics Chassis with a minimum of conductors. Off-the-shelf cables may provide more than these minimum connections, but must follow as a minimum the schematics depict in Figure 3. Connectors J3 and J4 are located at the rear panel of the Electronics Chassis, and are used for RS-232 or RS-422 communication respective. Both, RS-232 and RS-422 interfaces are isolated.



Cable Type	ADCP Signal	Chassis	Computer	Computer Signal
RS-232 25-pin to 25-pin	DATA IN DATA OUT GND	2 3 7	2 3 7	DATA OUT DATA IN GND
RS-232 25-pin to 9-pin	DATA IN DATA OUT GND	2 3 7	3 2 5	DATA OUT DATA IN GND
RS-422 9-pin to I/O board	DATA IN A DATA OUT A COMMON DATA IN B DATA OUT B	2 4 3 7 8	- - - - -	DATA OUT A (+) DATA IN A (+) COMMON DATA OUT B (-) DATA IN B (-)

NOTE: These cables provides RS-232 or RS-422 communications. Two cables are provided with the instrument: (1) 25-pin to 25-pin RS-232 cable, and (1) 25-pin to 9-pin RS-232 cable. Each cable is about 2-meters long and has a diameter of 8 mm (0.31 in.). For cable lengths longer than 15 meters, we recommend you use RS-422 communications. The cable for RS-422 communication is not provided with the equipment.

Figure 3. Serial Communication Cable Wiring Diagram

4 System Overview

This section presents a functional description of the Ocean Surveyor's operation using block diagrams.

4.1 Overview of Normal Ocean Surveyor Operation

The following events occur during a typical data collection cycle.

a. The user or a controlling software program sends setup and data collection parameters to the Ocean Surveyor. The user/program then sends a CS-command to start the data collection cycle. The firmware program stored in the CPU microprocessor takes control of Ocean Surveyor operation based on the commands received through the serial I/O cable.

b. The Ocean Surveyor Motherboard generates all transmit signals for driving the Quad Transmitter circuit, located on the Power Assembly board. The Transmitter drives the transducer, which projects the acoustic energy into four narrow and directed water columns. Unlike conventional multi beam transducers, these four beams in the Ocean Surveyor are generated during transmit via the transmitter signal phase relationships, and not by separate acoustic projectors.

c. Most backscatter from the water column is generated by zooplankton. The transducer receives echoes from the backscatter. The four receive beams are formed by the Beam Former inside the Transducer assembly. The formed and amplified signals of the four beams are fed to the Electronics Chassis via the Transducer Cable.

d. The Motherboard carries the four receiver channels necessary for amplifying, decoding, and filtering the four beam signals formed by the Beam Former.

e. The filtered signals are then sampled, along with the echo intensity signal, and processed by the Motherboard's Digital Signal processor (DSP).

f. The Thermistor measures the water temperature at the transducer head and sends it to the motherboard.

g. The TCM2 compass located inside the Transducer assembly, or Gyro Interface board sends pitch and roll from the tilt sensor and Ocean Surveyor heading from the compass to the Motherboard.

h. The system repeats steps "b" through "g" for a user-defined number of pings. The Motherboard averages the data from each ping to produce an ensemble data set.

i. At the end of the ensemble (sampling) interval, the Motherboard sends the collected data to the serial I/O connector.

4.2 Functional Description of Operation

The following sections describe how the Ocean Surveyor operates and interacts with its modules.

4.2.1 Input Power

The Ocean Surveyor Electronic Chassis requires a supply between 90 and 250 V~, and 47 – 63 Hz. A list of pertinent power specification is listed for reference in Table 5.

Table 5: Ocean Surveyor Input Power Requirements.

Input Characteristics	Specification
Mains input voltage range	90 - 250 Vac, 47 - 63 Hz
Mains power between transmit	60 VA
Mains power during transmit	1400 VA
Peak Mains power during transmit	2000 VA (for 4 or less Mains cycles)
Inrush current[1]	17 A rms @ 115 Vac
	34 A rms @ 230 Vac
Ride through time[1]	20 ms
Transient surge[1]	EN/IEC 1000-4-2 Level 4
(Common mode & Normal mode)[1]	EN/IEC 1000-4-5 Level 3

[1] Obtained from the power supply manufacturer data sheet.

The power supply generates a single 48 VDC supply voltage. It is fed to the Power Assembly. The Power Assembly consists of the Quad Transmitter, a 5-volt DC/DC converter for the Electronics Chassis's supply, a 12-volt DC/DC converter for the transducer supply, and the 10 VDC Transmitter gate drive supply. The 48 VDC is also the supply for the transmitter. A single replaceable fuse protects the system from shorts in the transmitter. Self-resetting fuses protect all other supplies.

4.2.2 Board Descriptions

Power Assembly Board.

- Receives the filtered/internal power.
- Limits the in-rush of current to the Ocean Surveyor and provides over and negative-voltage protection. Either condition will blow a protective fuse. However, damage could occur to other circuits <u>before</u> the fuse blows. Please ensure you apply voltages within the specified range (85 to 264 VAC).
- Converts the operating power supply voltage to power all other Ocean Surveyor circuits.

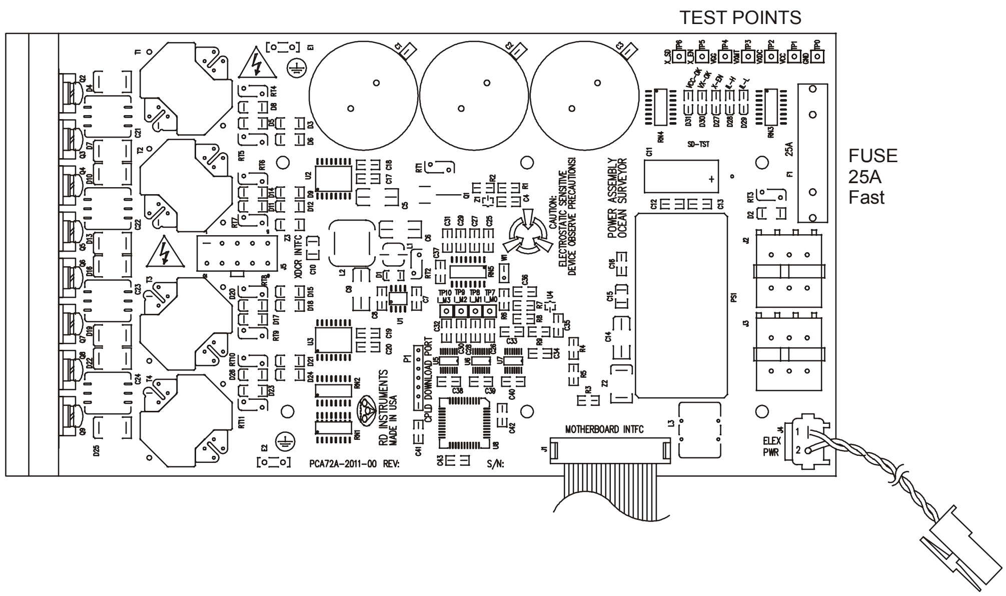


Figure 4. Power Assembly Board

Mother Board.

- Uses the Power Amplifier circuit to generate the high-amplitude pulse AC signal that drives the sonar transducers. The Power Amplifier sends the drive signal to the Beam Former Board (located in the transducer assembly).
- Real time clock.
- Generates most of the timing and logic signals used by the Ocean Surveyor.
- Analog to Digital converter.
- Digitizes information from sensors.

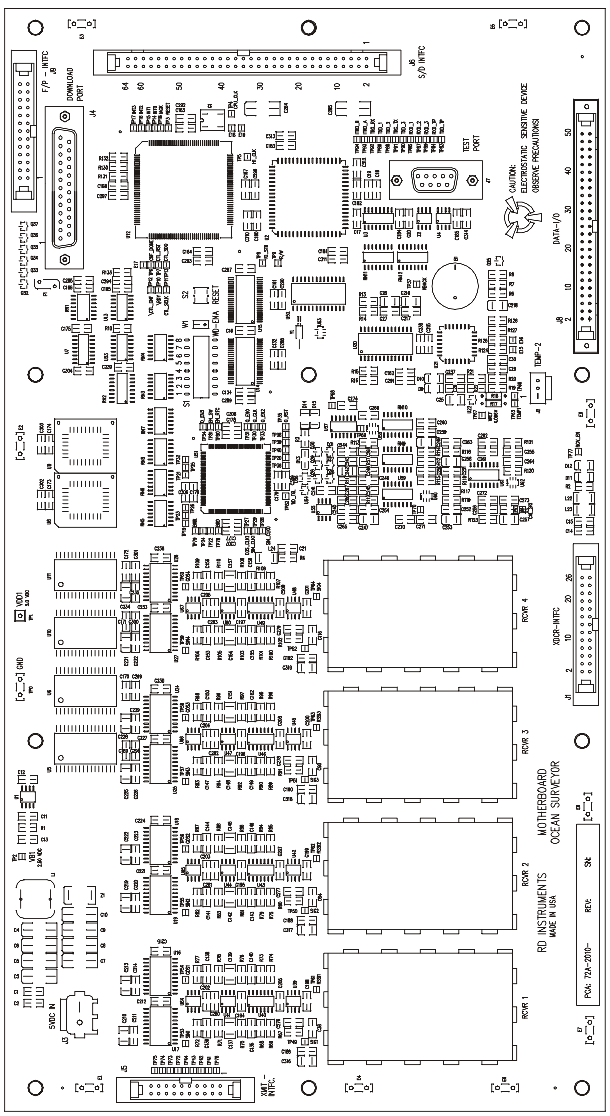


Figure 5. Motherboard

Transducer Interface Board.

- Routs all connections from the transducer cable connector on the rear of the Electronic Chassis to the motherboard.

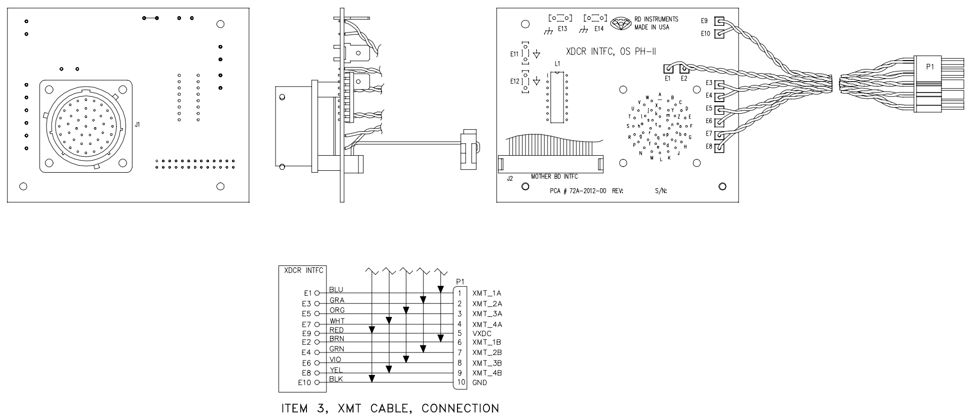


Figure 6. Transducer Interface Board

Data I/O Interface Board.

- Routs all connections from the serial cable connectors on the rear of the Electronic Chassis to the motherboard.

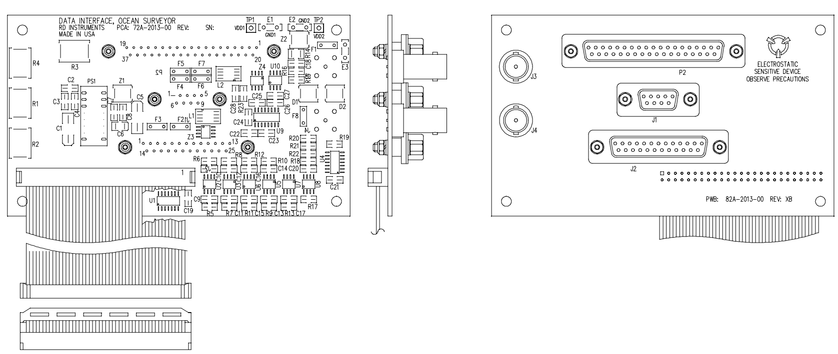


Figure 7. Data I/O Interface Board

TCM2 Board.

- Compass and attitude sensor circuits.

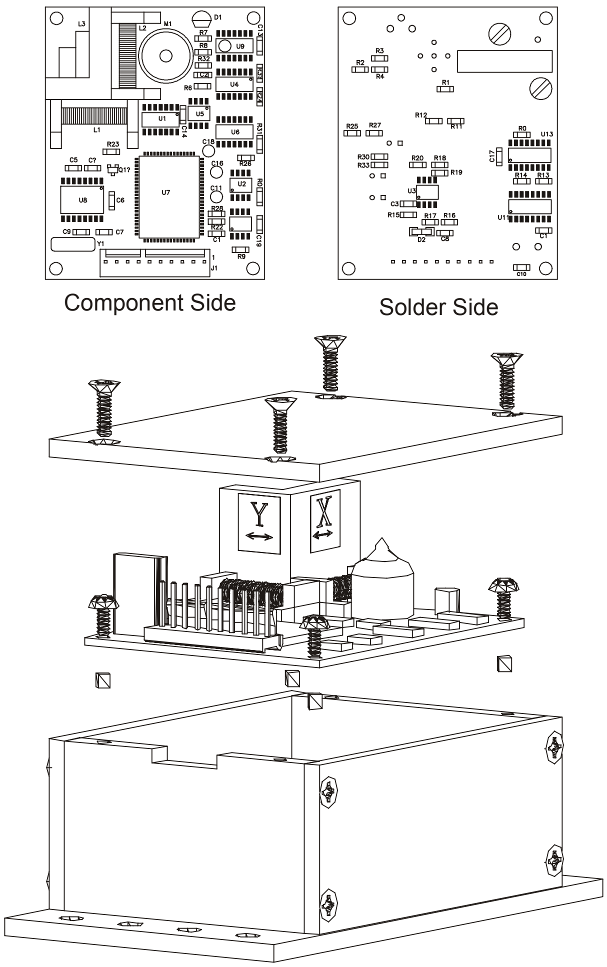


Figure 8. TCM2 Board

Beam Former Board.

- Tuning functions.
- Receiver functions.
- Temperature sensor.

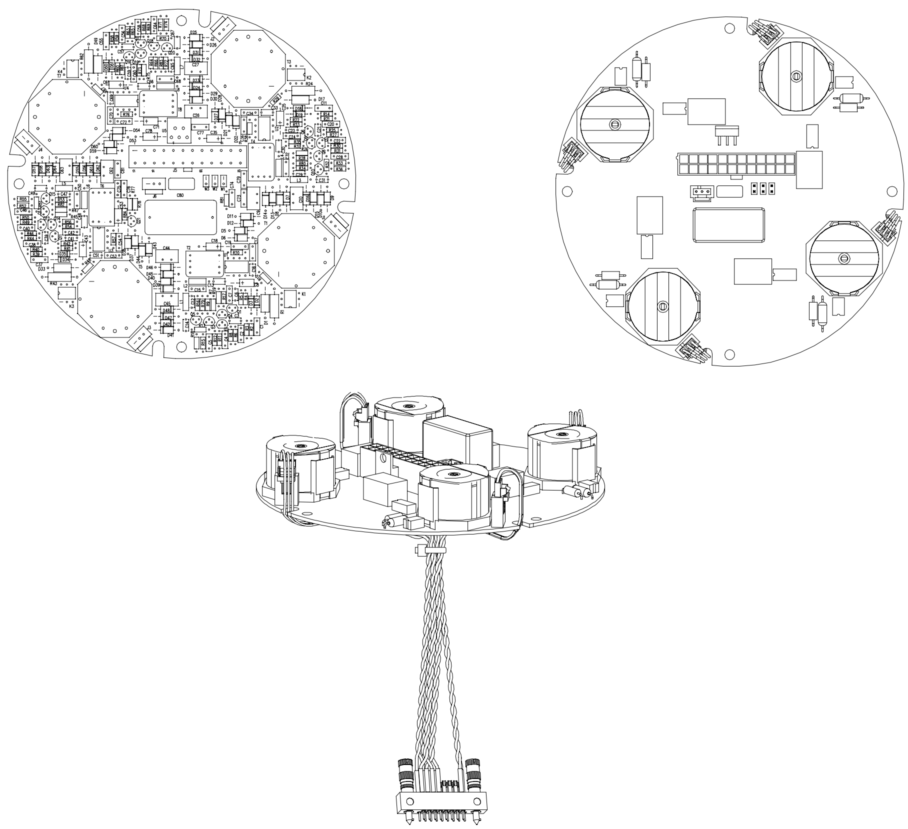


Figure 9. Beam Former Board

Ocean Surveyor

User's Guide

RD Instruments

Acoustic Doppler Solutions

P/N 95A-6013-00 (January 2001)

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RD Instruments
Acoustic Doppler Solutions

Ocean Surveyor User's Guide

1 Introduction

Thank you for purchasing the RD Instruments (RDI) Ocean Surveyor (OS). This guide is designed to help first time Ocean Surveyor users to set up and deploy their ADCP.

This guide is designed for use *with* the other Ocean Surveyor Technical Manual guides. Where needed, there are references to detailed information and figures contained in the Ocean Surveyor Technical Manual.

Ocean Surveyor deployments are Real-Time. Real-Time use refers to the fact you are viewing the data as the ADCP collects it via a personal computer. This data is also stored on the computer to allow for data playback and processing at a later time.

2 Ocean Surveyor Applications

Platform

RDI dominates the offshore oil and gas sector with field-proven instruments designed to facilitate exploration drilling, field development, and production. The Ocean Surveyor ADCP is usually installed on fixed platforms like deepwater drilling rigs for planning operations sensitive to ocean currents. This support is provided for station holding, riser deployment and monitoring, ROV surveys, ship loading, and anticipate and warn about extreme current conditions. Ocean Surveyor ADCPs remotely measure currents at many levels through the water column.

Vessel Mount

The Ocean Surveyor ADCP can be used to measure real-time current profiles of open ocean water current structures from permanent mountings in a vessel. These ADCPs provide detailed maps of the distribution of water currents and suspended materials through the water column and along the ship's path. The Ocean Surveyor ADCP's low profile makes hull mounting an easier process and a more reasonable expense. In real time, the ADCP is also used to aid in-situ decision making, to adapt field operations, and to understand current regime characteristics. Vessel-mounted ADCPs have contributed to a large range of ocean projects, as diverse as the following:

- Gulf Stream climate studies
- Mid-ocean frontal mapping
- Fisheries research
- Deep-water cable-laying jobs

When considering vessel mount or platform real time applications, RDI offers you choices in software packages that are intended to directly meet your needs. *VmDas* is the most often used software package for ADCP setup, real-time data collection, and data review. For detailed information on how to use *VmDas*, see the *VmDas* User's Guide.

3 System Overview

The Ocean Surveyor is designed for vessel-mount or fixed-mount current profile measurement in the upper ocean water from depths less than 100 meters. The Ocean Surveyor consists of a transducer and electronics chassis. The transducer housing is made from naval bronze and can be painted (with precautions) with anti-fouling paint. Data are transmitted in either an ASCII or binary format through the I/O cable.

3.1 Electronic Chassis Overview

The Ocean Surveyor Electronic Chassis (see Figure 1 and Figure 2, page 3) contains all of the interfaces to and from the transducer, computer, vessel gyrocompass, and power.

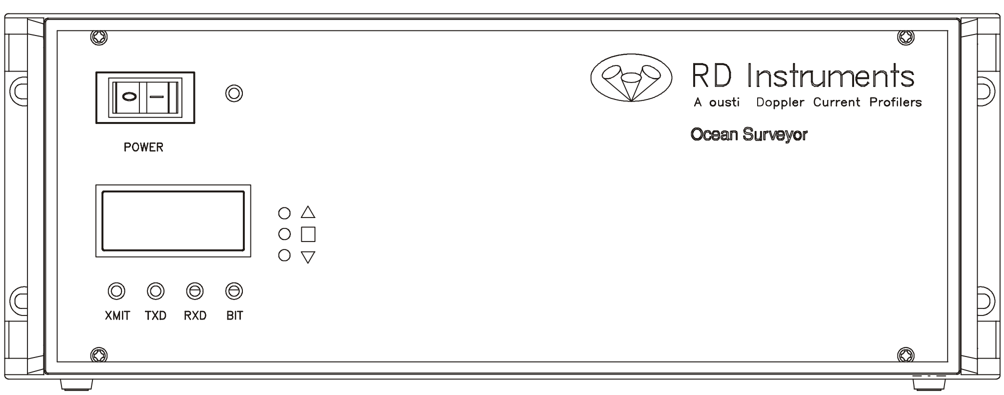


Figure 1. Electronic Chassis Overview (Front View)

Power Switch – The power switch is a combination switch/circuit breaker. The power status LED next to the circuit breaker lights when power is applied to the electronic chassis.

LCD Display - The LCD Display shows the vessel's gyro heading.

> **NOTE.** The Gyro Interface is optional. If you do not have a Gyro Interface board installed, the LCD display will be blank.

Up/Down/Set - Use the Up/Down/Set buttons to set the Gyro Offset for systems with the optional Gyro Interface board installed. The Offset Control buttons are Up, Set, and Down, as depicted by the upward arrow, the square box, and the downward arrow respectively.

For example, to set a heading offset for a multi-rate gyro, push the up or down button and set button simultaneously, using two small aids such as a pencil. When the desired offset is obtained, release the buttons. To prevent accidental re-adjustment, the buttons are recessed.

LEDs

- XMIT indicates the transducer is transmitting.
- TXD indicates data transmission from the Ocean Surveyor to the computer.
- RXD indicates data transmission from the computer to the Ocean Surveyor.
- BIT indicates a Built-In Test failure.

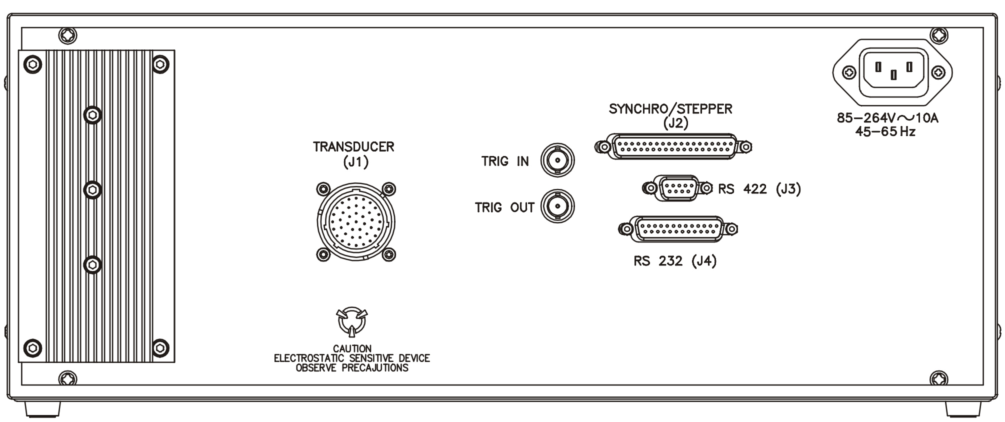


Figure 2. Electronic Chassis Overview (Rear View)

Transducer (J1) Connector – Input/Output (I/O) cable connects the Ocean Surveyor transducer to the Electronic Chassis.

Trigger Input/Output Connectors – The Trigger Input allows the Ocean Surveyor II to be pinged by an external +5Vlogic level signal. The minimum duration for the Trigger Input is 1ms. The Input resistance is at least 2.7 k Ohm. The Trigger Output is a +5V logic level signal as well. The nominal source resistance of the Trigger Output is 50 Ohms.

The command that controls the Trigger Output and Input is *CXab*, where *a* controls the Trigger Input mode, and *b* the Trigger Output mode. For flexibility, several modes for the Trigger Input and Output operation have been implemented. See the Command and Output Data Format book for a description of the CX-command.

Synchro/Stepper (J2) Connector – Optional Gyrocompass (gyro) interface (J2) connects the ship's gyro to the electronics chassis.

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

Power In – The electronics chassis automatically scales the input voltage to the proper level. No special jumpers or switch settings are required to select the input voltage. The electronics chassis accepts input voltages of 90 to 250 VAC, 47 to 63 Hz. This input voltage is converted to 48 VDC by the chassis power supply. This is the voltage supplied to the power assembly board. For details on power requirements, see the Installation Guide.

3.2 Transducer Overview

The transducer assembly contains the transducer ceramics and electronics. Standard acoustic frequencies are 38, 75, and 150kHz. See the outline drawings in the Installation Guide for dimensions and weights.

I/O Cable Connector – Input/Output (I/O) cable connects the Ocean Surveyor transducer to the Electronic Chassis.

Beam-3 Mark – The Beam-3 mark shows the location of Beam-3 (Forward).

Urethane Face – The urethane face covers the transducer ceramics. Never set the transducer on a hard surface. The urethane face may be damaged.

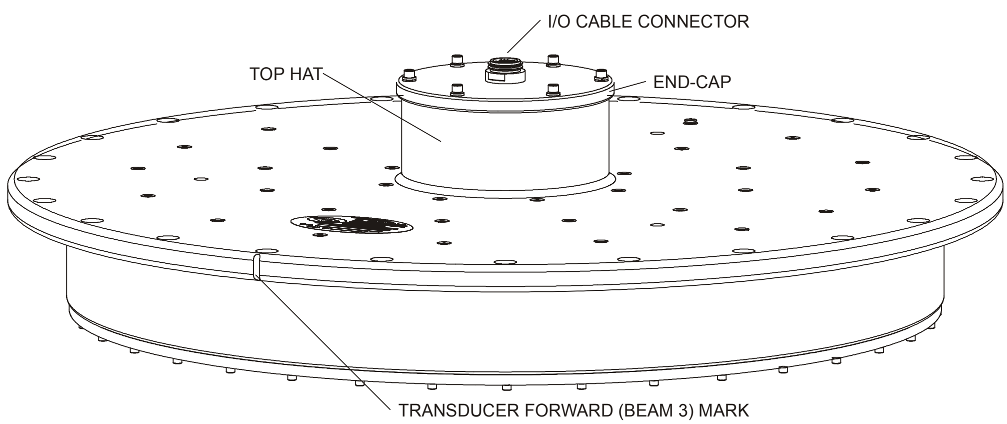


Figure 3. Transducer Overview (38 kHz Round Transducer Shown)

3.3 I/O Cable Overview

The I/O cable connects the Ocean Surveyor transducer to the Electronics Chassis.

Cable specifications:

- Minimum bend radius = 203 mm (8.0 in.)
- Typical cable OD = 19.8 mm (0.78 in.)
- Maximum pull load = 1132 N (250 lb.)
- Maximum length = 100 m (328 ft.)
- Available with either ends having straight or angled connectors or a combination thereof.

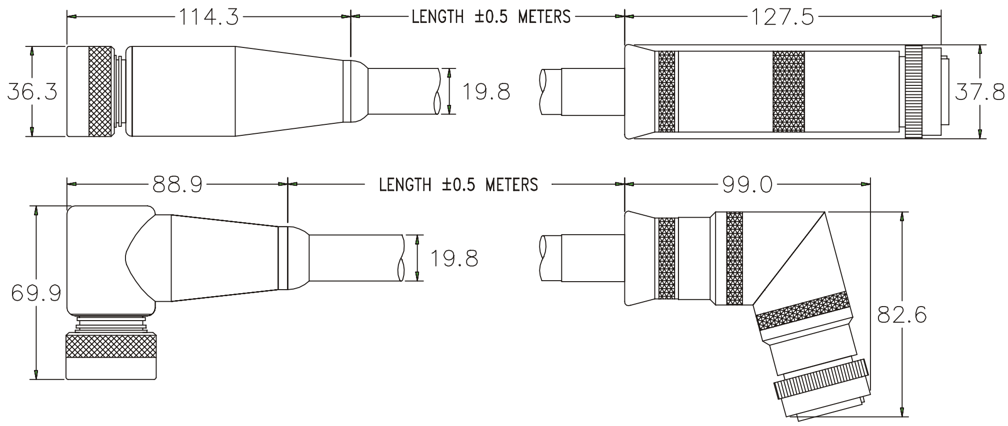


Figure 4. I/O Cable

3.4 Spare Parts

The following parts are included in the spare parts kit.

Table 1: Spare Parts

Item ID	Description	Where Used
2-020-70SH-EP	O-ring	End-Cap/Top Hat connector
2-022-70SH-EP	O-ring	I/O Cable
DC-111	Lubricant, silicone	O-ring lubricant
314025	Fuse, 25A Fast blow, 3AB	Power Interface PCB
M4x0.7x6PH	Screw, pan head, SST	Electronic Chassis cover

4 Ocean Surveyor Care

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

4.1 General Handling Guidelines

- Never set the transducer on a hard or rough surface. The urethane face may be damaged.
- Do not expose the transducer to prolonged sunlight. The urethane face may develop cracks. Cover the transducer face on the Ocean Surveyor if it will be exposed to sunlight.
- Do not scratch or damage the O-ring surfaces or grooves. All O-ring grooves and surfaces must be inspected for scratches or damages on every re-assembly. If scratches or damage exist, they must be sanded out using 400 to 600 grit sandpaper. If the damage cannot be repaired, contact RDI. Do not risk a deployment with damaged O-ring surfaces.
- Do not lift or support an Ocean Surveyor by the external I/O cable. The connector or cable will break.

4.2 Assembly Guidelines

- Always check that the I/O cable (wet end) O-rings are in place when connecting the I/O cable to the transducer. These O-rings have a tendency to fall out if the cable connector is dropped.
- Read the Maintenance guide for details on Ocean Surveyor re-assembly. Make sure the top hat assembly O-rings stay in their groove when you re-assemble the Ocean Surveyor. Tighten the Top Hat hardware as specified. Loose, missing, or stripped Top Hat mounting hardware or damaged O-rings can cause the Ocean Surveyor transducer to flood.

4.3 Deployment Guidelines

- Read the Ocean Surveyor User's Guide and the *VmDas* User's Guide. These guides have tutorials to help you learn how to use the ADCP.
- Use the default Command Files (included on the *VmDas* CD) to help setup the ADCP.

5 Software

RDI has utility programs to help you set up, use, test, and trouble-shoot your Ocean Surveyor ADCP. Each program has a help file that you can print, or you can view help while running the program.

Table 2: Ocean Surveyor Software Main Modules

Program Name	Description
DumbTerm	Windows ADCP communication program. Use this program to "talk" to the ADCP and to run test script files. *DumbTerm* is included on the RDI Tools CD. For detailed information on how to use *DumbTerm*, see the RDI Tools User's Guide.
WinADCP	Gives users a visual display of the entire set of data. You can zoom in on a portion of the data for closer analysis and export data to text or MatLab files. For detailed information on how to use *WinADCP*, see the *WinADCP* User's Guide.
Documentation CD	The Documentation CD has an Adobe Acrobat® (*.pdf) electronic version of the Ocean Surveyor Technical Manual. Use the Documentation CD to search for information. For detailed information on how to use Adobe Acrobat® and the Documentation CD, see the Read This First guide.

5.1 System Requirements

The Ocean Surveyor software requires the following:

- Windows 95®, Windows 98®, or Windows® NT 4.0 with Service Pack 4 installed
- Pentium class PC 233 MHz (350 MHz or higher recommended)
- 32 megabytes of RAM (64 MB RAM recommended)
- 6 MB Free Disk Space (20 MB recommended)
- One Serial Port (two High Speed UART Serial Ports recommended)
- Minimum display resolution of 800 x 600, 256 color (1024 x 768 recommended)

NOTE. *VmDas* has special system requirements; see the *VmDas* User's Guide for details.

5.2 Software Installation

To install the Ocean Surveyor software, do the following.

a. Insert the compact disc into your CD-ROM drive and then follow the browser instructions on your screen. If the browser does not appear, complete Steps “b” through “d.”

b. Click the **Start** button, and then click **Run**.

c. Type **<drive>:launch**. For example, if your CD-ROM drive is drive D, type **d:launch**.

d. Follow the browser instructions on your screen

5.3 Utility Software

The following DOS programs (on the RDI Tools CD) have been provided to supplement features not yet implemented into the Windows environment. RDI will incorporate these features in future releases. These programs have been installed to the directory C:\Program Files\Rd Instruments\Utilities.

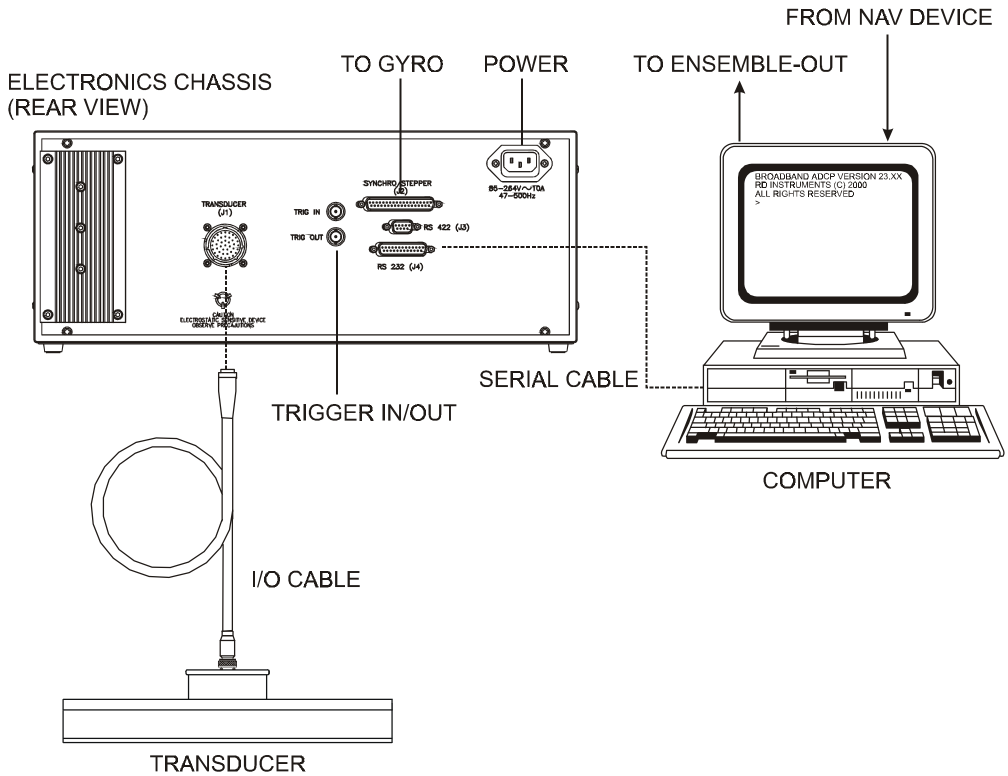
Table 3: Ocean Surveyor DOS Utility Software

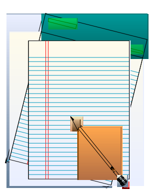
Program Name	Description
BBLIST	Executable program that can be operated through the Windows environment. This program will display binary data in tabular format as well as convert the data into an ASCII file.
BBBATCH	Automatically converts a named binary data set to a named ASCII data set using an existing format file. Use this program to convert binary files unattended through a DOS batch file.
BBCONV	Executable program that cannot be operated through the Windows environment. Removes user selected data from binary files and stores the information into ASCII comma delimited format. See BCONV.DOC for decoder file format.
BBMERGE	Executable program that cannot be operated through the Windows environment. BBMERGE merges ASCII comma delimited format data described by a decoder (.DEC) file into the raw BroadBand ADCP data file "infilename", resulting in an output ADCP data file called "outfilename". See BCONV.DOC for decoder file format.
BBSUB	Executable program that cannot be operated through the Windows environment. BBSUB is intended to allow users to subsection binary data files. BBSUB starts copying ensembles from 'infilename' to 'outfilename' starting with the user specified “start” and “stop” ensemble.
SS	Executable program that can be operated through the Windows environment. SS allows you to quickly calculate the speed of sound in the water.
SURFACE	Executable program that cannot be operated through the Windows environment. Surface estimates the range from the ADCP to the water surface or bottom from the echo intensity data. This program does not change the original data. It creates a text file with the estimated ranges. Intended for customers to estimate where to cut off their data.
CHECKDAT	Executable program that cannot be operated through the Windows environment. CHECKAT will scan a data file for missing ensembles, ensemble number out of order, bad checksum ensembles and ensembles with bit errors. If the DOS redirect command (> symbol) is used then the output will be placed into a file.
C++ Code Library	The C++ Code library has been provided to help you in the creation of your own programs. These files are provided as is and in general are not supported. Use at your own discretion. The files are located in the directory: C:\Program Files\Rd Instruments\Utilities\C_Code.

6 Deployment Guide

Use the following steps and the Ocean Surveyor Quick Reference card to setup the Ocean Surveyor for a deployment.

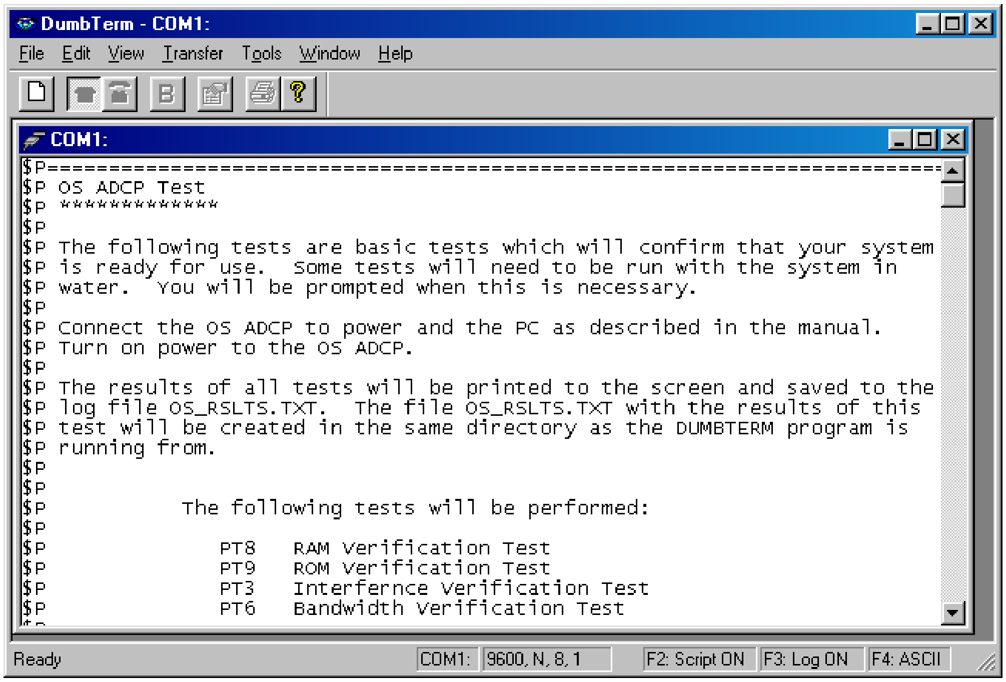
6.1 Prepare the ADCP for Deployment



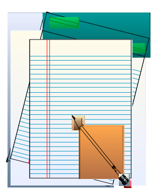


Use this area for notes.

6.2 Test the Ocean Surveyor

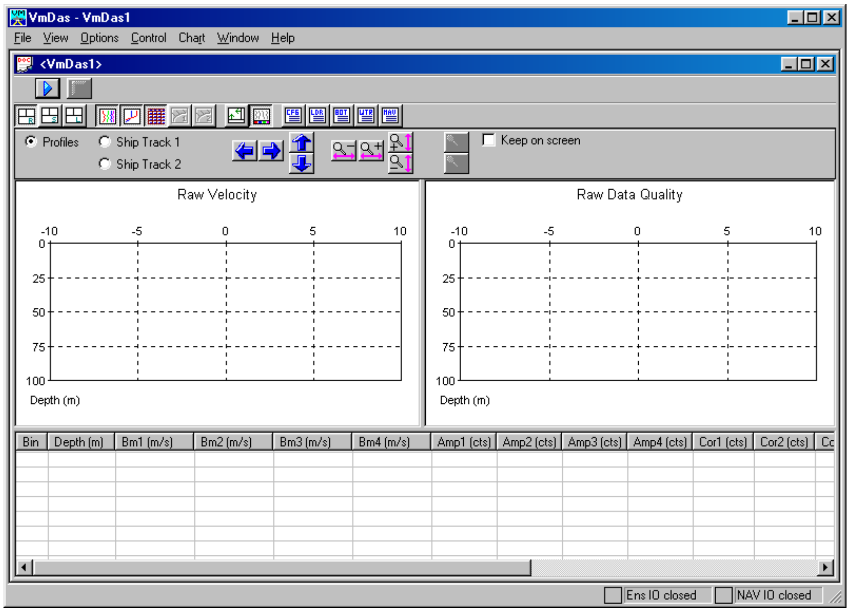


Run the *DumbTerm* script file OStest.txt to verify the Ocean Surveyor is functioning properly. Some tests will fail if the ADCP is not placed in water while the tests are being run.



Use this area for notes.

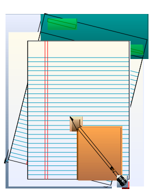
6.3 Start VmDas



The *VmDas* software is designed to allow you to set up your Ocean Surveyor to get the best possible data without having to understand and use Ocean Surveyor commands. *VmDas* helps you create the commands necessary to deploy the ADCP.

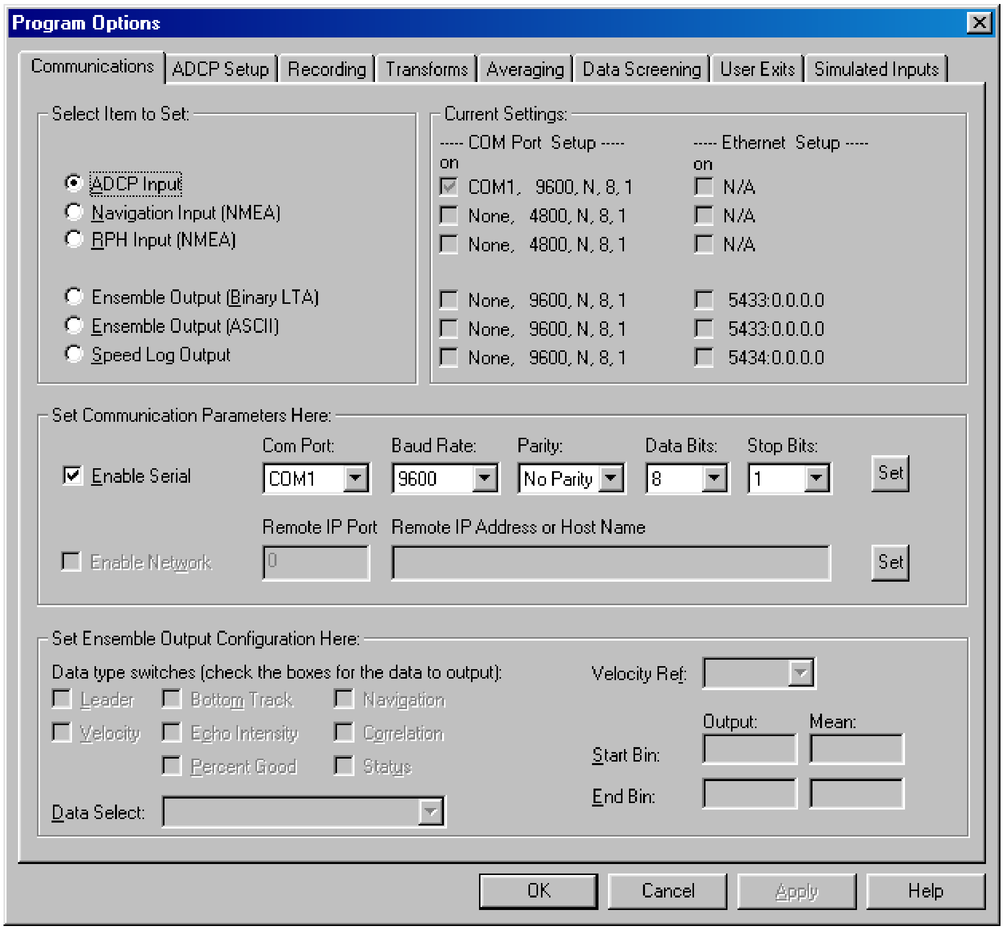
NOTE. Refer to the *VmDas* User's Guide for information on how to use this program.

Start *VmDas*. On the **File** menu, click **Collect Data**. On the **Options** menu, click **Load**. Select the Default.ini file and click **Open**.

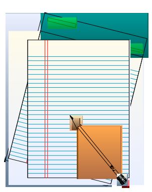


Use this area for notes.

6.4 Setup Communications

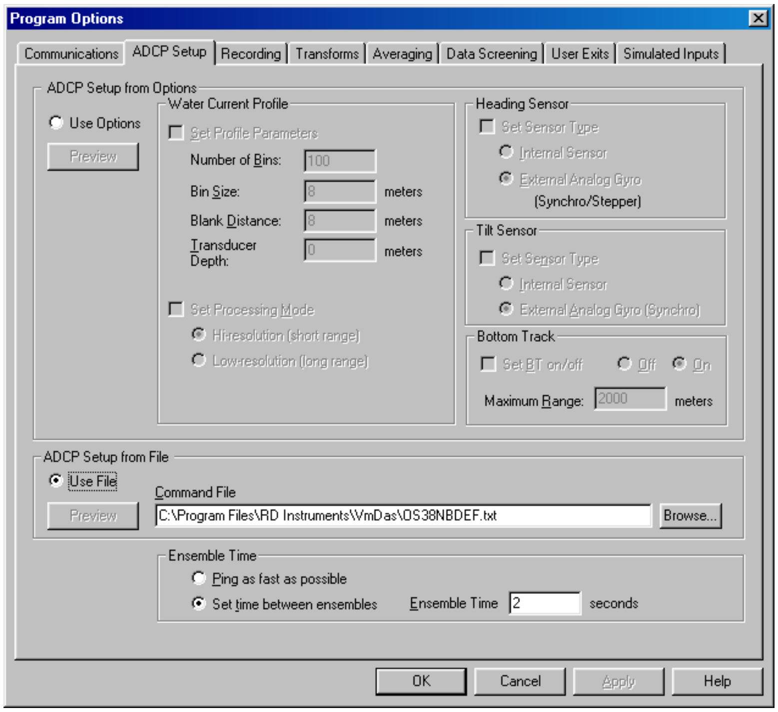


On the **Options** menu, click **Edit Data Options**. Click the **Communications** tab and set the communications settings with the ADCP and NMEA ports.



Use this area for notes.

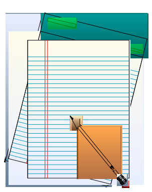
6.5 ADCP Setup Tab



Click the **ADCP Setup** tab. Set the **Ensemble Time** to the value shown below. Select the **Use File** button and choose a default command file for your ADCP, and load it into *VmDas* using the **Browse** button.

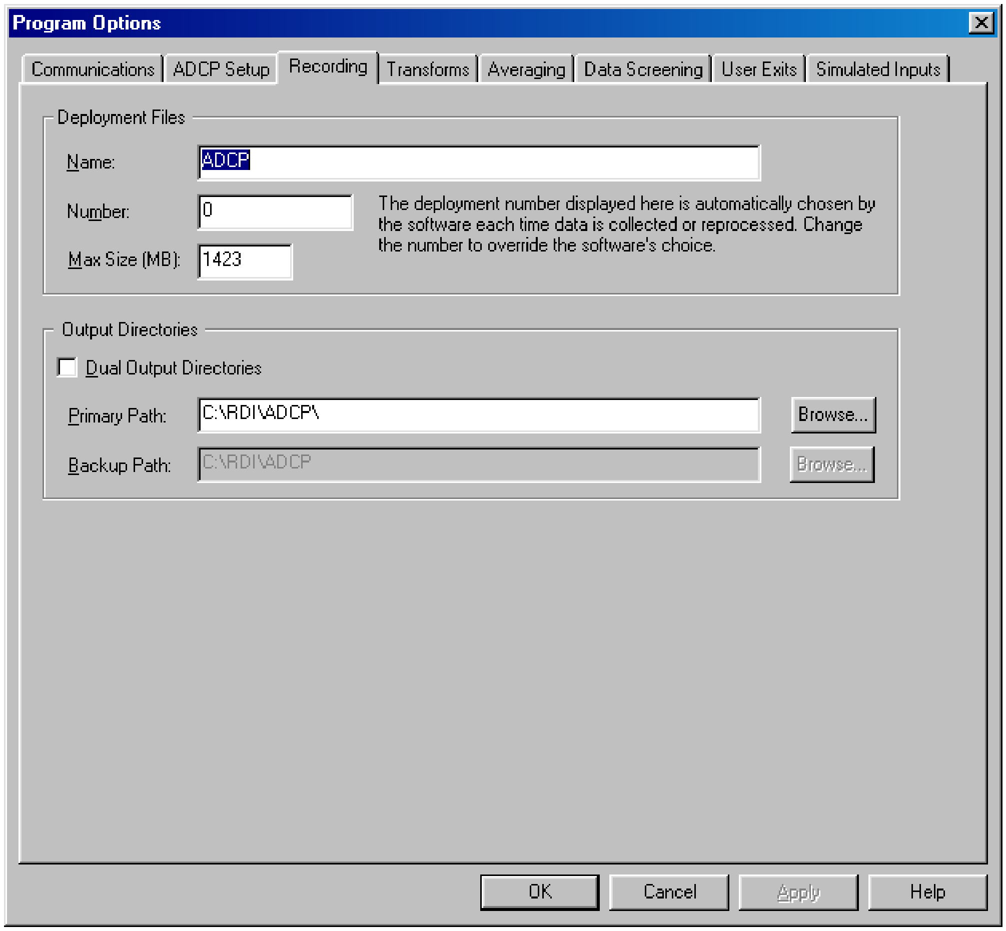
Table 4: Ensemble Time

Frequency (kHz)	w Bottom Track (sec)	w/o Bottom Track (sec)
38	4	2
75	2	1
150	1	1

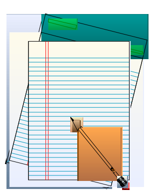


Use this area for notes.

6.6 Recording Tab Setup

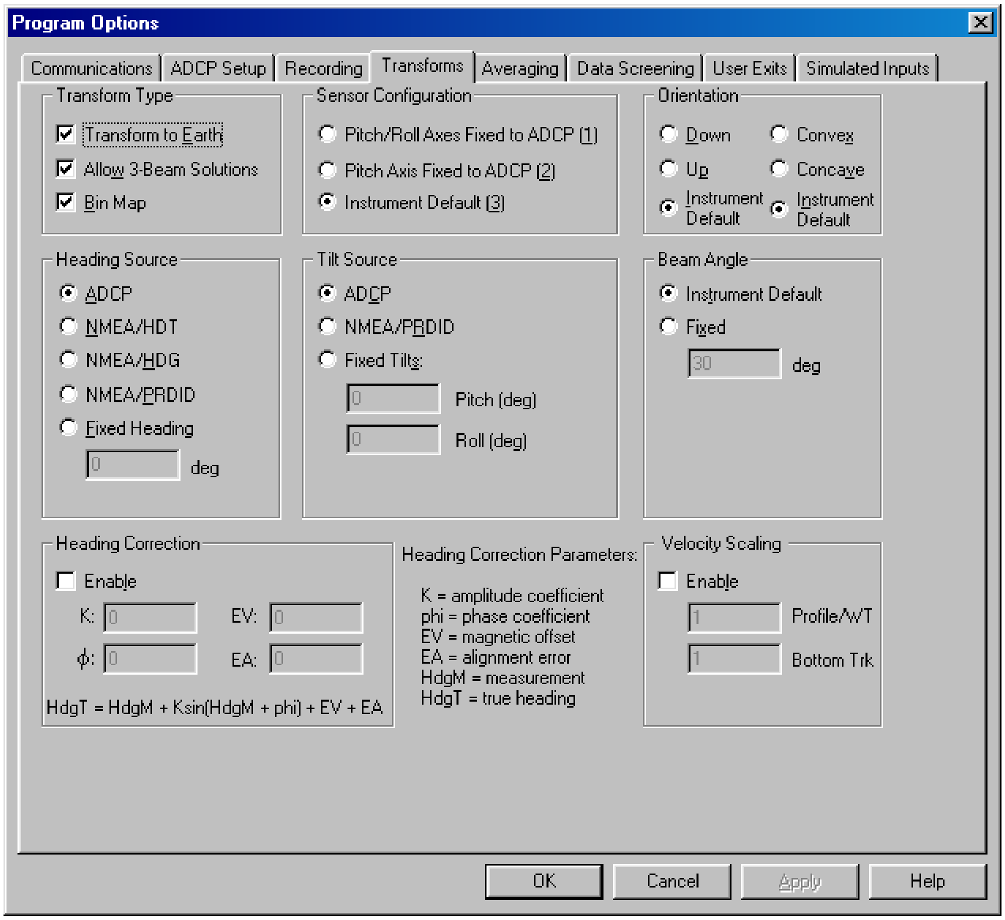


Click the **Recording** tab. Set the deployment name and path to where the data files are recorded.

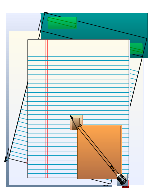


Use this area for notes.

6.7 Transforms Tab Setup



Click the **Transforms** tab and verify the **Transform Type**, **Sensor Configuration**, **Orientation**, **Heading Source**, **Tilt Source**, **Beam Angle**, and **Heading Correction** are set to your input. Click **OK**.



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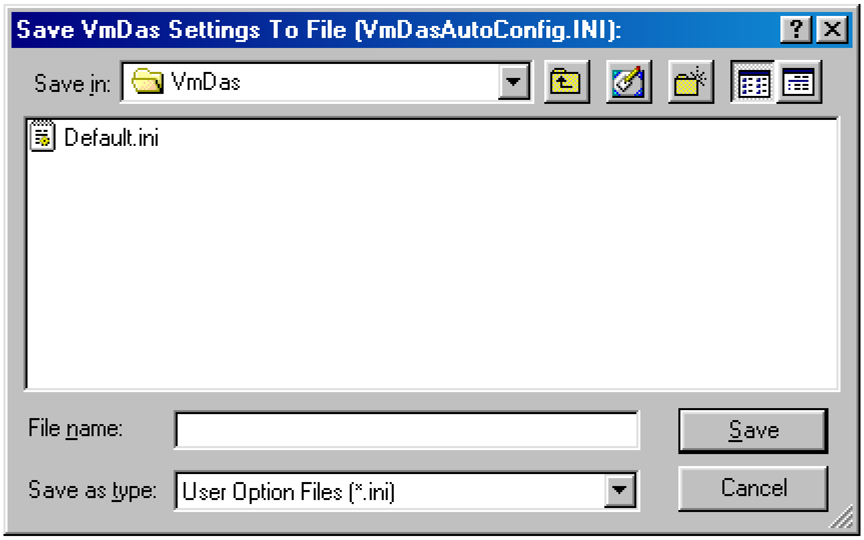
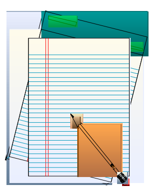
6.8 Save the User Option File

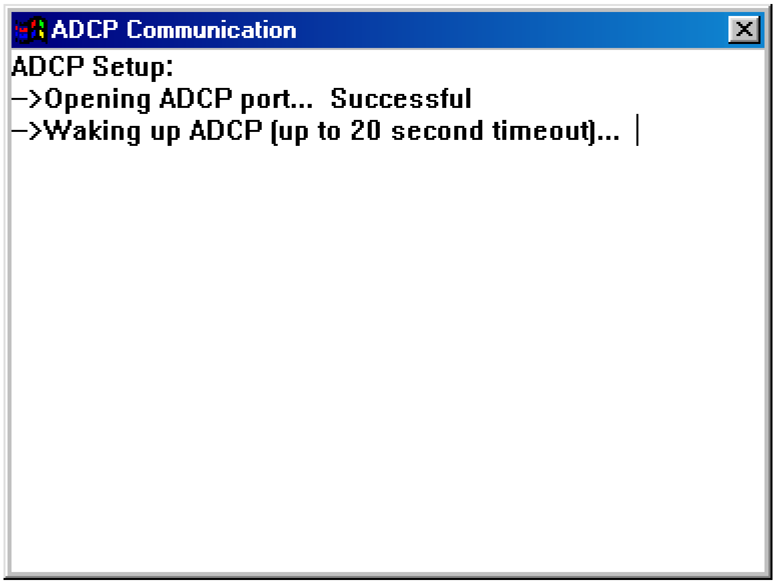


On the **Options** menu, click **Save As**. The options may be saved to a file for later retrieval.

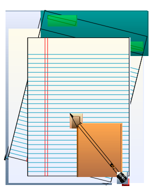


Use this area for notes.

6.9 Begin Collecting Data



On the **Control** menu, click **Go** to begin collecting data. The ADCP Communication and NMEA window will open and show the commands from the command file being sent to the Ocean Surveyor and the Ocean Surveyor's response.



Use this area for notes.

7 Reviewing the Data

7.1 'Where' was the Data?

The quickest way to find out the depth of each depth cell is to display your recorded data using *WinADCP*. The velocity display tells you the distance to the center of each cell. The computed distance assumes that the speed of sound is constant from the transducer to the depth cell. The actual distance is proportional to the average sound speed; if the average sound speed is 1% less than the sound speed at the transducer, the distance to the depth cell is 1% less than the displayed distance.

7.2 'When' was the Data?

The time recorded with each data record is the time of the beginning of the first ping of the ensemble. *VmDas* is designed to ping once per ensemble (single ping data). It leaves a few seconds at the end of each ensemble to allow time for data recording. Hence, the average time of the ensemble is midway between the recorded ensemble time and the time of the next ensemble.

7.3 'What' is the Data?

The Ocean Surveyor records velocity data in units of mm/s. Calibration depends on how well the Ocean Surveyor knew the speed of sound (which it computed based on its measured temperature and the salinity value it was given). A salinity error of 5 ppt introduces less than 0.5% velocity error.

8 A Few Principles of Operation

Consult RDI's Primer (ADCP Principles of Operation: a Practical Primer, Second Edition for BroadBand ADCPs) to learn more about Ocean Surveyor principles of operation. The following are a few points from the Primer that may be worth knowing:

- Horizontal velocity measurement accuracy is unaffected by vertical stratification.
- Stratification has negligible affect on the ability of the Ocean Surveyor to penetrate through the water; concentration of suspended particles is the main factor influencing profiling range.
- Ocean Surveyor measurements are automatically corrected for tilts up to ±20°. In addition to correcting for the beam pointing angles, the Ocean Surveyor maps depth cells to other cells at the same depth.
- If you want to make measurements near the surface from a bottom-mounted Ocean Surveyor, you should minimize the tilt.
- Depth cells are most sensitive to velocities at the center of the depth cell and less sensitive at the top and bottom. This sensitivity is reflected by what we call a 'triangular weighting function'. The details of this weighting function are rarely important for interpretation and use of your data.
- Weak backscatter can sometimes reduce range by a factor of two or more.

9 How to Contact RD Instruments

If you have technical problems with your instrument, contact our field service group in any of the following ways:

RD Instruments	**RD Instruments Europe**
9855 Businesspark Ave.	5 Avenue Hector Pintus
San Diego, California 92131	06610 La Gaude, France
(858) 693-1178	+33(0) 492-110-930
FAX (858) 695-1459	+33(0) 492-110-931
Sales – rdi@rdinstruments.com	rdi@rdieurope.com
Field Service - rdifs@rdinstruments.com	rdifs@rdieurope.com

Web: www.rdinstruments.com

Ocean Surveyor

Commands and Output Data Format

P/N 95A-6022-00 (January 2001)

RD Instruments

Acoustic Doppler Solutions

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Acoustic Doppler Solutions

Ocean Surveyor Commands and Output Data Format

1 Introduction

This guide defines the commands and Output Data Format used by the Ocean Surveyor. Most ADCP settings use the factory-set values (Table 2, page 5). If you change these values without thought, you could ruin your deployment. *Be sure you know what effect each command has before using it*. Call RDI if you do not understand the function of any command.

> **NOTE.** This guide applies to Ocean Surveyor firmware version 23.08. When new firmware versions are released, some commands and/or output data formats may be modified or added. Read the README file on the upgrade disk, or check RDI's web site for the latest changes.

2 Data Communication & Command Format

You can enter commands with an IBM-compatible computer running a terminal emulator program such as RDI's *DumbTerm*. The ADCP communicates with the computer through an RS-232 or RS-422 serial interface. We initially set the ADCP at the factory to communicate at 9600 baud, no parity, and 1 stop bit.

The ADCP wakes up as soon as power is applied. Sending a BREAK signal from a terminal/program awakens the ADCP (press **End** using *DumbTerm*). The BREAK signal must last at least 300 ms. When the ADCP receives a BREAK signal, it responds with a wake-up message similar to the one shown below. The ADCP is now ready to accept commands at the ">" prompt from either a terminal or computer program.

```
Ocean Surveyor Broadband/Narrowband ADCP
RD Instruments (c) 1997-2000
All rights reserved
Firmware Version 23.xx
>
```

3 Command Input Processing

Input commands set ADCP operating parameters, start data collection, run built-in tests (BIT), and asks for output data. All commands (Table 1, page 3) are ASCII character(s) and must end with a carriage return (CR). For example,

```
>WP1<CR> [Your input]
```

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

```
>WP1<CR>      [Your original input]
>             [ADCP response to a valid, no-output command]
```

If you enter a valid command that produces output data, the ADCP executes the command, displays the output data, and then redisplays the ">" prompt. Some examples of commands that produce output data are ? (help menus), PS (system configuration data), and PA (run built-in tests).

If the command is not valid, the ADCP responds with an error message similar to the following.

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

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

3.1 Data Output Processing

After the ADCP completes a data collection cycle, it sends a block of data called a *data ensemble*. A data ensemble consists of the data collected during the ensemble interval (see TE-command). A data ensemble can contain header, leader, velocity, correlation magnitude, echo intensity, status, and bottom track.

ADCP output data can be in either hexadecimal-ASCII (Hex-ASCII) or binary format (set by CF-command). The Hex-ASCII mode is useful when you use a terminal to communicate with, and view data from the ADCP. The binary mode is useful for reducing the ensemble size to as small as possible for use with a computer program. You would not use the binary mode to view data on a terminal because the terminal could interpret some binary data as control codes.

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

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

Table 1 gives a summary of the ADCP input commands, their format, and a brief description of the parameters they control. Refer to the listed page for more information about a command. Table 2, page 5 lists the factory default command settings.

Table 1: ADCP Input Command Summary

Command	Description
?	Shows Command Menu
<BREAK>	Interrupts or wakes up Ocean Surveyor and loads last settings used
V	Display banner
BAnnn	Bottom Track Amplitude Threshold (0 to 255 counts)
BCnnn	Bottom Track Correlation Threshold (0 to 255 counts)
BEnnnn	Bottom Track Error Velocity Threshold (0 to 9999 mm/s)
BPn	Bottom Track Pings (0 = disable, 1 to 999 = number of pings)
BXnnnn	Bottom Track Maximum Tracking Depth (0 to 9999 dm)
CBnnn	Serial Port Control (Baud Rate/Parity/Stop Bits)
CFabcde	Flow Control (a = ensemble cycling, b = ping cycling, c= binary/ASCII, d = serial port, e = not used)
CK	Keep Parameters as User Defaults
CRn	Retrieve Parameters (0 = User, 1 = Factory)
CS	Start Pinging
CXn,n	Trigger Mode (In, Out)
EA±nnnnn	Heading Alignment (-179.99 to 180.00)
ECnnnn	Speed of Sound (1400 to 1600 m/s)
EDnnnnn	Depth of Transducer (0 to 65535 decimeters)
EEnnnn nnnn	Attitude Data Output and Interpolation
EF±nn	External Pitch/Roll Factor (-99 to 99)
EHnnnnn,n	Heading Angle (heading (-179.99 to 180.00); frame (0 = instrument coordinates, 1 = ship coordinates))
EI±nnnnn	Roll Misalignment Angle (-179.99 to 180.00)
EJ±nnnnn	Pitch Misalignment Angle (-179.99 to 180.00)
EP±nnnn, ±nnnn,z	Tilts (pitch (-179.99 to 180.00), roll (-179.99 to 180.00), frame (0 = instrument coordinates, 1 = ship coordinates))
ESnn	Salinity (0 to 40 parts per thousand)
ET±nnnn	Temperature (-5.00 C to +40.00C)
EUn	Orientation (0 = Down, 1 = Up)
EV±nnnnnn	Heading Bias (-179.99 to 180.00)
EXnnnnn	Coordinate Transformations
EZnnnnnnn	Sensor Source (c; d; h; p; r; s; t, u); (0 = manual, 1 = transducer, 2 = synchro)
LC	Clear Fault Log
LD	Display Fault Log

Command	Description
LL	Display Fault List
NAnnn	Narrow Bandwidth Profiling Mode False Target Amplitude Threshold (0 to 255 counts)
NDabc def ghi	Narrow Bandwidth Profiling Mode Data Out (a = velocity, b = power, c = echo intensity, d = percent good, e = status f to i = reserved)
NEnnnn	Narrow Bandwidth Profiling Mode Error Velocity Threshold (0 to 9999 mm/s)
NFnnnn	Narrow Bandwidth Profiling Mode Blanking Distance (0 to 9999 cm)
NNnnn	Narrow Bandwidth Profiling Mode Number of bins (0 to 128 bins)
NPnnn	Narrow Bandwidth Profiling Mode Number of Pings (0 to 999 pings)
NSnnnn	Narrow Bandwidth Profiling Mode Bin Size (1600 to 6400 cm for 38 kHz, 800 to 3200 cm for 75 kHz, 400 to 1600 cm for 150 kHz)
PA	Runs Built-In tests
PCn	Show Sensor Data (0 = help, 2 = sensor data)
PDn	Data Stream Select (n = 0)
PSn	Display System Parameters (0 = Sys Configuration, 1 = fixed leader, 2 = variable leader, 3 = reserved, 4 = ping sequence)
PTn	Diagnostic Tests (0 = help, 3 = receive path, 5 = electronic wrap around, 6 = re-ceive bandwidth)
TC	System Timer Value
TEhh:mm:ss.ff	Time per Ensemble (hh = hours, mm = minutes, ss = seconds, ff = hundredths of seconds)
TPmm:ss.ff	Time Between Pings (mm = minutes, ss = seconds, ff = hundredths of seconds)
TSyymmddhhmmss	Set System Date and Time (Year/Month/Day, Hour: Minute: Second)
WAnnn	Broad Bandwidth Profiling Mode False Target Amplitude Threshold (0 to 255 counts)
WCnnn	Broad Bandwidth Profiling Mode Correlation Threshold (0 to 255 counts)
WDabc de0 000	Broad Bandwidth Profiling Mode Profile Data Out (a = Velocity; b= Correlation; c = Intensity; d = percent good, e = Status)
WEnnnn	Broad Bandwidth Profiling Mode Error Velocity Threshold (0 to 9999 mm/s)
WFnnnn	Broad Bandwidth Profiling Mode Blanking Distance (0 to 9999 cm)
WNnnn	Broad Bandwidth Profiling Mode Number of bins (1 to 128 bins)
WPnnn	Broad Bandwidth Profiling Mode Number of Pings (0 to 999 pings)
WSnnnn	Broad Bandwidth Profiling Mode Bin Size (80 to 6400 cm for 38 kHz, 40 to 3200 cm for 75 kHz, 20 to 1600 cm for 150 kHz)
WVnnn	Broad Bandwidth Profiling Mode Ambiguity Velocity (0 to 390 cm/s)

NOTE. This table applies to the Ocean Surveyor firmware version 23.08.

Table 2: ADCP Factory Defaults

COMMAND	38.8 kHz	75 kHz	150 kHz
BAnnn	30	30	30
BCnnn	220	220	220
BEnnnn	1000	1000	1000
BPnnn	1	1	1
BXnnnn	20000	10000	05000
CBabc	411	411	411
CFabcde	11110	11110	11110
CXn,n	0,0	0,0	0,0
EA±nnnnn	0	0	0
ECnnnn	1500	1500	1500
EDnnnnn	0	0	0
EEnnnnnn	111111	111111	111111
EF±nn	1	1	1
EH±xxxx,y	0,0 (Stationary) 0,1 (Vessel)	0,0 (Stationary) 0,1 (Vessel)	0,0 (Stationary) 0,1 (Vessel)
EI±nnnnn	0	0	0
EJ±nnnnn	0	0	0
EP±xxxx, ±nnnn,z	0,0,0 (Stationary) 0,0,1 (Vessel)	0,0,0 (Stationary) 0,0,1 (Vessel)	0,0,0 (Stationary) 0,0,1 (Vessel)
ESnn	35	35	35
ET±nnnn	2100	2100	2100
EUn	0	0	0
EV±nnnnn	0	0	0
EXnnnnn	00000	00000	00000
EZnnnnnnn	1011101	1011101	1011101
NAnnn	255	255	255
NDnnnnnnnnn	111110000	111110000	111110000
NEnnnn	1000	1000	1000
NFnnnn	1600	800	400
NNnnn	050	050	050
NPnnn	000	000	000
NSnnnn	3200	1600	800
PDn	0	0	0
TEhhmmssff	00000000	00000000	00000000
TPmmssff	000300	000200	000100
WAnnn	255	255	255
WCnnn	120	120	120
WDnnn nnn nnn	111 110 000	111 110 000	111 110 000
WEnnnn	1000	1000	1000
WFnnnn [min]	1600	800	400
WNnnn	128	128	128
WPnnn	1	1	1
WSnnnn	3200	1600	800
WVnnnn	390	390	390

NOTE. This table applies to the Ocean Surveyor firmware version 23.08.

3.2 Command Descriptions

This section lists all ADCP commands. Each listing includes the command's purpose, format, range, and description. When appropriate, we include amplifying notes and examples. If a numeric value follows the command, the ADCP uses it to set a processing value (time, range, percentage, processing flags). All measurement values are in metric units (mm, cm, dm).

? - Help Menus

Purpose : Lists the major help groups.

Format : See description

Description : Entering ? by itself displays the command groups (deploy and System). To display help for one command group, enter *x*?, where *x* is the command group you wish to view. When the ADCP displays the help for a command group, it also shows the format and present setting of those commands. To see the help or setting for one command, enter the command name followed by a question mark. For example, to view the WP-command setting enter WP?.

Examples : See below.

```
>?
Available Commands:

@ ------------------------------ Special Commands
& ------------------------------ Engineering Test Commands
# ------------------------------ Expert Commands
B ------------------------------ Bottom Track Commands
C ------------------------------ Control Commands
E ------------------------------ Environment Commands
L ------------------------------ Fault Log Commands
N ------------------------------ Narrow Band Mode Commands
P ------------------------------ Performance Test Commands
T ------------------------------ Time Commands
V ------------------------------ Display Banner
W ------------------------------ Water Profiling Commands
? ------------------------------ Display Main Menu
```

> **NOTE.** The Special @, &, and # commands are for RDI use only and are not documented in this book.

Break

Purpose : Interrupts the ADCP without erasing present settings.

Format : <BREAK>

Description : A BREAK signal interrupts ADCP processing. It is falling-edge triggered and the transition must last at least 300 ms. A BREAK initializes the system, returns a wake-up (copyright) message, and places the ADCP in the DATA I/O mode. The BREAK command does not erase any settings or data. Using *DumbTerm*, pressing the **End** key sends a BREAK.

Example : <BREAK>

```
Ocean Surveyor Broadband/Narrowband ADCP
RD Instruments (c) 1997-2000
All rights reserved
Firmware Version 23.xx
>
```

V - Display Banner

Purpose : Displays the (wakeup message)

Format : V

Description : Only displays the banner message. This command does not wakeup the ADCP.

Example : See below.

```
>v
Ocean Surveyor Broadband/Narrowband ADCP
RD Instruments (c) 1997-2000
All rights reserved.
Firmware Version: 23.xx
```

3.3 Bottom-Track Commands

The Ocean Surveyor uses these commands for bottom-tracking applications. Bottom-track (BT) commands tell the ADCP to collect speed-over-bottom data and detected range-to-bottom data. Bottom Tracking is ON (BP1) by default. Sending a zero BP-command (BP0) turns off the bottom-tracking process.

BA - Amplitude Threshold

Purpose	:	Sets the minimum value for a valid bottom detection.
Format	:	BA*nnn*
Range	:	*nnn* = 1 to 255 counts
Default	:	BA030
Description	:	BA sets the minimum amplitude of an internal bottom-track filter that determines bottom detection. Reducing BA increases the bottom-track detection range, but also may increase the possibility of false bottom detections.

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

BC - Correlation Threshold

Purpose	:	Sets minimum correlation magnitude for valid velocity data.
Format	:	BC*nnn*
Range	:	*nnn* = 0 to 255 counts
Default	:	BC220
Description	:	Sets a minimum threshold for good bottom-track data. The ADCP flags as bad any bottom-track data with a correlation magnitude less than this value.
Note	:	A count value of 255 is a perfect correlation (i.e. a solid target).

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

BE - Error Velocity Threshold

Purpose	:	Sets maximum error velocity for good bottom-track water-current data.
Format	:	BE*n*
Range	:	*n* = 0 to 9999 mm/s
Default	:	BE1000
Description	:	The ADCP uses this parameter to determine good bottom-track velocity data. If the error velocity is greater than this value, the ADCP marks as bad all four beam velocities (or all four coordinate velocities, if transformed). If three beam solutions are allowed (see EX-command) and only three beams are good, then the data is accepted since four good beams are needed for error velocity calculation.

CAUTION. The default setting is set purposely high. We recommend extreme caution and testing before changing this setting. **Data rejected by this command is lost and cannot be regained.**

BP - Bottom-Track Pings

Purpose	:	Sets the number of bottom-track pings to average together in each data ensemble.
Format	:	BP*n*
Range	:	*n* = 0 to 999 pings
Default	:	BP1
Description	:	BP sets the number of bottom-track pings to average together in each ensemble before sending/recording bottom-track data.
Notes	:	1. The ADCP interleaves bottom-track pings with water-track pings (see TP-command) with the bottom track ping being the first ping in an ensemble. 2. If BP = zero, the ADCP does not collect bottom-track data.

BX - Maximum Tracking Depth

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

Format : BX*nnnn*

Range : *nnnn* = 0 to 99999 decimeters (meters x 10)

Default : BX20000 (38 kHz), BX10000 (75 kHz), BX05000 (150 kHz)

Description : BX sets the maximum tracking depth used by the ADCP during bottom tracking. This prevents the ADCP from searching too long, and too deep for the bottom, allowing a faster ping rate when the ADCP loses track of the bottom.

Example : If you know the maximum depth in the deployment area is 500 meters (5000 decimeters), set BX to a value slightly larger than 5000 dm, say 5250 dm, instead of 9999 dm. Now if the ADCP loses track of the bottom, it will stop searching for the bottom at 5250 dm (525 m) rather than spend time searching down to 9999 dm (999.9 m).

3.4 Control System Commands

The Ocean Surveyor uses the following commands to control certain system parameters.

CB - Serial Port Control

Purpose	:	Sets the RS-232/422 serial port communications parameters (Baud Rate/Parity/Stop Bits).
Format	:	CB*abc*
Range	:	*a* = baud rate, *b* = parity, *c* = stop bits (see description)
Default	:	CB411
Description	:	The ADCP and your external device (dumb terminal, computer software) MUST use the same communication parameters to *talk* to each other. After you enter valid CB parameters, the ADCP responds with a ">" prompt. You may now change the external device's communication parameters to match the ADCP parameters before sending another command.

Table 3: Serial Port Control

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

Setting the Baud Rate in the ADCP. The ADCP can be set to communicate at baud rates from 1200 to 115200. The factory default baud rate is always 9600 baud. The baud rate is controlled via the CB-command. The following procedure explains how to set the baud rate and save it in the ADCP. This procedure assumes that you will be using the program *DumbTerm* that is supplied by RD Instruments.

a. Connect the ADCP to the computer and apply power (see the Read This First book).

b. Start the *DumbTerm* program and wakeup the ADCP by sending a break signal with the **End** key.

c. Send the command CR1 to place the ADCP in the factory default setup.

d. Send the CB-command that selects the baud rate you wish. The following are the typical CB-command settings for different baud rates with no parity and 1 stop bit:

Table 4: Baud Rate

Baud Rate	CB-Command
1200	CB111
2400	CB211
4800	CB311
9600	CB411 (Default)
19200	CB511
38400	CB611
57600	CB711
115200	CB811

e. On the **File** menu, click **Options** to open the *DumbTerm* communication port setup window. Change the communication port settings to match your new CB command setting.

f. Press **OK** to exit the communication port setup window. The ADCP is now set for the new baud rate. The baud rate will stay at this setting until you send a <break>. To permanently save the new baud rate, send the CK command (see "CK - Keep Parameters," page 13). The baud rate will stay at this setting until you send a CR1 command (return to factory defaults).

CF - Flow Control

Purpose : Sets various ADCP data flow-control parameters.

Format : CF*abcde*

Range : *a* = ensemble cycling, *b* = ping cycling, *c*= binary/ASCII, *d* = serial port, *e* = not used

Default : 11110

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

Table 5: Flow Control

Command	Description
CF1xxxx	Automatic Ensemble Cycling – Automatically starts the next data collection cycle after the current cycle is completed. Only a <BREAK> can stop this cycling.
CFØxxxx	Manual Ensemble Cycling – Enters the STANDBY mode after transmission of the data ensemble, displays the “>” prompt, and waits for a new command.
CFx1xxx	Automatic Ping Cycling – Pings immediately when ready.
CFxØxxx	Manual Ping Cycling – Sends a “<” character to signal ready to ping, and then waits to receive an <Enter> before pinging. The <Enter> sent to the ADCP is not echoed. This feature lets you manually control ping timing within the ensemble.
CFxx1xx	Binary Data Output – Sends the ensemble in binary format, if serial output is enabled (see below).
CFxxØxx	Hex-ASCII Data Output – Sends the ensemble in readable hexadecimal-ASCII format, if serial output is enabled (see below).
CFxxx1x	Enable Serial Output – Sends the data ensemble out the RS-232/422 serial interface.
CFxxxØx	Disable Serial Output – No ensemble data are sent out the RS-232/422 interface.
CFxxxx1	Not used
CFxxxxØ	Not used
Example	CF1111Ø (default) selects automatic ensemble cycling, automatic ping cycling, Binary data output, and enables serial output.

NOTE. The *VmDas* program sets the Ocean Surveyor to a manual ensemble mode (CF01110) so that it controls when the ensemble occurs.

CK - Keep Parameters

Purpose : Stores present parameters to non-volatile memory.

Format : CK

Description : CK saves the present user command parameters to non-volatile memory. The ADCP maintains data stored in the non-volatile memory (user settings) even if power is lost. You can recall parameters stored in non-volatile memory with the CR0-command. When CR0 is sent, the command set is restored to values previously saved to non-volatile memory.

CR - Retrieve Parameters

Purpose : Retrieves the command set from non-volatile memory or restores factory defaults.

Format : CR*n*

Range : *n* = 0 (User) to 1 (Factory Default)

Description : If *n* is zero, then the command set previously stored with the CK command (see "CK - Keep Parameters," page 13) is retrieved from non-volatile memory. If *n* is one, then the factory default commands are restored.

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

CS - Start Pinging (Go)

Purpose : Starts the data collection cycle.

Format : CS

Description : The ADCP starts data collection. While collecting data, the ADCP will ignore further commands unless a <BREAK> is sent to interrupt data collection.

CX – Trigger Input/Output

Purpose : The Trigger Input allows the Ocean Surveyor to be pinged by an external +5V logic level signal.

Format : CX*a*,*b*

Range : *a* = 0 to 5

b = 0 to 5

Default : CX0,0

Descriptions : The minimum duration for the Trigger Input is 1 ms. The Input resistance is at least 2.7 kOhm. The Trigger Output is a +5V logic level signal as well. The nominal source resistance of the Trigger Output is 50 Ohms. The command that controls the Trigger Output and Input is CX*a*,*b*, where "*a*" controls the Trigger Input mode, and "*b*" the Trigger Output mode. For flexibility, several modes for the Trigger Input and Output operation have been implemented. See Table 6, page 15 for a description of the command.

Table 6: CX Command Description

Command	Action:	Description
CX 0,b	Trigger Input off	Normal Ocean Surveyor operating mode.
CX 1,b	Positive edge Trigger Input	Used if the Ocean Surveyor is to be Triggered by other equipment. One ping is executed on every rising edge of the Trigger signal. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%.
CX 2,b	Negative edge Trigger Input	Used if the Ocean Surveyor is to be Triggered by other equipment. One ping is executed on every falling edge of the Trigger signal. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%.
CX 3,b	Any edge Trigger Input	Used if the Ocean Surveyor is to be Triggered by other equipment. One ping is executed on every rising and falling edge of the Trigger signal. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%.
CX 4,b	High level Trigger Input	Used if the Ocean Surveyor is to be Triggered by other equipment. The Ocean Surveyor transmits pings as long as the positive level of the Trigger signal is present. In this way, a single ping or multiple pings can be transmitted depending on the duration of the positive level. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%. A time between pings has to be set for cases where multiple pings should be transmitted.
CX 5,b	Low level Trigger Input	Same as CX4,b except the Trigger is active at the low-level of the Trigger signal. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%. A time between pings has to be set for cases where multiple pings should be transmitted.
CX a,0	Trigger Output off	Normal Ocean Surveyor operating mode.
CX a,1	Trigger Output – XMT	The Trigger Output is at a high level during the time the Ocean Surveyor transmits.
CX a,2	Trigger Output – RCV	The Trigger Output is at a high level during the time the Ocean Surveyor receives.
CX a,3	Trigger Output – X/R	The Trigger Output is at a high level during the time the Ocean Surveyor transmits and receives.
CX a,4	Trigger Output – inverted X/R Trigger	Identical to CXa,3, except the signal is inverted. The Trigger Output is at a high level while the OS is not transmitting or receiving.

3.5 Environmental Commands

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

EA - Heading Alignment

Purpose : Corrects for physical heading-like misalignment between the projection of Beam 3 onto the ship's forward-starboard plane and the ship's forward axis.

Format : EA±*nnnnn*

Range : ±*nnnnn* = -179.99 to 180.00 degrees

Default : EA0

Description : EA is a heading-like alignment angle between the projection of the Y axis and the forward axis of the ship used in heading output and for transformation to earth coordinates. EA is a rotation about the mast (M) axis of the ship. It is defined as the heading of the Y instrument axis when the ship is level with ship heading zero. The Y instrument axis is the projection of beam 3 onto the instrument's X-Y plane. Use the EV-command to correct for heading bias (e.g., synchro/stepper signal bias, magnetic variation).

For systems that are fixed in place on a moving vessel and that have an external heading source or an internal heading source, use EA to set the amount of rotation that the Y axis is physically offset from the vessel's centerline (see Figure 1, page 17). For systems that are stationary and have an internal compass that are not on a moving platform, EA is typically set to zero, unless ship attitude output data is desired for other purposes (see the EE command).

NOTE. See the Installation Guide for a description of methods to calibrate EA after installation of an obliquely mounted ADCP (EI and EJ not zero).

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

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

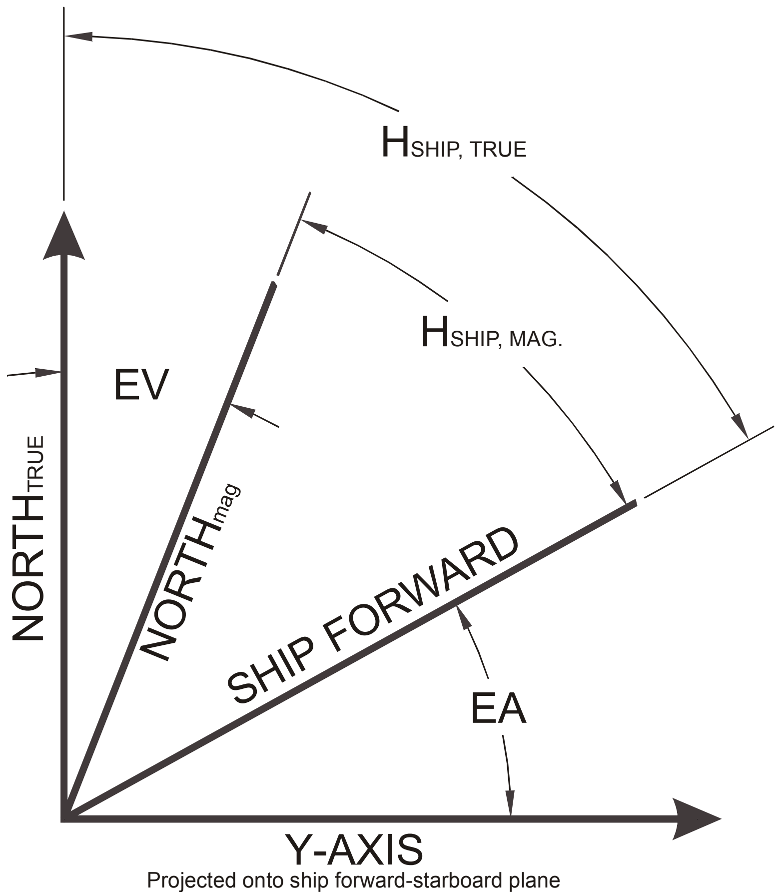


Figure 1. Y-axis Alignment

NOTE. This view shows positive values for EV and EA.

NOTE. If you are using the *VmDas* software, then this setting is performed in the same fashion from the **Transforms** tab. See the *VmDas* User's Guide for details.

EC - Speed of Sound

Purpose	:	Sets the speed of sound value used for ADCP data processing.
Format	:	EC*nnnn*
Range	:	*nnnn* = 1400 to 1600 meters per second
Default	:	EC1500
Description	:	EC sets the sound speed value used by the Ocean Surveyor ADCP to scale depth cell size, and range to the bottom. The ADCP assumes the speed of sound reading is taken at the transducer head. See the primer for information on speed of sound calculations.
Note	:	If the EZ *Speed of Sound* field = 1, the ADCP overrides the manually-set EC value and calculates speed of sound using the values determined by transducer depth (ED), salinity (ES), and transducer temperature (ET). EZ also selects the source for ED, ES, and ET.

ED - Depth of Transducer

Purpose	:	Sets the ADCP transducer depth.
Format	:	ED*nnnnn*
Range	:	*nnnnn* = 0 to 65535 decimeters (meters × 10)
Default	:	ED00000
Description	:	ED sets the ADCP transducer depth. This measurement is taken from sea level to the transducer faces. The ADCP uses ED in its speed of sound calculations. The ADCP assumes the speed of sound reading is taken at the transducer head. See the primer for information on speed of sound calculations.
Note	:	If the EZ *Transducer Depth* field = 1, the ADCP overrides the manually set ED value and uses depth from the depth sensor. If a depth sensor is not available, the ADCP uses the manual ED setting.

EE - Attitude Data Output and Interpolation

Purpose : Specifies the coordinate frame used to reference the specialized attitude data types of Table 7.

Format : EE *abcdef*

Range : Firmware switches (see description)

Default : EE111111

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

Description : Bits "a" and "b" are firmware switches that tell the ADCP what coordinate frame will be used to reference the heading, pitch and roll in the specialized attitude data type of Table 7.

Depending on the EE command bits "c" and "d" (see below), the attitude data will either be the pre-ping sample, an interpolation to the center of the profile for water track, an interpolation to the middle of the bottom echo or water mass layer. The attitude data at these times in addition to the attitude rates will be output for each of the selected ping types (bottom track, water mass or water profile) and in the specified coordinate system(s) if either of the first two EE bits is set.

The coordinate frames specified by bits "a" and "b" are as follows:

Table 7: Coordinate Frame

Ab	Coordinate Frame
00	No specialized attitude data type output
01	Instrument referenced data will be output
10	Ship referenced data will be output
11	Both ship and instrument referenced data will be output

Bits "c" and "d" control the interpolation of attitude information that is used for earth velocity transformations. These bits have the following meaning:

Field	Value	Description
Water Profile		
c	0	Use pre-ping attitude sample only for water ping. Apply the same transformation to all bins. Similar to early RDI firmware. The attitude data output by bits "a" and "b" will be the pre-ping sample.
c	1	Use a single interpolated attitude value based on pre and post ping sample corresponding to half the length of the profile for water profiling. The attitude data output by bits "a" and "b" will be this interpolated value.
c	2	Interpolate attitude across each bin of the profile using the pre and post ping samples of attitude. The attitude data output by bits a and b will be the value corresponding to the first bin of the profile. For the case of an even number of bins, the lower bin will be used.
Bottom Track or Water Mass		
d	0	Use pre-ping attitude sample only for each bottom and/or water mass ping. Similar to early RDI firmware.
d	1	Use a single interpolated attitude value based on pre and post ping sample corresponding to the time when the transmit pulse is halfway across the bottom and/or water mass layer for bottom track and water mass layers, respectively.

Bit "e" controls the output of Attitude Command Parameters. Bit e = 1 causes this data type to be output. See “Binary Fixed Attitude Data Format,” page 62 for a description of this data type.

Bit "f" controls the type of beam velocity data. Setting bit "f" set to 1 results in nominal 30° beam coordinate velocities output in the ensemble (later firmware will have the correction for autocorrelation peak movement and beam angle change with temperature). Setting Bit "f" to 0 results in raw beam velocities output in the ensemble.

EF - External Pitch/Roll Factor

Purpose : Applies an integer factor to pitch and roll inputs.

Format : EF±*nn*

Range : *n* = -99 to 99

Default : EF1

Description : The EF command applies an integer divisor or a multiplier to pitch and roll inputs received from an external synchro (e.g., EZxxx22xxx). For positive EF command inputs, a divisor is applied. For negative EF command inputs, a multiplier is applied. The range of divisors or multipliers is 1 to 99. When the EF-command is set to zero it forces pitch and roll to zero.

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

EH - Heading Angle

Purpose : Sets the ADCP heading and the coordinate frame (instrument or ship) to which EH-command input refers.

Format : EH±*xxxx*, *y*

Range : ±*xxxx* = -179.99 to +180.00 degrees

y = 0 for instrument coordinates

y = 1 for ship coordinates

Default : EH0,0 (Stationary systems), EH0,1 (Vessel)

Description : EH sets the ADCP heading and heading coordinate frame if both arguments are entered.

EH sets the ADCP heading if only one argument is entered. This heading value is assumed to be in instrument coordinates.

Figure 2, page 28 shows transducer beam axes and tilt signs.

EH may be entered after the unit is commanded to ping (CS command) and will be used in subsequent pings.

Example : Convert pitch and roll values of +14 degrees and -3.5 degrees to EP-command values referenced to ship coordinates.

```
Pitch in hundredths = 14.00 × 100 = 1400
Roll in hundreths = -3.50 × 100 = -350
EP 1400, -350, 1            (+ in front of 1400 is optional)
```

Note : If the EZ *Roll and Pitch* fields = 1, the ADCP overrides the manually-set EP value and uses roll from the transducer's internal tilt sensor. If the EZ *Roll and Pitch* fields = two the ADCP takes roll from an external synchro. If EZ *Roll and Pitch* fields are zero the ADCP uses the manual EP command settings.

See the EZ command for more details and on restrictions for the case of mixed pitch and roll sources.

EI - Roll Misalignment Angle

Purpose : Corrects for a physical roll-like misalignment between the x-axis of the instrument and the ship's starboard axis.

Format : EI±*nnnnn*

Range : ±*nnnnn* = -179.99 to 180.00 degrees

Default : EI0

Description : EI is a rotation about the ship's forward axis. It is defined as the roll of the ship when the instrument is level.

For systems that are fixed in place on a moving vessel and that have an external roll source or an internal roll source, use EI to set the amount of rotation that the instrument's x-axis is physically offset from the ship's starboard axis. Note that EI command can also be used to align an upward pointing unit (e.g., mounted on a submarine) to the ship's axis.

For systems that are stationary and have an internal compass, EI is typically set to zero since the velocity data is referenced to either beam, instrument or geographic coordinates instead of ship coordinates. However, a non-zero value may be used if ship attitude output data is desired for other purposes (see the EE command).

NOTE. See the Installation Guide for a description of methods to calibrate EI after installation of the ADCP.

EJ - Pitch Misalignment Angle

Purpose : Corrects for a physical pitch-like misalignment between the y-axis of the instrument and the ship's forward axis.

Format : EJ±*nnnnn*

Range : ±*nnnnn* = -179.99 to 180.00 degrees

Default : EJ0

Description : EJ is a rotation about the ship's starboard axis. It is defined as the roll of the ship when the instrument is level.

For systems that are fixed in place on a moving vessel and that have an external pitch source or an internal pitch source, use EJ to set the amount of rotation that the instrument's y-axis is physically offset from the ship's forward axis.

For systems that are stationary and have an internal compass, EJ is typically set to zero since the velocity data is referenced to either beam, instrument or geographic coordinates instead of ship coordinates. However, a non-zero value may be used if ship attitude output data is desired for other purposes (see the EE command).

> **NOTE.** See the Installation Guide for a description of methods to calibrate EJ after installation of the ADCP.

EP - Pitch and Roll Angles

Purpose	:	Sets the ADCP pitch (tilt 1) and, optionally, the roll (tilt 2) and the coordinate frame (instrument or ship) to which EP-command pitch and roll inputs refer. Alternatively, the EP commands may be used with single arguments, in which case it is assumed that the pitch and roll inputs represent the pitch and roll of the instrument rather than those of the ship.
Format	:	EP±*xxxx*, ±*yyyy*, *z*
Range	:	±*xxxx and* ±*yyyy* = -179.99 to +180.00 degrees *z* = 0 for instrument coordinates, *z* = 1 for ship coordinates
Default	:	EP0,0,0 (Stationary), EP0,0,1 (Vessel)
Description	:	EP sets the ADCP pitch (tilt 1) and roll (tilt 2) and the pitch/roll coordinate frame if all three arguments are entered. EP sets the ADCP pitch (tilt 1) if only one argument is entered. This pitch value is assumed to be in instrument coordinates. If only two fields are entered, a command entry error is issued. Figure 2, page 28 shows transducer beam axes and tilt signs. EP may be entered after the unit is commanded to ping (CS command) and will be used in subsequent pings.
Example	:	Convert pitch and roll values of +14 degrees and -3.5 degrees to EP-command values referenced to ship coordinates.

```
Pitch in hundredths = 14.00 × 100 = 1400
Roll in hundredths = -3.50 × 100 = -350
```

```
EP 1400, -350, 1           (+ in front of 1400 is optional)
```

Note : If the EZ *Roll and Pitch* fields = 1, the ADCP overrides the manually-set EP value and uses roll from the transducer's internal tilt sensor. If the EZ *Roll and Pitch* fields = 2, the ADCP takes roll from an external synchro. If EZ *Roll and Pitch* fields are 0, the ADCP uses the manual EP command settings.

See the EZ command for more details and on restrictions for the case of mixed pitch and roll sources.

ES - Salinity

Purpose : Sets the water's salinity value.

Format : ES*nn*

Range : *nn* = 0 to 40 parts per thousand

Default : ES35

Description : ES sets the water's salinity value. The ADCP uses ES in its speed of sound calculations. The ADCP assumes the speed of sound reading is taken at the transducer head.

ET - Temperature

Purpose : Sets the water's temperature value.

Format : ET±*nnnn*

Range : ±*nnnn* = -5.00 C to +40.00 C

Default : ET2100

Description : ET sets the water's temperature value. The ADCP uses ET in its speed of sound calculations (see the primer). The ADCP assumes the speed of sound reading is taken at the transducer head.

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

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

Note : If the EZ *Temperature* field = 1, the ADCP overrides the manually-set ET value and uses temperature from the transducer's temperature sensor. If neither sensor is available, the ADCP uses the manual ET setting.

EU - Up/Down Orientation

Purpose : Sets the ADCP up/down orientation.

Format : EU*n*

Range : *n* = 0 or 1 (0 = down, 1 = up)

Default : EU0

Description : In conjunction with the EZ command, EU is used to manually specify the orientation of the ADCP.

EV - Heading Bias

Purpose : Corrects for electrical/magnetic bias between the ADCP heading value and the heading reference.

Format : EV±*nnnnn*

Range : ±*nnnnn* = -179.99 to 180.00 degrees

Default : EV0

Description : EV is the heading angle that counteracts the electrical bias or magnetic variation (declination) between the ADCP and the heading source. Use the EA-command to correct for physical heading misalignment between the ADCP and a vessel's centerline.

For systems that are fixed in place on a moving vessel and that have an external heading source, use EV to set the amount of electrical bias between the vessel's heading source reading and the ADCP's output heading value. The EV command is usually required only when using an external gyrocompass that has a stepper output voltage or that has a non 1:1 turns ratio. If the gyrocompass has a 1:1 turns ratio, EV is usually set to zero.

For systems that are stationary and have an internal compass, use EV to counteract the effects of magnetic variation at the deployment site.

For many synchro systems, an independent method is available to dial in a heading offset from the front panel of the VM chassis, so that the EV command is not needed for this purpose.

Examples : 1. A vessel-mounted ADCP is receiving heading from an external gyrocompass that has a 360:1 turns ratio. When you initialize the system, the ADCP heading output constantly reads 10 degrees higher (+10 degrees) than the gyro's value. To counteract this electrical bias caused by incorrect synchronization, you must enter a heading bias value of -10. To convert -10 to an EV-command value, multiply the desired bias angle in degrees by 100: EV = -10.00 × 100 = -1000 = EV-1000.

2. A bottom-mounted ADCP is receiving heading from its internal compass. A magnetic variation chart for the deployment area shows a variation of W3.5 (-3.5). To counteract the effects of this magnetic field, you must enter a heading bias value of -3.5. To convert -3.5 to an EV-command value, multiply the desired bias angle in degrees by 100: EV = -3.5 × 100 = -350 = EV-350.

NOTE. In firmware version 14.09 and lower, the EB command was used in place of the EV command. If you are using command files created for these firmware versions, make sure you change the EB command to the new EV command.

If you are using the *VmDas* software, then this setting is performed in the same fashion from the **Transforms** tab. See the *VmDas* User's Guide for details.

EX - Coordinate Transformation

Purpose : Sets the coordinate transformation processing flags.

Format : EX*nnnnn*

Range : Firmware switches (see Table 8, page 25)

Default : EX00000

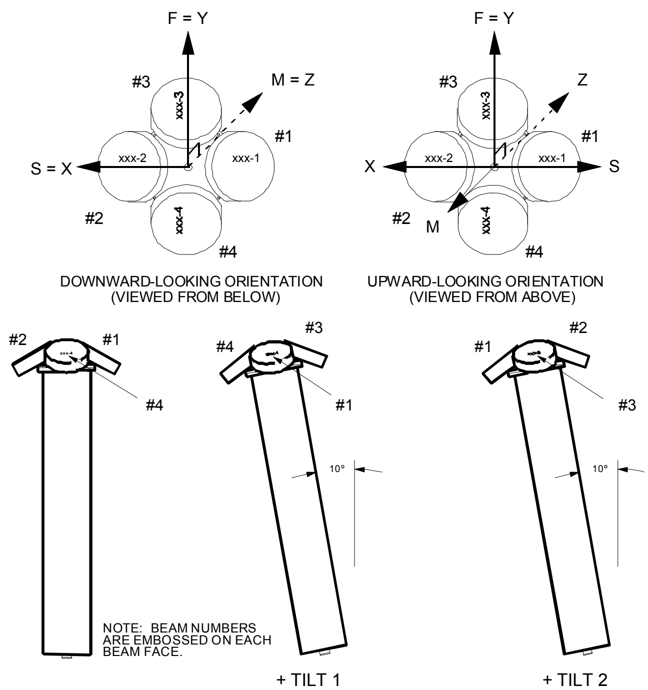
Description : EX sets firmware switches that control the coordinate transformation processing for velocity (see "Binary Velocity Data Format," page 58)and percent-good output data.

Table 8: Coordinate Transformation Processing Flags

Bit Number	Description
EX00xxx	No transformation. Radial beam coordinates, i.e., 1, 2, 3, 4. Heading/Pitch/Roll not applied.
EX01xxx	Instrument coordinates. X, Y, Z components relative to the ADCP. Heading/Pitch/Roll not applied.
EX100xx	Unleveled Ship coordinates (Note 1) S, F, M components relative to the ship. Heading, pitch and roll not applied. EA, EI and EJ commands affect velocity rotations.
EX101xx	Leveled Ship coordinates (Note 1) S, F, M components relative to the projected ship's forward axis and the earth's horizontal plane. Heading not applied. Pitch and roll applied. The EA command always affects velocity rotations. The EI and EJ commands affect velocity rotations if either external pitch/roll sensors or external heading sensor is selected with the EZ or EP command.
EX110xx	Unleveled Earth coordinates (Note 1). Heading applied, but pitch and roll assumed zero for the raw sensor data, no matter whether referring to ship or instrument axes as selected by the EZ and EP command. The EA , EI and EJ commands always affects velocity rotations if either external sensors are selected with the EZ, EP or EH command.
EX111xx	Earth coordinates (Note 1) East, North, Vertical components relative to Earth East, North and Up components. Heading, pitch and roll applied for velocity rotations. EA, EI and EJ commands affect velocity rotations if external sensors are selected by the EZ, EP or EH command. Sometimes called geographic coordinates.
Exxx1xx	Use tilts (pitch and roll) in transformation
Exxxx1x	Allows 3-beam solutions if one beam is below the correlation threshold set by WC
Exxxxx1	Allow bin mapping (only performed for leveled ship and leveled earth transformations).

Notes : 1. For ship and earth-coordinate transformations to work properly, you must set Heading, Pitch and Roll alignment (EA, EI and EJ) and Heading Bias (EV) correctly. You also must ensure that the tilt and heading sensors are active (EZ).

NOTE. *VmDas* set the Ocean Surveyor ADCP to beam coordinates (EX00000).



SIGN OF ANGLE FOR A UNIT FACING	UP	DOWN
TILT 1 (PITCH) BEAM #3 HIGHER THAN BEAM #4	+	+
TILT 2 (ROLL) BEAM #2 HIGHER THAN BEAM #1	+	-

Figure 2. ADCP Coordinate Transformation

NOTE. Depicted alignment of the ship and instrument axes is for the case EA0, EJ0. Up/Down orientation is specified by the EI, EU and EZ commands.

Downward:

a. EI0 when either up/down sensor indicates downward orientation

b. EU and EZ commands specify a downward looking instrument.

Upward:

a. EI180 when either up/down sensor indicates downward orientation

b. EU and EZ commands specify an upward looking instrument.

EZ - Sensor Source

Purpose : Selects the source of environmental sensor data.

Format : EZ*cdhprstu*

Range : Firmware switches (see description)

Default : EZ1011101

Description : Setting the EZ-command firmware switches tells the ADCP to use data from a manual setting or from an associated sensor. When a switch value is nonzero, the ADCP overrides the manual E-command setting and uses data from the appropriate sensor. If no sensor is available, the ADCP defaults to the manual E-command setting in instrument coordinates regardless of the coordinate frame parameter of the E-command setting.

Refer to Figure 3, page 31 for a description of how the EV and EA commands are used for internal and external heading sensors.

The following table shows how to interpret the sensor source switch settings.

Table 9: Sensor Source Switch Settings

FIELD		VALUE = 0	VALUE = 1	VALUE = 2
C	Speed of sound	Manual EC	Calculates using ED, ES, ET	SVP-16 sensor
D	Depth	Manual ED	Depth sensor	SVP-16 sensor
H	Heading	Manual EH	Internal transducer sensor	External synchro/Stepper Gyro
P	Pitch (tilt 1)	Manual EP	Internal transducer sensor	External synchro Gyro
R	Roll (tilt 2)	Manual ER	Internal transducer sensor	External synchro Gyro
S	Salinity	Manual ES	Conductivity sensor	Not allowed
T	Temperature	Manual ET	Internal transducer sensor	SVP-16 sensor
U	Up/Down Orientation	Manual EU	Internal transducer sensor	N/A

Example : EZ11122010 means calculate speed of sound from readings, use manual depth, transducer heading, external tilt sensors, manual salinity, transducer temperature, manual up/down orientation.

Note : When you send a PS1-command, the displayed Fixed Leader data shows the available sensors connected to the ADCP. To interpret this PS1 field, convert the value to binary. Although you can enter a “2” (for external synchro) as part of the EZ-command string, the ADCP only displays zeroes and ones (0 = manual, 1 = either internal or external sensor) (see "Binary Fixed Leader Data Format," page 55).

If EZ pitch is one (internal sensor), a pendulum pitch correction will be applied that removes the effect of roll on pitch. This effect is common to most tilt sensors (electrolytic tilt and pendulum).

The Pitch and Roll bits "p" and "r" must both reference the same coordinate system. The following table summarizes the valid EZ and EP inputs.

EZpr	EP Coordinate Frame	Comment
00	Ship or Instrument (EP X,X,X)	Allowed
01	Instrument (EP X,X,0)	Allowed
02	Ship (EP X,X,1)	Allowed
10	Instrument (EP X,X,0)	Allowed
10	Ship (EP X,X,1)	Not Allowed
11	Not Applicable	Allowed
12	Not Applicable	Not Allowed
20	Ship (EP X,X,1)	Allowed
20	Instrument (EP X,X,0)	Not Allowed
21	Not Applicable	Not Allowed
22	Not Applicable	Allowed

Note : "X" in the above table is an arbitrary value.

When specifying hard-coded values (either EZpr bit 0), the EP command must be in the correct coordinate frame. To avoid conflicts when setting EZpr, these bits must set to non-zero values until the EP command has been entered with the coordinate frame that matches desired non-zero EZpr.

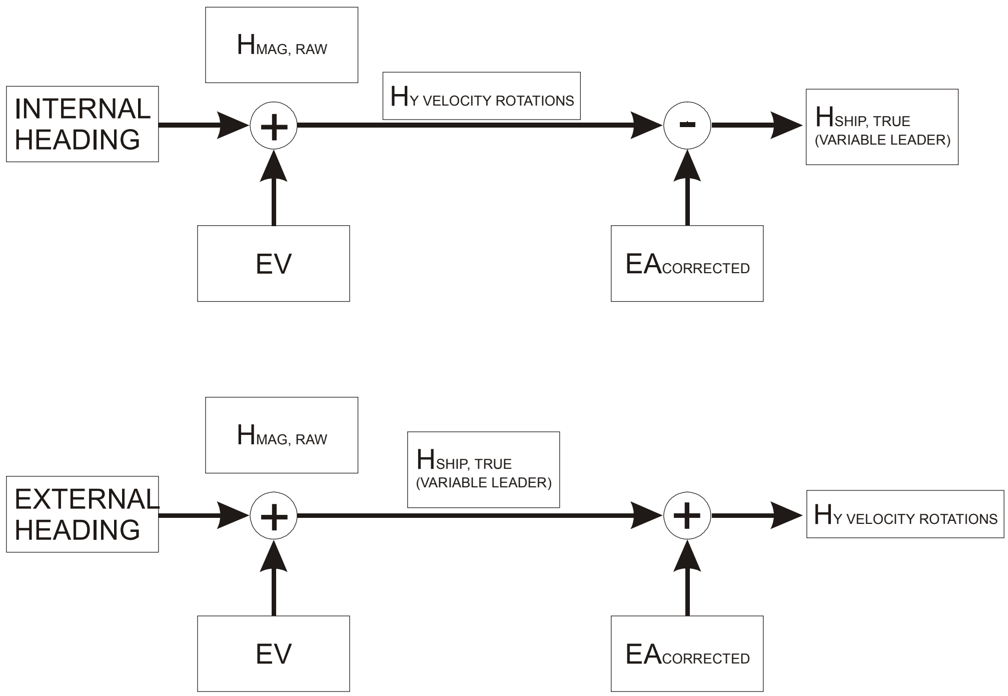


Figure 3. Heading Sensor Source and the Application of EV and EA.

3.6 Fault Log Commands

The Ocean Surveyor uses the following commands to aid in troubleshooting and testing.

LC - Clear Fault Log

Purpose : Clears the fault log.

Format : LC

Description : This commands removes all recorded faults from the fault log..

Recommend : Use as needed.

Example

```
>LC
>LD  No faults recorded.
```

LD - Display Fault Log

Purpose : Displays the fault log.

Format : LD

Description : This commands shows all faults recorded in the fault log. This may aid in troubleshooting.

Recommend : Use as needed.

Example

```
>LD
Time of first fault:    2000/05/02,13:09:50
Overflow count:              0

Fault Log:
     Code            Count            Time                  Parameter
202   RTC POWER          1       2000/05/02,13:09:50       08410003h

End of fault log.
```

LL - Display Fault List

Purpose : Lists possible faults.

Format : LL

Description : This commands lists all fault conditions that are checked for by the ADCP.

Recommend : Use as needed.

Example

```
>LL
Fault List:
Code    Fault
001     RESET
100     FPGA
201     RTC BATT LO
202     RTC POWER
203     RTC CAL
300     COM TIMEOUT
301     BUFFER OUT
400     RAM FAULT
401     ROM FAULT
402     MALLOC FAIL
500     GYRO COM
501     GYRO CKSUM
502     TCM2 COM
503     TCM2 CKSUM
504     TEMP INIT
505     TEMP READ
506     TEMP RANGE
600     SYS CONFIG
601     CMD PARAMS
602     COM PARAMS
```

3.7 Narrow Bandwidth Profiling Commands

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

NA – Narrow Bandwidth Profiling False Target Threshold

Purpose	:	Sets a false target (fish) filter
Format	:	NA*n*
Range	:	*n* = 0 to 255 counts
Default	:	NA255
Description	:	The ADCP uses the NA-command to screen profile data for false targets (usually fish). NA sets the maximum difference between echo intensity readings among the four profiling beams. If the NA threshold value is exceeded, the ADCP rejects velocity data on a cell-by-cell basis for either the affected beam (fish detected in only one beam) or for the affected cell in all four beams (fish detected in more than one beam). This usually occurs when fish pass through one or more beams.
Notes	:	A NA value of 255 disables this feature. A typical setting is 55 to 75.

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

ND - Narrow Bandwidth Profiling Data Out

Purpose	:	Selects the type of data that is output by the ADCP
Format	:	ND *abc def ghi*
Range	:	*a* = 0 to 1, *b* = 0 to 1, *c* = 0 to 1, *d* = 0 to 1, *e* = 0 to 1, *f* = 0 to 1, *g* = 0 to 1, *h* = 0 to 1, *i* = 0 to 1
Default	:	ND111 110 000
Description	:	The ND selects the type of data that is output depending on the value in each field. Setting a bit to 1 enables the output while a 0 disables output. The fields listed below.

a = velocity	*d* = percent good	*g* = reserved
b = power	*e* = status	*h* = reserved
c = echo intensity	*f* = reserved	*i* = reserved

Notes	:	If NP = 0, then no narrowband profile data is output regardless of the ND setting.

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

NE - Narrow Bandwidth Profiling Error Velocity Threshold

Purpose	:	Sets the maximum error velocity for good profile data.
Format	:	NE*n*
Range	:	*n* = 0 to 9999 mm/s
Default	:	NE1000
Description	:	NE sets a threshold value used to flag water-current data as good or bad. If the ADCP's error velocity value exceeds this threshold, it flags data as bad for a given depth cell. The NE-command screens for error velocities in both beam and transformed-coordinate data.

CAUTION. The default setting is set purposely high. We recommend extreme caution and testing before changing this setting. **Data rejected by this command is lost and cannot be regained.**

NF - Narrow Bandwidth Profiling Blank after Transmit

Purpose	:	Moves the location of first depth cell away from the transducer head to allow the transmit circuits time to recover before the receive cycle begins.
Format	:	NF*n*
Range	:	*n* = 0 to 9999 cm
Default	:	NF1600 (38kHz), NF800 (75kHz), NF400 (150kHz)
Description	:	NF positions the start of the first depth cell at some vertical distance from the transducer head. This allows the ADCP transmit circuits time to recover before beginning the receive cycle. In effect, NF blanks out bad data close to the transducer head, thus creating a depth window that reduces unwanted data in the ensemble.
Notes	:	Small NF values may show ringing/recovery problems in the first depth cells that cannot be screened by the ADCP. We recommend you set NF to no less than the default value.

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

NN - Narrow Bandwidth Profiling Number of Profile Depth Cells

Purpose	:	Sets the number of depth cells collected in each profile.
Format	:	NN*nnn*
Range	:	*nnn* = 1 to 128 depth cells
Default	:	NN50
Description	:	NN Sets the number of depth cells over which the ADCP collects data. The range of the profile is set by the number of depth cells (NN) times the size of each depth cell (NS).

NP - Narrow Bandwidth Profiling Pings Per Ensemble

Purpose	:	Sets the number of narrowband profile pings to average together in each data ensemble.
Format	:	NP*nnn*
Range	:	*nnn* = 0 to 999 pings
Default	:	NP0
Description	:	NP sets the number of narrowband profile pings to average together in each ensemble before sending profile data.
Notes	:	The ADCP interleaves profile pings with bottom-track pings (see TP-command). If NP = zero, the ADCP does not collect narrowband profile data.

NOTE. When using *VmDas*, the typical setup will use single ping (NP1) when doing Narrow Bandwidth profiling.

NS - Narrow Bandwidth Profiling Depth Cell Size

Purpose	:	Selects the volume of water for one measurement cell.
Format	:	NS*n*
Range	:	*n* = 1600 to 6400 cm for 38kHz systems. *n* = 800 to 3200 cm for 75kHz systems. *n* = 400 to 1600 cm for 150kHz systems.
Default	:	NS3200 (38kHz), NS1600 (75kHz), NS800 (150kHz)
Description	:	NS Sets the size of depth cells over which the ADCP collects data. The range of the profile is set by the number of depth cells (NN) times the size of each depth cell (NS).

3.8 Performance and Testing Commands

The ADCP uses the following commands for calibration and testing.

PA - Built-In Tests

Purpose : Sends and displays the results of a series of ADCP system diagnostic tests.

Format : PA

Description : These diagnostic tests check the major ADCP modules and signal paths. We recommend you run this command before data collection.

Example : See below.

```
>PA
RAM test...........PASS
ROM test...........PASS
```

PC - Show Sensor Data

Purpose : Displays output of various ADCP sensors.

Format : PC*nnn*

Range : *nnn* = 0 to 2

Description : PC0 displays the help menu. PC1 is reserved for RDI use. PC2 shows sensor data for heading, pitch, roll, and temperature.

Examples : See below.

Note : Heading display is raw data from sensor and does not use any heading corrections. Heading source will correspond to source selected by the EZ-command.

```
>PC0
0=Help;2=Show Sensors

>PC2
Heading     Pitch      Roll        Temperature
 (int)      (int)      (int)       cts    degs
 000.0      +00.0      +00.0       0FF6   -36.3
 000.0      +00.0      +00.0       0FF5   -36.2
 000.0      +00.0      +00.0       0FF5   -36.2
 000.0      +00.0      +00.0       0FF5   -36.2
>
```

PD - Data Stream Select

Purpose	:	Selects the type of ensemble output data structure.
Format	:	PD*n*
Range	:	*n* = 0
Description	:	The Ocean Surveyor currently supports only the PD0 output data structure.

PS - Display System Parameters

Purpose	:	Displays ADCP system configuration data.
Format	:	PS*n*
Range	:	*n* = 0 to 4
Description	:	See below.

PS0

PS0 displays system configuration info.

```
>PS0
       Frequency:  38400 HZ
   Configuration:  4 BEAM, JANUS
 Transducer Type:  ROUND 36x36
  Beamformer Rev:  A02 or later
      Beam Angle:  30 DEGREES
    Beam Pattern:  CONVEX
     Orientation:  DOWN
    CPU Firmware:  23.03
    FPGA Version:  XA
 Attitude Sensor:  SYNCHRO
```

PS1

PS1 displays the contents of the PD0 fixed leader (i.e., fixed system commands and hardware/firmware information) in Hex-ASCII or binary format with the Least Significant Byte (LSB) first (see the Output Data Format book). For example, a Hex-ASCII output may look like this:

```
>PS1
3300000E0449020000048001002003C8000100156400000000000000000000005D1D06043603010100
00270000000000000000006003
>
```

PS2

PS2 displays the contents of the PD0 variable leader (i.e., variable system commands and sensor readings) in Hex-ASCII or binary format with the Least Significant Byte (LSB) first (see the Output Data Format book). For example, a Hex-ASCII output may look like this:

```
>PS2
3D80000000045020D12222808000000A60500007D0EE8FEA9002300C8FF0000000000000000000000
0000000000000000000000000000000000000000000000000724
>
```

PS3

PS3 is reserved for RDI use.

PS4

PS4 displays the ping sequence.

```
>PS4
Ping Sequence:  BW
>
```

PT - Diagnostic Tests

Purpose	:	Displays results of the ADCP system diagnostic tests.
Format	:	PT*nnn*
Range	:	*n* = 0 to 200
Description	:	See below

PTØ - Help

Displays the test menu (shown below). As implied by the NOTE, adding 100 to the test number repeats the test continually until the ADCP receives a <BREAK>. Sending PT2ØØ runs all tests. PT3ØØ runs all tests continually until the ADCP receives a <BREAK>.

```
>PT0
Built In Tests
----------------
 PT0 = Help
 PT1 = NA
 PT2 = NA
 PT3 = Receive Path Test
 PT4 = NA
 PT5 = NA
 PT6 = Receive Bandwidth Test
 PT7 = NA
 PT8 = NA
 PT9 = NA
NOTE: Add 100 for automatic test repeat
PT200 = All tests
```

PT3 - Receive Path Test

This test displays receive path characteristics.

```
>PT3
Correlation Magnitude:
      Lag    Bm1      Bm2      Bm3      Bm4
       0     1.00     1.00     1.00     1.00
       1     0.84     0.67     0.86     0.77
       2     0.68     0.32     0.68     0.36
       3     0.52     0.10     0.54     0.14
       4     0.55     0.11     0.53     0.12
       5     0.54     0.01     0.52     0.06
       6     0.58     0.06     0.53     0.01
       7     0.54     0.08     0.50     0.01

RSSI: 13 11 10 13
```

NOTE. The PT3 test does not have a pass/fail condition, but indicates systems parameters sensitive to external interference. PT3 Test is considered to have normal values if the correlation values at lag 5 and greater are less than 0.50.

PT6 - Receive Bandwidth Test

This test measures the receive bandwidth of the system.

```
>pt6
Receive Bandwidth:
.......................................
  Expected      Bm1    Bm2    Bm3    Bm4
  --------     -----  -----  -----  -----
     3840       3922   3792   3766   3895
```

NOTE. The PT6 test does not have a pass/fail condition, but indicates systems parameters sensitive to external interference. The PT6 Test is considered to have normal values if the received bandwidth for each beam is within ± 20% of the expected bandwidth.

3.9 Timing Commands

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

TC - System Timer Value

Purpose	:	Outputs the system timer raw value.
Format	:	TC
Description	:	For RDI use only.

TE - Time Per Ensemble

Purpose	:	Sets the minimum interval between data collection cycles (data ensembles).
Format	:	TE*hhmmssff*
Default	:	00:00:00.00
Range	:	*hh* = 00 to 23 hours *mm* = 00 to 59 minutes *ss* = 00 to 59 seconds *ff* = 00 to 99 hundredths of seconds
Description	:	During the ensemble interval set by TE, the ADCP transmits the number of pings set by the WP, NP, and BP commands. If TE = 0, the ADCP starts collecting the next ensemble immediately after processing the previous ensemble.
Example	:	TE0115300 tells the ADCP to collect data ensembles every 1 hour, 15 minutes, 30 seconds.
Notes	:	The ADCP automatically increases TE if ((WP + NP + BP) x TP > TE). The time tag for each ensemble is the time of the first ping of that ensemble, not the time of output.

TP - Time Between Pings

Purpose : Sets the *minimum* time between pings.

Format : TP*mm:ss.ff*

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

Default : TP000300 (38kHz), TP000200 (75kHz), TP000100 (150kHz)

Description : The ADCP interleaves individual pings within a group so they are evenly spread throughout the ensemble. During the ensemble interval set by TE, the ADCP transmits the number of pings set by the WP,NP, and BP commands. TP determines the spacing between the pings. If TP = 0, the ADCP pings as quickly as it can based on the time it takes to transmit each ping plus the overhead that occurs for processing.

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

Note : The ADCP automatically increases TE if ((WP + NP + BP) x TP > TE).

TS - Set System Date and Time

Purpose : Sets the ADCP's internal clock.

Format : TS*yymmddhhmmss*

Range : *yy* = year 00-99
mm = month 01-12
dd = day 01-31
hh = hours 00-23
mm = minutes 00-59
ss = seconds 0-59

Description : When the ADCP receives the carriage return after the TS-command, it enters the new time into the clock and sets hundredths of seconds to zero. The clock will continue to function through and after the transition from 2359 31DEC1999 to 0000 1JAN2000. The clock is also aware of leap years and the fact that 2000 is a leap year.

Example : TS000617131500 sets the clock to 1:15:00 pm, June 17, 2000.

3.10 Broad Bandwidth Water-Profiling Commands

The following commands define the criteria used to collect the Broad Bandwidth (or Wide Bandwidth) water-profile data.

WA – Broad Bandwidth Profiling False Target Threshold

Purpose : Sets a false target (fish) filter

Format : WA*n*

Range : *n* = 0 to 255 counts

Default : WA255

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

Notes : A WA value of 255 disables this feature. A typical setting is 55 to 75.

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

WC - Broad Bandwidth Profiling Water Correlation Threshold

Purpose : Sets the minimum correlation for valid velocity data.

Format : WC*nnn*

Range : *nnn* = 0 to 255 counts

Default : WC120

Description : The ADCP uses WC to screen water-track data for the minimum acceptable correlation requirements. WC sets the threshold of this correlation below which the ADCP flags the data as bad.

Note : The default threshold for all Ocean Surveyor frequencies is 120 counts. A solid target would have a correlation of 255 counts.

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

WD - Broad Bandwidth Profiling Data Out

Purpose : Selects the data types collected by the ADCP.

Format : WD *abc de*0 000

Range : Firmware switches (see description)

Default : WD111 110 000

Description : WD uses firmware switches to tell the ADCP the types of data to collect. The ADCP always collects header data, fixed/variable leader data, and checksum data. Setting a bit to 1 tells the ADCP to collect that data type. The bits are described as follows:

a = Velocity
b = Correlation
c = Echo Intensity
d = Percent Good
e = Status

Example : WD 111 110 000 (default) tells the ADCP to collect velocity, correlation magnitude, echo intensity, percent good, and status.

Notes :

1. Each bit can have a value of one or zero: one means output data; zero means suppress data.
2. If WP = 0, the ADCP does not collect water-track data.
3. Spaces in the command line are allowed.

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

WE - Broad Bandwidth Profiling Error Velocity Threshold

Purpose : Sets the maximum error velocity for good profile data.

Format : WE*nnnn*

Range : *n* = 0 to 9999 mm/s

Default : WE1000

Description : The WE-command sets a threshold value used to flag water-current data as good or bad. If the ADCP's error velocity value exceeds this threshold, it flags data as bad for a given depth cell. The WE-command screens for error velocities in both beam and transformed-coordinate data.

CAUTION. The default setting is set purposely high. We recommend extreme caution and testing before changing this setting. **Data rejected by this command is lost and cannot be regained.**

WF - Broad Bandwidth Profiling Blank after Transmit

Purpose	:	Moves the location of first depth cell away from the transducer head to allow the transmit circuits time to recover before the receive cycle begins.
Format	:	WF*nnnn*
Range	:	*nnnn* = 0 to 9999 cm (328 feet)
Default	:	WF1600 (38kHz), WF800 (75kHz), WF400 (150kHz)
Description	:	WF positions the start of the first depth cell at some vertical distance from the transducer head. This allows the ADCP transmit circuits time to recover before beginning the receive cycle. In effect, WF blanks out bad data close to the transducer head, thus creating a depth window that reduces unwanted data in the ensemble.
Notes	:	Small WF values may show ringing/recovery problems in the first depth cells that cannot be screened by the ADCP. We recommend you set WF to no less than the default value.

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

WN - Broad Bandwidth Profiling Number Of Depth Cells

Purpose	:	Sets the number of depth cells over which the ADCP collects data.
Format	:	WN*nnn*
Range	:	*nnn* = 001 to 128 depth cells
Default	:	WN128
Description	:	The range of the ADCP is set by the number of depth cells (WN) times the size of each depth cell (WS).

WP - Broad Bandwidth Profiling Pings Per Ensemble

Purpose	:	Sets the number of broadband profile pings to average together in each data ensemble.
Format	:	WP*nnn*
Range	:	*nnn* = 0 to 999 pings
Default	:	WP1
Description	:	WP sets the number of broadband profile pings to average together in each ensemble before sending profile data.

Notes : The ADCP interleaves profile pings with bottom-track pings (see TP-command).

If WP = zero, the ADCP does not collect broadband profile data.

> **NOTE.** When using *VmDas*, the typical setup will use single ping (WP1) when doing Broad Bandwidth profiling.

WS - Broad Bandwidth Profiling Depth Cell Size

Purpose : Selects the volume of water for one measurement cell.

Format : WS*nnnn*

Range : *n* = 80 to 6400 cm for 38kHz systems.

n = 40 to 3200 cm for 75kHz systems.

n = 20 to 1600 cm for 150kHz systems.

Default : WS3200 (38kHz), WS1600 (75kHz), WS800 (150kHz)

Description : WN Sets the size of depth cells over which the ADCP collects data. The range of the profile is set by the number of depth cells (WN) times the size of each depth cell (WS).

WV - Broad Bandwidth Profiling Ambiguity Velocity

Purpose : Sets the radial ambiguity velocity for broadband profiling.

Format : WV*nnn*

Range : *nnn* = 0 to 390 cm/s

Default : WV390

Description : WV sets the radial ambiguity velocity for broadband profiling. Velocities above this value may cause ambiguity errors.

> **NOTE.** It is strongly recommended that the WV command be left at its' default value of 390.

Narrow Bandwidth Mode Ambiguity

With the default setup, the beam-radial ambiguity velocity Ua is 450 cm/s. The formula for calculating the max speed in Narrow Bandwidth mode is:

NBmax = Ua / sin(beam angle) / cos(rotation angle)

For a 45-degree rotation, this gives a max horizontal speed of 12.7 m/s or about 25 knots.

Broad Bandwidth Mode Ambiguity

The maximum WV setting is 390 cm/s. This is because the PA transducer cannot produce a bandwidth wider than that to support larger ambiguity settings (smaller lags than 390 cm/s). Therefore, we have added the capability to offset the ambiguity lane. The equation for calculating the max speed in Broad Bandwidth mode is:

BBmax = (Ua + offset) / sin(beam angle) / cos(rotation angle)

The default offset values (&W+00,+00,+195,-195) assume that beam 3 is forward and have values of:

beam 1: 0
beam 2: 0
beam 3: +195 cm/s
beam 4: -195 cm/s

Consequently, the default max speed in Broad Bandwidth mode for a 45-degree rotation is:

beam 1: -11 m/s to + 11 m/s
beam 2: -11 m/s to + 11 m/s
beam 3: -5.5 m/s to + 16.5 m/s
beam 4: -5.5 m/s to + 16.5 m/s

Which means the maximum speed is effectively 11 ms/ (22 knots). You can raise the maximum speed to 16.5 m/s (33 knots) by setting the ambiguity offset with &W +195,-195,+195,-195.

NOTE. If you set WV above 390, the system will still use 390 because it will not use a shorter lag. No errors will occur by using higher values of WV390.

4 Introduction to Output Data Format

This guide shows the Hexadecimal-ASCII format and the format of the VmDas Short Term Average (STA) and Long Term Average (LTA) files when using an Ocean Surveyor ADCP (firmware version 23.xx and higher). The VmDas STA and LTA output can only be binary. We explain the output data formats in enough detail to let you create your own data processing or analysis programs.

> **NOTE.** This guide applies to Ocean Surveyor firmware version 23.08. When new firmware versions are released, some output data formats may be modified or added. Read the README file on the upgrade disk, or check RDI's web site for the latest changes.

5 Hexadecimal-ASCII Output Data

Use the hexadecimal-ASCII (Hex ASCII) format when you are viewing raw ADCP data on a computer. This format uses the standard ASCII codes for 0 through F to represent numeric values as hexadecimal digits. Other standard ASCII characters (text) and control commands (carriage return, line feed, end of file, etc.) are interpreted normally. In the Hex ASCII mode, the ADCP sends data in one line of ASCII characters. There are no carriage returns and/or line feed sequences (CR/LF) sent from the ADCP. The CRT provides a CR/LF after 60 characters. Figure 4, page 50 shows the Hex ASCII data format for one ensemble and how it looks on a CRT display. The ADCP by default is set to collect velocity, correlation data, echo intensity, and percent good data.

The data, preceded by ID code 7F7F, contains header data (explained in Table 11, page 68). The fixed and variable leader data is preceded by ID codes 0000 and 8000, (explained in Table 12, page 69 and Table 13, page 72). The ADCP always collects Header and Leader.

The remaining lines include velocity (ID Code: 0001), correlation magnitude (0002), and echo intensity (0003). The final field is a data-validity checksum. Table 14, page 74 through Table 24, page 86 define these fields. Figure 5, page 51 shows the format of the Hex ASCII output data for the sample data in Figure 4, page 50.

5.1 How to Decode an ADCP Ensemble

Use the “Binary Header Data Format,” page 55 to locate the offset to the specific ID of the data type you wish to decode. Table 10 shows some of the most common IDs.

Table 10: Data IDs

ID[1]	ID[2]	Description
7F7F	7F7F	Header
0000	0001	Fixed Leader
0080	0081	Variable Leader
0100	0101	Velocity Profile Data
0200	0201	Correlation Profile Data
0300	0301	Echo Intensity Profile Data
0400	0401	Percent Good Profile Data
0500	0501	Status Profile Data
0600	0601	Bottom Track Data
2000	2000	Navigation
3000	3000	Binary Fixed Attitude
3040 – 30F0	3040 – 30F0	Binary Variable Attitude

Note 1 – If only WP > 1 *or* NP > 1

Note 2 – If both WP > 1 *and* NP > 1

Once the ID of the data type is located use the data format section to locate the bytes you wish to decode using the data format for your ADCP (i.e. BroadBand, Workhorse, or Ocean Surveyor)

NOTE. Each type of ADCP (BroadBand, Workhorse, and Ocean Surveyor) can have slight differences in their data formats. For example, differences occur in the variable leader when bytes were added for WorkHorse pressure sensor data. This same type of thing can happen in the fixed leader data format.

```
Hex     Data Bytes
Offset  0 1 2 3 4 5 6 7 8 9 A B C D E F
0000    7F7FB30100081600480084 00D5002701
0010    51017B01A50100000E04490200000 40A
0020    01002003C80001000064000000000000
0030    000000005D0100000000010100000000
0040    00000000000000008000010000010100
0050    00005F000000E0040000000000000000
0060    230027F3000000000000000000000000
0070    00000000000000000000000000000000
0080    00000000000601000000461400050000
0090    00000000000000000000000000800080
00A0    00800080000000000000000000000000
00B0    00000000000000800080008000800000
00C0    00000000000064646464881317162308
00D0    00000000000001008000800080008000
00E0    80008000800080008000800080008000
00F0    80008000800080008000800080008000
0100    80008000800080008000800080008000
0110    80008000800080008000800080008000
0120    80008000800080000200000000000000
0130    00000000000000000000000000000000
0140    00000000000000000000000000000000
0150    00000300000000000000000000000000
0160    00000000000000000000000000000000
0170    00000000000000000000000005000000
0180    00000000000000000000000000000000
0190    00000000000000000000000000000000
01A0    00000000000310003000000000000000
01B0    00000000000000000000000000000000
01C0    000000000000000000E8300000000000
01D0    00000000000000000000000000000000
01E0    00000000000000000000000000000000
01F0    000000000000000000000000007727
```

Figure 4. HexAscii PD0 Output Data Format

NOTE. The values listed here are simulated data for one ensemble with ten depth cells and WP > 1 or NP > 1 (not both). Figure 5, page 51 shows a detailed view of the data format. 16-Bit Data words are sent LSB first followed by the MSB.

Examples:

The offset to the checksum word is sent as B3 01 (LSB, MSB). Read this as 01B3 h, which is the offset to the checksum 2777 h.

The address offset for the first data type is sent 16 00 (LSB, MSB). Read this as 0016 h, which is the offset to the Fixed Leader ID code 0000 (see Table 10, page 49).

Figure 5. HexAscii Standard Output Data Format

Header Data	Header ID Data ID Offset to Cksum Spare # of data types 7F 7F B301 00 08 Address Offsets for Data Types #1 #2 #3 #4 #5 #6 #7 #8 **1600** 4800 **8400** D500 **2701** 5101 **7B01** A501
Fixed Leader Data	Fixed Leader ID 0000 fv fr cfg Res Res #bm WN #Pings WS WF WM Res #cr %Good 0E 04 4902 00 00 04 0A 0100 2003 C800 01 00 00 64 Err Vel TPmmsshh EA EB EZ Sensor dis1 WT WL WA Res LagD 0000 000000 0000 0000 5D 01 0000 0000 0101 00 00 0000 Res 0000000000000000
Variable Leader Data	Variable Leader ID 8000 ENS Date yymmdd Time hhmmsshh #MSB res EC ED EH EP 0100 000101 0000005F 00 0000 E004 0000 0000 0000 ER ES ET 0000 2300 27F3 res 0000000000000000000000000000000000000000000000000000000000000000
Velocity Data	Velocity ID 0001 Depth Cell #1 Depth Cell #2 Depth Cell #3 1 2 3 4 1 2 3 4 1 2 3 4 0080 0080 0080 0080 0080 0080 0080 0080 0080 0080 0080 0080 Depth Cell #4 → Depth Cell #10 1 2 3 4 → 1 2 3 4 0080 0080 0080 0080 0080 0080 0080 0080
Correlation Magnitude	Correlation Magnitude ID 0002 Cell#1 Cell#2 Cell#3 Cell#4 → Cell#10 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 → 1 2 3 4 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 → 00 00 00 00
Echo Intensity	Echo Intensity ID 0003 Cell#1 Cell#2 Cell#3 Cell#4 → Cell#10 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 → 1 2 3 4 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 → 00 00 00 00
Status Data	Status ID 0005 Cell#1 Cell#2 Cell#3 Cell#4 → Cell#10 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 → 1 2 3 4 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 → 00 00 00 00

Continued next page.

Figure 2. HexAscii Standard Output Data Format (Continued)

Bottom-Track	Bottom Track ID 0006 BP Res BC BA %Good Mode Err Vel Reserved 0100 0000 46 14 00 05 0000 00000000 BT Range BT Velocity BT Corr Mag Bm1 Bm2 Bm3 Bm4 Bm1 Bm2 Bm3 Bm4 1 2 3 4 0000 0000 0000 0000 0080 0080 0080 0080 00 00 00 00 BTEA BT%G Reserved 1 2 3 4 1 2 3 4 ↑ 00 00 00 00 00 00 00 00 000000000000 Ref Velocity RLCM Reserved RLPG BX Bm1 Bm2 Bm3 Bm4 1 2 3 4 ↑ 1 2 3 4 ↑ 0080 0080 0080 0080 00 00 00 00 00000000 64 64 64 64 8813 RSSI Gain BT Range 1 2 3 4 ↑ 1 2 3 4 17 16 23 08 00 00 00 00 00
Fixed Attitude	Fixed Attitude ID 0030 EE EF EH EI EJ EP EU EV 0000000000000000 00 0000 0000 0000 0000000000 00 0000 EZ 0000000000000000
Variable Attitude	Variable Attitude ID 30E8 Wtr/BT Data Type 1 NB Water Instrument Data Hdg Pitch Roll Hdg Rate Pitch Rate Roll Rate 00 00 00 00 00 00 Wtr/BT Data Type 1 NB Water Ship Data Hdg Pitch Roll Hdg Rate Pitch Rate Roll Rate 00 00 00 00 00 00 Wtr/BT Data Type 1 BT Instrument Data Hdg Pitch Roll Hdg Rate Pitch Rate Roll Rate 00 00 00 00 00 00 Wtr/BT Data Type 1 BT Ship Data Hdg Pitch Roll Hdg Rate Pitch Rate Roll Rate 00 00 00 00 00 00
Reserved	03100C33010005000000FFFF0001
Checksum	7727

NOTE. This figure lists all bytes in order of output from the ADCP. All 16-bit word values must be byte-swapped to convert them to their proper values. For example, the Variable Leader ID word shown as 80 00 h has the value 0080 h when properly converted and WP > 1 <u>or</u> NP > 1 (not both). See Table 10, page 49 for the IDs when <u>both</u> WP > 1 <u>and</u> NP > 1.

6 Binary Output and VmDas

The Ocean Surveyor binary output data buffer contains header data, leader data, velocity, correlation magnitude, echo intensity, percent good, and a checksum. The Ocean Surveyor collects all data in the output buffer during an ensemble. The *VmDas* program writes this Ocean Surveyor output into the *.ENR files and then inserts the navigation data before the checksum (and reserved bytes) when it saves the *.STA and *.LTA files.

Figure 6, page 53 shows the format of this buffer and the sequence in which the VmDas program creates the *.STA and *.LTA files. Figure 8, page 55 through Figure 18, page 67 show the format of the individual items that make up the binary output buffer. Table 11, page 68 through Table 24, page 86 lists the format, bytes, fields, scaling factors, and a detailed description of every item in the binary output buffer.

6.1 Binary Standard Output Data Buffer Format

Always Output	**HEADER** (6 BYTES + [2 x No. OF DATA TYPES])
	FIXED LEADER DATA (50 BYTES)
	VARIABLE LEADER DATA (58 BYTES)
WD or ND command WP or NP command	**VELOCITY** (2 BYTES + 8 BYTES PER DEPTH CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
	STATUS (2 BYTES + 4 BYTES PER DEPTH CELL)
BP command	**BOTTOM-TRACK** (81 BYTES)
	FIXED ATTITUDE (41 BYTES)
	VARIABLE ATTITUDE (12 BYTES PER DATA TYPE)
	NAVIGATION (78 BYTES) (*VmDas* ENS, ENX, STA, and LTA files only)
Always Output	**RESERVED** (14 BYTES)
	CHECKSUM (2 BYTES)

Figure 6. Binary Standard Output Data Buffer Format (WP or NP Command)

NOTE. Figure 6 shows the binary output data buffer format when WP > zero or NP > zero (one or the other, not both). See Figure 7, page 54 for the output buffer when both WP and NP > zero.

Always Output	**HEADER** (6 BYTES + [2 x No. OF DATA TYPES])
	FIXED LEADER DATA (50 BYTES)
	VARIABLE LEADER DATA (58 BYTES)
WD command WP command	**VELOCITY** (2 BYTES + 8 BYTES PER DEPTH CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
	STATUS (2 BYTES + 4 BYTES PER DEPTH CELL)
BP command	**BOTTOM-TRACK** (81 BYTES)
	VARIABLE LEADER DATA (58 BYTES)
ND command NP command	**VELOCITY** (2 BYTES + 8 BYTES PER DEPTH CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
	STATUS (2 BYTES + 4 BYTES PER DEPTH CELL)
BP command	**BOTTOM-TRACK** (81 BYTES)
	FIXED ATTITUDE (41 BYTES)
	VARIABLE ATTITUDE (12 BYTES PER DATA TYPE)
	NAVIGATION (78 BYTES) (*VmDas* ENS, ENX, STA, and LTA files only)
Always Output	**RESERVED** (14 BYTES)
	CHECKSUM (2 BYTES)

Figure 7. Binary Standard Output Data Buffer Format (WP and NP Command)

Some data outputs are in bytes per depth cell. For example, if the WN-command (number of depth cells) = 23, and the following data are selected for output, the required data buffer storage space is 792 bytes per ensemble:

WD-Command =WD 111 100 000 (default), WP-Command = zero, BP-Command > zero, NP-Command > zero, EE-Command = EE11111100 (Default)

```
50    Bytes of Header Data (6+2x8)
58    Bytes of Fixed Leader Data (fixed)
42    Bytes of Variable Leader Data (fixed)
186   Bytes of Velocity Data (2+8x23)
94    Bytes of Correlation Magnitude Data (2+4x23)
94    Bytes of Echo Intensity (2+4x23)
81    Bytes of Bottom Track Data (fixed)
43    Bytes of Fixed Attitude Data (fixed)
50    Bytes of Variable Attitude Data (2+4x12)
78    Bytes of Navigation Data (fixed)
14    Bytes of Reserved for RDI Use (fixed)
2     Bytes of Checksum Data (fixed)
792   Bytes of data per ensemble
```

6.2 Binary Header Data Format

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

Figure 8. Binary Header Data Format

NOTE. This data is always output in this format.

6.3 Binary Fixed Leader Data Format

BYTE	BIT POSITIONS (7 6 5 4 3 2 1 0)	
1	FIXED LEADER ID 00h	LSB
2	00h	MSB
3	CPU F/W VER.	
4	CPU F/W REV.	
5	SYSTEM CONFIGURATION	LSB
6		MSB
7	RESERVED	
8		
9	NUMBER OF BEAMS	
10	NUMBER OF CELLS {WN}	

Continued next page

Continued from previous page

11	NUMBER OF PINGS	LSB
12		MSB
13	DEPTH CELL LENGTH {WS}	LSB
14		MSB
15	BLANK AFTER TRANSMIT {WF}	LSB
16		MSB
17	SIGNAL PROCESSING MODE {WM}	
18	RESERVED	
19	NUMBER CODE REPS	
20	PERCENT GOOD MINIMUM {WG}	
21	ERROR VELOCITY MAXIMUM {WE}	
22		
23	TPP MINUTES	
24	TPP SECONDS	
25	TPP HUNDREDTHS {TP}	
26	COORDINATE TRANSFORMATION {EX}	
27	HEADING ALIGNMENT {EA}	LSB
28		MSB
29	HEADING BIAS {EB}	LSB
30		MSB
31	SENSOR SOURCE {EZ}	
32	SENSORS AVAIL	
33	BIN 1 DISTANCE	LSB
34		MSB
35	XMIT PULSE LENGTH	LSB
36	BASED ON {WT}	MSB
37	REF LAYER (starting cell)	
38	REF LAYER (ending cell)	
39	FALSE TARGET THRESH {WA}	
40	RESERVED	
41	TRANSMIT LAG DISTANCE	LSB
42		MSB
43	RESERVED	
↓		↓
50		

Figure 9. Binary Fixed Leader Data Format

NOTE. This data is always output in this format.

6.4 Binary Variable Leader Data Format

BYTE	BIT POSITIONS 7 6 5 4 3 2 1 0	
1	VAR LEADER ID 80h	LSB
2	00h	MSB
3	ENSEMBLE	LSB
4	NUMBER	MSB
5	SYSTEM DATE YEAR	
6	MONTH	
7	DAY	
8	SYSTEM TIME HOUR	
9	MINUTE	
10	SECOND	
11	HUNDREDTHS	
12	ENSEMBLE # MSB	
13	RESERVED	LSB
14		MSB
15	SPEED OF SOUND {EC}	LSB
16		MSB
17	DEPTH OF TRANSDUCER {ED}	LSB
18		MSB
19	HEADING {EH}	LSB
20		MSB
21	PITCH (TILT 1) {EP}	LSB
22		MSB
23	ROLL (TILT 2) {ER}	LSB
24		MSB
25	SALINITY {ES}	LSB
26		MSB
27	TEMPERATURE {ET}	LSB
28		MSB
29 ↓ 58	RESERVED	

Figure 10. Binary Variable Leader Data Format

NOTE. This data is always output in this format.

6.5 Binary Velocity Data Format

	BIT POSITIONS								
BYTE	7/S	6	5	4	3	2	1	0	
1	VELOCITY ID							00h	LSB
2								01h	MSB
3	DEPTH CELL #1, VELOCITY 1								LSB
4									MSB
5	DEPTH CELL #1, VELOCITY 2								LSB
6									MSB
7	DEPTH CELL #1, VELOCITY 3								LSB
8									MSB
9	DEPTH CELL #1, VELOCITY 4								LSB
10									MSB
11	DEPTH CELL #2, VELOCITY 1								LSB
12									MSB
13	DEPTH CELL #2, VELOCITY 2								LSB
14									MSB
15	DEPTH CELL #2, VELOCITY 3								LSB
16									MSB
17	DEPTH CELL #2, VELOCITY 4								LSB
18									MSB
↓	(SEQUENCE CONTINUES FOR UP TO 128 CELLS)								↓
1019	DEPTH CELL #128, VELOCITY 1								LSB
1020									MSB
1021	DEPTH CELL #128, VELOCITY 2								LSB
1022									MSB
1023	DEPTH CELL #128, VELOCITY 3								LSB
1024									MSB
1025	DEPTH CELL #128, VELOCITY 4								LSB
1026									MSB

Figure 11. Binary Velocity Data Format

NOTE. The number of depth cells is set by the WN-command.

6.6 Binary Correlation Magnitude, Echo Intensity, and Status Data Format

BIT POSITIONS

BYTE	7/S	6	5	4	3	2	1	0	
1	ID CODE								LSB
2									MSB
3	DEPTH CELL #1, FIELD #1								
4	DEPTH CELL #1, FIELD #2								
5	DEPTH CELL #1, FIELD #3								
6	DEPTH CELL #1, FIELD #4								
7	DEPTH CELL #2, FIELD #1								
8	DEPTH CELL #2, FIELD #2								
9	DEPTH CELL #2, FIELD #3								
10	DEPTH CELL #2, FIELD #4								
↓	(SEQUENCE CONTINUES FOR UP TO 128 BINS)								↓
511	DEPTH CELL #128, FIELD #1								
512	DEPTH CELL #128, FIELD #2								
513	DEPTH CELL #128, FIELD #3								
514	DEPTH CELL #128, FIELD #4								

Figure 12. Binary Correlation Magnitude, Echo Intensity, and Status Data Format

NOTE. The number of depth cells is set by the WN-command.

6.7 Binary Bottom-Track Data Format

BIT POSITIONS

BYTE#	7 6 5 4 3 2 1 0	
1	BOTTOM-TRACK ID 00h	LSB
2	06h	MSB
3	BOTTOM-TRACK # OF PINGS {BP}	LSB
4		MSB
5	RESERVED	LSB
6		MSB
7	BT CORR MAG MIN {BC}	
8	BT EVAL AMP MIN {BA}	
9	RESERVED	
10	BOTTOM TRACK MODE {BM}	
11	ERROR VELOCITY MAXIMUM {BE}	
12		
13	RESERVED	
↓		↓
16		
17	BEAM#1 BT RANGE	LSB
18		MSB
19	BEAM#2 BT RANGE	LSB
20		MSB
21	BEAM#3 BT RANGE	LSB
22		MSB
23	BEAM#4 BT RANGE	LSB
24		MSB
25	BEAM#1 BT VEL	LSB
26		MSB
27	BEAM#2 BT VEL	LSB
28		MSB
29	BEAM#3 BT VEL	LSB
30		MSB
31	BEAM#4 BT VEL	LSB
32		MSB

Continued next page

Continued from previous page

33	BEAM#1 BT CORR.	
34	BEAM#2 BT CORR.	
35	BEAM#3 BT CORR.	
36	BEAM#4 BT CORR.	
37	BEAM#1 EVAL AMP	
38	BEAM#2 EVAL AMP	
39	BEAM#3 EVAL AMP	
40	BEAM#4 EVAL AMP	
41 ↓ 70	RESERVED	↓
71	BT MAXIMUM DEPTH {BX}	LSB
72		MSB
73	BM#1 RSSI AMP	
74	BM#2 RSSI AMP	
75	BM#3 RSSI AMP	
76	BM#4 RSSI AMP	
77	GAIN	
78	(*SEE BYTE 17)	MSB
79	(*SEE BYTE 19)	MSB
80	(*SEE BYTE 21)	MSB
81	(*SEE BYTE 23)	MSB

Figure 13. Binary Bottom-Track Data Format

NOTE. This data is output only if the BP-command is >0 and PD0 is selected.

6.8 Binary Fixed Attitude Data Format

BYTE	BIT POSITIONS 7 6 5 4 3 2 1 0		
1	FIXED ATTITUDE ID	00h	LSB
2		30h	MSB
3–10	Attitude Output Coordinates and Processing Control using Interpolated Attitude (EE)		
11	External Pitch/Roll Scaling (EF)		
12–14	Fixed Heading Scaling (EH)		
15–16	Roll Misalignment (EI)		
17–18	Pitch Misalignment (EJ)		
19–23	User Input for Pitch, Roll, and Coordinate Frame (EP)		
24	User Input for Up/Down Orientation (EU)		
25–26	User Input for Heading Bias/Variation/Synchro Offset (EV)		
27 ↓ 34	Sensor Source (EZ)		

Figure 14. Binary Fixed Attitude Data Format

NOTE. This data is always output in this format.

6.9 Binary Variable Attitude Data Format

BIT POSITIONS

BYTE	7	6	5	4	3	2	1	0	
1	VARIABLE ATTITUDE ID								LSB
2	3040 - 30FC								MSB
3	Heading Water/Bottom Ping Type 1								LSB
4									MSB
5	Pitch Water/Bottom Ping Type 1								LSB
6									MSB
7	Roll Water/Bottom Ping Type 1								LSB
8									MSB
9	Heading Rate Water/Bottom Ping Type 1								LSB
10									MSB
11	Pitch Rate Water/Bottom Ping Type 1								LSB
12									MSB
13	Roll Rate Water/Bottom Ping Type 1								LSB
14									MSB
15	Heading Water/Bottom Ping Type 2								LSB
16									MSB
17	Pitch Water/Bottom Ping Type 2								LSB
18									MSB
19	Roll Water/Bottom Ping Type 2								LSB
20									MSB
21	Heading Rate Water/Bottom Ping Type 2								LSB
22									MSB
23	Pitch Rate Water/Bottom Ping Type 2								LSB
24									MSB
25	Roll Rate Water/Bottom Ping Type 2								LSB
26									MSB
↓	(Sequence Continues up to 8 Water/Bottom Ping Types)								↓

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75	Heading Water/Bottom Ping Type 7	LSB
76		MSB
77	Pitch Water/Bottom Ping Type 7	LSB
78		MSB
79	Roll Water/Bottom Ping Type 7	LSB
80		MSB
81	Heading Rate Water/Bottom Ping Type 7	LSB
82		MSB
83	Pitch Rate Water/Bottom Ping Type 7	LSB
84		MSB
85	Roll Rate Water/Bottom Ping Type 7	LSB
86		MSB
87	Heading Water/Bottom Ping Type 8	LSB
88		MSB
89	Pitch Water/Bottom Ping Type 8	LSB
90		MSB
91	Roll Water/Bottom Ping Type 8	LSB
92		MSB
93	Heading Rate Water/Bottom Ping Type 8	LSB
94		MSB
95	Pitch Rate Water/Bottom Ping Type 8	LSB
96		MSB
97	Roll Rate Water/Bottom Ping Type 8	LSB
98		MSB

Figure 15. Binary Variable Attitude Data Format

NOTE. The number of Water/Bottom Ping Types varies based on the setting of the EE, WP, NP, and BP commands.

6.10 Binary Navigation Data Format

BIT POSITIONS

BYTE#	7	6	5	4	3	2	1	0	
1	NAVIGATION ID						00h		LSB
2							20h		MSB
3	UTC DAY								
4	UTC MONTH								
5	UTC YEAR								LSB
6									MSB
7	UTC TIME OF FIRST FIX								LSB
8									
9									
10									MSB
11	PC CLOCK OFFSET FROM UTC								LSB
12									
13									
14									MSB
15	FIRST LATITUDE								LSB
16									
17									
18									MSB
19	FIRST LONGITUDE								LSB
20									
21									
22									MSB
23	UTC TIME OF LAST FIX								LSB
24									
25									
26									MSB
27	LAST LATITUDE								LSB
28									MSB
29									LSB
30									MSB
31	LAST LONGITUDE								LSB
32									MSB
33									LSB
34									MSB

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Byte	Field	
35	AVG SPEED	LSB
36		MSB
37	AVG TRACK TRUE	LSB
38		MSB
39	AVG TRACK MAGNETIC	LSB
40		MSB
41	SPEED MADE GOOD	LSB
42		MSB
43	DIRECTION MADE GOOD	LSB
44		MSB
45	RESERVED	
46		
47	FLAGS	
48		
49	RESERVED	
50		
51	ADCP ENSEMBLE NUMBER	LSB
52		
53		
54		MSB
55	ADCP ENSEMBLE YEAR	LSB
56		MSB
57	ADCP ENSEMBLE DAY	
58	ADCP ENSEMBLE MONTH	
59	ADCP ENSEMBLE TIME	
60		
61		
62		
63	PITCH	LSB
64		MSB
65	ROLL	LSB
66		MSB
67	HEADING	LSB
68		MSB

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Byte	Field	
69	NUMBER OF SPEED AVG	LSB
70		MSB
71	NUMBER OF TRUE TRACK AVG	LSB
72		MSB
73	NUMBER OF MAG TRACK AVG	LSB
74		MSB
75	NUMBER OF HEADING AVG	LSB
76		MSB
77	NUMBER OF PITCH/ROLL AVG	LSB
78		MSB

Figure 16. Binary Navigation Data Format

NOTE. This data is output in this format only by the VmDas program in the STA and LTA data files.

6.11 Binary Reserved BIT Use

BIT POSITIONS

BYTE	7	6	5	4	3	2	1	0
1 ↓ 14	RESERVED FOR RDI USE ↓							

Figure 17. Binary Reserved BIT Use

NOTE. This data is always output in this format.

6.12 Binary Checksum Data Format

BIT POSITIONS

BYTE	7	6	5	4	3	2	1	0	
1	CHECKSUM DATA								LSB
2									MSB

Figure 18. Binary Checksum Data Format

NOTE. This data is always output in this format.

7 Binary Output Buffer - Detailed Description

Table 11 through Table 24, page 86 lists the format, bytes, fields, scaling factors, and a detailed description of every item in the binary output buffer.

7.1 Binary Header Data Format

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

Table 11: Binary Header Data Format

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

7.2 Binary Fixed Leader Data Format

Fixed Leader data refers to the non-dynamic ADCP data that only changes when you change certain commands. Fixed Leader data also contain hardware information. The ADCP always sends Fixed Leader data as output data (LSBs first). See "Command Descriptions," page 6 for detailed descriptions of commands used to set these values.

Table 12: Binary Fixed Leader Data Format

<table>
<tr><th>Hex Digit</th><th>Binary Byte</th><th>Field</th><th>Description</th></tr>
<tr><td>1-4</td><td>1,2</td><td>FID / Fixed Leader ID</td><td>Stores the Fixed Leader identification word (00 00h).</td></tr>
<tr><td>5,6</td><td>3</td><td>fv / CPU F/W Ver.</td><td>Contains the version number of the CPU firmware.</td></tr>
<tr><td>7,8</td><td>4</td><td>fr / CPU F/W Rev.</td><td>Contains the revision number of the CPU firmware.</td></tr>
<tr><td>9-12</td><td>5,6</td><td>Sys Cfg / System Configuration</td><td>This field defines the ADCP hardware configuration. Convert this field (2 bytes, LSB first) to binary and interpret as follows.<pre>
LSB
BITS   7 6 5 4 3 2 1 0
       - - - - - 0 0 0   75-kHz SYSTEM
       - - - - - 0 0 1   150-kHz SYSTEM
       - - - - - 0 1 0   300-kHz SYSTEM
       - - - - - 0 1 1   600-kHz SYSTEM
       - - - - - 1 0 0 1200-kHz SYSTEM
       - - - - - 1 0 1 2400-kHz SYSTEM
       - - - - - 1 1 0   38-kHz SYSTEM
       - - - - 0 - - - CONCAVE BEAM PAT.
       - - - - 1 - - - CONVEX BEAM PAT.
       - - 0 0 - - - - SENSOR CONFIG #1
       - - 0 1 - - - - SENSOR CONFIG #2
       - - 1 0 - - - - SENSOR CONFIG #3
       - 0 - - - - - - XDCR HD NOT ATT.
       - 1 - - - - - - XDCR HD ATTACHED
       0 - - - - - - - DOWN FACING BEAM
       1 - - - - - - - UP-FACING BEAM

MSB
BITS   7 6 5 4 3 2 1 0
       - - - - - - 0 0 15E BEAM ANGLE
       - - - - - - 0 1 20E BEAM ANGLE
       - - - - - - 1 0 30E BEAM ANGLE
       - - - - - - 1 1 OTHER BEAM ANGLE
       0 1 0 0 - - - - 4-BEAM JANUS CONFIG
       0 1 0 1 - - - - 5-BM JANUS CFIG DEMOD)
       1 1 1 1 - - - - 5-BM JANUS CFIG.(2 DEMD)
</pre>Example: Hex 5249 (i.e., hex 49 followed by hex 52) identifies a 150-kHz system, convex beam pattern, down-facing, 30E beam angle, 5 beams (3 demods).</td></tr>
<tr><td>13,14</td><td>7</td><td>Reserved</td><td>Always 0</td></tr>
<tr><td>15,16</td><td>8</td><td>Reserved</td><td>Always 0</td></tr>
</table>

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Table 12: Binary Fixed Leader Data Format (Continued)

Hex Digit	Binary Byte	Field	Description
17,18	9	#Bm / Number of Beams	Contains the number of beams used to calculate velocity data (not physical beams). The ADCP needs only three beams to calculate water-current velocities. The fourth beam provides an error velocity that determines data validity. If only three beams are available, the ADCP does not make this validity check. The Percent-Good Data Format has more information.
19,20	10	WN / Number of Cells	Contains the number of depth cells over which the ADCP collects data (WN-command). Scaling: LSD = 1 depth cell; Range = 1 to 128 depth cells
21-24	11,12	WP / Pings Per Ensemble	Contains the number of pings averaged together during a data ensemble (WP-command). If WP = 0, the Ocean Surveyor does not collect the WD water-profile data. Note: The Ocean Surveyor automatically extends the ensemble interval (TE) if the product of WP and time per ping (TP) is greater than TE (i.e., if WP x TP > TE). Scaling: LSD = 1 ping; Range = 0 to 16,384 pings
25-28	13,14	WS / Depth Cell Length	Contains the length of one depth cell (WS-command). Scaling: LSD = 1 centimeter; Range = 1 to 6400 cm (210 feet)
29-32	15,16	WF / Blank after Transmit	Contains the blanking distance used by the ADCP to allow the transmit circuits time to recover before the receive cycle begins (WF-command). Scaling: LSD = 1 centimeter; Range = 0 to 9999 cm (328 feet)
33,34	17	Singal Processing Mode	Contains the Signal Processing Mode.
35,36	18	Reserved	Always 0
37,38	19	cr# / No. code reps	Contains the number of code repetitions in the transmit pulse. Scaling: LSD = 1 count; Range = 0 to 255 counts
39,40	20	WG / %Gd Minimum	Contains the minimum percentage of water-profiling pings in an ensemble that must be considered good to output velocity data (WG-command). Scaling: LSD = 1 percent; Range = 1 to 100 percent
41-44	21,22	WE / Error Velocity Threshold	This field, initially set by the WE-command, contains the actual threshold value used to flag water-current data as good or bad. If the error velocity value exceeds this threshold, the Workhorse flags all four beams of the affected bin as bad. Scaling: LSD = 1 mm/s; Range = 0 to 5000 mm/s
45,46	23	Minutes	These fields, set by the TP-command, contain the amount of time between ping groups in the ensemble. NOTE: The Ocean Surveyor automatically extends the ensemble interval (set by TE) if (WP x TP > TE).
47,48	24	Seconds	
49,50	25	Hundredths	

Table 12: Binary Fixed Leader Data Format (Continued)

Hex Digit	Binary Byte	Field	Description

51,52	26	EX / Coord Transform	Contains the coordinate transformation processing parameters (EX-command). These firmware switches indicate how the Ocean Surveyor collected data.
			`xxx00xxx = NO TRANSFORMATION (BEAM COORDINATES)`
			`xxx01xxx = INSTRUMENT COORDINATES`
			`xxx10xxx = SHIP COORDINATES`
			`xxx11xxx = EARTH COORDINATES`
			`xxxxx1xx = TILTS (PITCH AND ROLL) USED IN SHIP OR EARTH TRANSFORMATION`
			`xxxxxx1x = 3-BEAM SOLUTION USED IF ONE BEAM IS BELOW THE CORRELATION THRESHOLD SET BY THE WC-COMMAND`
			`xxxxxxx1 = BIN MAPPING USED`

53-56	27,28	EA / Heading Alignment	Contains a correction factor for physical heading misalignment (EA-command). Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees
57-60	29,30	EB / Heading Bias	Contains a correction factor for electrical/magnetic heading bias (EB-command). Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees

61,62	31	EZ / Sensor Source	Contains the selected source of environmental sensor data (EZ-command). These firmware switches indicate the following.
			`Field     Description`
			`x1xxxxxx = calculates EC from ED, ES, and ET`
			`xx1xxxxx = uses ED from depth sensor`
			`xxx1xxxx = uses EH from transducer heading sensor`
			`xxxx1xxx = uses EP from transducer pitch sensor`
			`xxxxx1xx = uses ER from transducer roll sensor`
			`xxxxxx1x = uses ES from conductivity sensor`
			`xxxxxxx1 = uses ET from transducer temp sensor`
			NOTE: If the field = 0, or if the sensor is not available, the ADCP uses the manual command setting. If the field = 1, the ADCP uses the reading from the internal sensor or an external synchro sensor (only applicable to heading, roll, and pitch). Although you can enter a "2" in the EZ-command string, the ADCP only displays a 0 (manual) or 1 (int/ext sensor).

63,64	32	SA / Sensors Avail	This field reflects what sensors are available. The bit pattern is the same as listed for the EZ-command (above), except that the EC bit is always zero because there is no speed of sound sensor.
65-68	33,34	dis1 / Bin 1 distance	This field contains the distance to the middle of the first depth cell (bin). This distance is a function of depth cell length (WS), the profiling mode (WM), the blank after transmit distance (WF), and speed of sound. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)
69-72	35,36	WT Xmit pulse length	This field, set by the WT-command, contains the length of the transmit pulse. When the ADCP receives a <BREAK> signal, it sets the transmit pulse length as close as possible to the depth cell length (WS-command). This means the ADCP uses an WT <u>command</u> of zero. However, the WT <u>field</u> contains the actual length of the transmit pulse used. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)

Table 12: Binary Fixed Leader Data Format (Continued)

Hex Digit	Binary Byte	Field	Description
73-76	37,38	Reserved	Always 1,1
77,78	39	Reserved	Always 0
79,80	40	Reserved	Always 0
81-84	41,42	LagD / Transmit lag distance	This field, determined mainly by the setting of the WM-command, contains the distance between pulse repetitions. Scaling: LSD = 1 centimeter; Range = 0 to 65535 centimeters

7.3 Binary Variable Leader Data Format

Variable Leader data refers to the dynamic ADCP data (from clocks and sensors) that change with each ping. The ADCP always sends Variable Leader data as output data (LSBs first). See "Command Descriptions," page 6 for detailed descriptions of commands used to set these values.

Table 13: Binary Variable Leader Data Format

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

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

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

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Table 13: Binary Variable Leader Data Format (continued)

Hex Digit	Binary Byte	Field	Description
25-28	13,14	Reserved	Always 0
29-32	15,16	EC / Speed of Sound	Contains either manual or calculated speed of sound information (EC-command). Scaling: LSD = 1 meter per second; Range = 1400 to 1600 m/s
33-36	17,18	ED / Depth of Transducer	Contains the depth of the transducer below the water surface (ED-command). This value may be a manual setting or a reading from a depth sensor. Scaling: LSD = 1 decimeter; Range = 1 to 9999 decimeters
37-40	19,20	EH / Heading	Contains the ADCP heading angle (EH-command). This value may be a manual setting or a reading from a heading sensor. Scaling: LSD = 0.01 degree; Range = 000.00 to 359.99 degrees
41-44	21,22	EP / Pitch (Tilt 1)	Contains the ADCP pitch angle (EP-command). This value may be a manual setting or a reading from a tilt sensor. Positive values mean that Beam #3 is spatially higher than Beam #4. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
45-48	23,24	ER / Roll (Tilt 2)	Contains the ADCP roll angle (ER-command). This value may be a manual setting or a reading from a tilt sensor. For up-facing ADCPs, positive values mean that Beam #2 is spatially higher than Beam #1. For down-facing ADCPs, positive values mean that Beam #1 is spatially higher than Beam #2. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
49-52	25,26	ES / Salinity	Contains the salinity value of the water at the transducer head (ES-command). This value may be a manual setting or a reading from a conductivity sensor. Scaling: LSD = 1 part per thousand; Range = 0 to 40 ppt
53-56	27,28	ET / Temperature	Contains the temperature of the water at the transducer head (ET-command). This value may be a manual setting or a reading from a temperature sensor. Scaling: LSD = 0.01 degree; Range = -5.00 to +40.00 degrees
57-84	29-58	Reserved	Always 0

7.4 Binary Velocity Data Format

The ADCP packs velocity data for each depth cell of each beam into a two-byte, two's-complement integer [-32768, 32767] with the LSB sent first. The ADCP scales velocity data in millimeters per second (mm/s). A value of -32768 (8000h) indicates bad velocity values.

Table 14: Binary Velocity Data Format

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

7.5 Binary Correlation Magnitude Data Format

Correlation magnitude data for Broad Bandwidth ensembles give the magnitude of the normalized echo autocorrelation at the lag used for estimating the Doppler phase change. The ADCP represents this magnitude by a linear scale between 0 and 255, where 255 is perfect correlation (i.e., a solid target).

Correlation magnitude data for Narrow Bandwidth ensembles give the magnitude of the energy (power) in the low pass filter. Values of 170 to 190 counts represent normal levels. Lower values mean a reduced signal to noise ratio.

Table 15: Binary Correlation Magnitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the correlation magnitude data identification word (00 02h).
5,6	3	Depth Cell 1, Field 1	Stores correlation magnitude data for depth cell #1, beam #1. See above.
7,8	4	Depth Cell 1, Field 2	Stores correlation magnitude data for depth cell #1, beam #2. See above.
9,10	5	Depth Cell 1, Field 3	Stores correlation magnitude data for depth cell #1, beam #3. See above.
11,12	6	Depth Cell 1, Field 4	Stores correlation magnitude data for depth cell #1, beam #4. See above.
13-1028	7-514	Cells 2 - 128 (if used)	These fields store correlation magnitude data for depth cells 2 through 128 (depending on the WN-command) for all four beams. These fields follow the same format as listed above for depth cell 1.

7.6 Binary Echo Intensity Data Format

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

Table 16: Binary Echo Intensity Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the echo intensity data identification word (00 03h).
5,6	3	Depth Cell 1, Field 1	Stores echo intensity data for depth cell #1, beam #1. See above.
7,8	4	Depth Cell 1, Field 2	Stores echo intensity data for depth cell #1, beam #2. See above.
9,10	5	Depth Cell 1, Field 3	Stores echo intensity data for depth cell #1, beam #3. See above.
11,12	6	Depth Cell 1, Field 4	Stores echo intensity data for depth cell #1, beam #4. See above.
13-1028	7-514	Cells 2 - 128 (if used)	These fields store echo intensity data for depth cells 2 through 128 (depending on the WN-command) for all four beams. These fields follow the same format as listed above for depth cell 1.

7.7 Binary ADCP Status Data Format

These fields contain information about the status and quality of ADCP data. A value of zero means the measurement was good. A value of one means the measurement was bad.

Table 17: Binary ADCP Status Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the status data identification word (00 05h).
5,6	3	Depth cell 1, Field 1	Stores status data for depth cell #1, beam #1. See above.
7,8	4	Depth cell 1, Field 2	Stores status data for depth cell #1, beam #2. See above.
9,10	5	Depth cell 1, Field 3	Stores status data for depth cell #1, beam #3. See above.
11,12	6	Depth cell 1, Field 4	Stores status data for depth cell #1, beam #4. See above.
13 - 1028	7 - 514	Depth cells 2 - 128 (if used)	These fields store status data for depth cells 2 through 128 (depending on the WN-command) for all four beams. These fields follow the same format as listed above for depth cell 1.

7.8 Binary Bottom-Track Data Format

The LSB is always sent first. See "Command Descriptions," page 6 for detailed descriptions of commands used to set these values.

Table 18: Binary Bottom-Track Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the bottom-track data identification word (00 06h).
5-8	3,4	BP / BT # Pings	Stores the BP-command. If BP = zero, the ADCP does not collect bottom-track data. The ADCP automatically extends the ensemble interval (TE) if BP x TP > TE.
9-12	5,6	Reserved	Reserved
13,14	7	BC / BT Corr Mag Min	Stores the minimum correlation magnitude value (BC-command). Scaling: LSD = 1 count; Range = 0 to 255 counts
15,16	8	BA / BT Eval Amp Min	Stores the minimum evaluation amplitude value (BA-command). Scaling: LSD = 1 count; Range = 1 to 255 counts
17,18	9	Reserved	Reserved – always 0
19,20	10	BM/BT Mode	Stores the bottom-tracking mode (BM-command).
21-24	11,12	BE/BT Err Vel Max	Stores the error velocity maximum value (BE-command). Scaling: LSD = 1 mm/s; Range = 0 to 5000 mm/s (0 = did not screen data)
25-32	13–16	Reserved	Reserved
33-48	17-24	BT Range / Beam #1-4 BT Range	Contains the two lower bytes of the vertical range from the ADCP to the sea bottom (or surface) as determined by each beam. This vertical range does not consider the effects of pitch and roll. When bottom detections are bad, BT Range = 0. See bytes 78 through 81 for MSB description and scaling. Scaling: LSD = 1 cm; Range = 0 to 65535 cm
49-64	25-32	BT Velocity / Beam #1-4 BT Vel	The meaning of the velocity depends on the EX (coordinate system) command setting. The four velocities are as follows: a) Beam Coordinates: Beam 1, Beam 2, Beam 3, Beam 4 b) Instrument Coordinates: 1->2, 4->3, toward face, error c) Ship Coordinates: Stbd, Fwd, Upward, Error d) Earth Coordinates: East, North, Upward, Error

Continued next page

Table 18: Binary Bottom-Track Data Format (Continued)

Hex Digit	Binary Byte	Field	Description
65-72	33-36	BTCM / Beam #1-4 BT Corr.	Contains the correlation magnitude in relation to the sea bottom (or surface) as determined by each beam. Bottom-track correlation magnitudes have the same format and scale factor as water-profiling magnitudes.
73-80	37-40	BTEA / Beam #1-4 BT Eval Amp	Contains the evaluation amplitude of the matching filter used in determining the strength of the bottom echo. Scaling: LSD = 1 count; Range = 0 to 255 counts
81-88	41-44	Reserved	Reserved
89-100	45-50	Reserved	Reserved
101-140	51-70	Reserved	Reserved
141-144	71,72	BX / BT Max. Depth	Stores the maximum tracking depth value (BX-command). Scaling: LSD = 1 decimeter; Range = 80 to 9999 decimeters
145-152	73-76	RSSI/Bm #1-4 RSSI Amp	Contains the Receiver Signal Strength Indicator (RSSI) value in the center of the bottom echo as determined by each beam. Scaling: LSD˜ ≈ 0.45 dB per count; Range = 0 to 255 counts
153,154	77	GAIN	Contains the Gain level for shallow water. See WJ-command.
155-162	78-81	BT Range MSB / Bm #1-4	Contains the most significant byte of the vertical range from the ADCP to the sea bottom (or surface) as determined by each beam. This vertical range does not consider the effects of pitch and roll. When bottom detections are bad, BT Range=0. See bytes 17 through 24 for LSB description and scaling. Scaling: LSD = 65,536 cm, Range = 65,536 to 16,777,215 cm

7.9 Binary Fixed Attitude Data Format

Fixed Attitude data refers to the dynamic ADCP data (from heading, pitch, and roll sensors) that change with each ping. The ADCP will output Fixed Attitude data as output data (LSBs first). See "Command Descriptions," page 6 for detailed descriptions of commands used to set these values.

Table 19: Binary Fixed Attitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	FAID / Fixed Attitude ID	Stores the Fixed Attitude identification word (00 30h).
5-20	3-10	Attitude Output Coordinates	Stores the setting of the EE command; a user input for the Variable Attitude data to be output.
21,22	11	External Pitch/Roll Scaling	Stores the setting of the EF command; a user input for scaling the external synchro input for pitch and roll.
23-28	12-14	Fixed Heading Scaling	Stores the setting of the EH command; a user input for heading.
29-32	15,16	Roll Misalignment	Stores the setting of the EI command; a user input for the roll misalignment.
33-36	17,18	Pitch Misalignment	Stores the setting of the EJ command; a user input for the pitch misalignment.
37-46	19-23	Pitch, Roll and Coordinate Frame	Stores the setting of the EP command; a user input for the pitch, roll, and coordinate (instrument or ship) frame.
47,48	24	Orientation	Stores the setting of the EU command; a user input for the up/down orientation.
49-52	25,26	Heading Offset	Stores the setting of the EV command; a user input for the heading offset due to heading bias, variation, or synchro initialization.
53-68	27-34	Sensor Source	Stores the setting of the EZ command; a user input defining the use of internal, external, or fixed sensors.

7.10 Binary Variable Attitude Data Format

Fixed Attitude data refers to the dynamic ADCP data (from heading, pitch, and roll sensors) that change with each ping. The ADCP will output Fixed Attitude data as output data (LSBs first). See "Command Descriptions," page 6 for detailed descriptions of commands used to set these values.

The Variable Attitude identification word varies depending on the setting of the EE, NP, WP BP, and BK commands. See Table 20 for details on which ID to expect based on these command settings.

Table 20: Variable Attitude Identification Word

EE bits ab	#HPR (WP_{NB})	#HPR (WP_{BB})	#HPR (BP_{BB})	#HPR (WM_{BB})	Data Type ID
00	X	X	X	X	No Output
Instrument					
01	0	0	0	0	3040h
01	0	0	0	1	3044h
01	0	0	1	0	3048h
01	0	0	1	1	304Ch
01	0	1	0	0	3050h
01	0	1	0	1	3054h
01	0	1	1	0	3058h
01	0	1	1	1	305Ch
01	1	0	0	0	3060h
01	1	0	0	1	3064h
01	1	0	1	0	3068h
01	1	0	1	1	306Ch
01	1	1	0	0	3070h
01	1	1	0	1	3074h
01	1	1	1	0	3078h
01	1	1	1	1	307Ch
Ship					
10	0	0	0	0	3080h
10	0	0	0	1	3084h
10	0	0	1	0	3088h
10	0	0	1	1	308Ch
10	0	1	0	0	3090h
10	0	1	0	1	3094h
10	0	1	1	0	3098h
10	0	1	1	1	309Ch
10	1	0	0	0	30A0h
10	1	0	0	1	30A4h
10	1	0	1	0	30A8h
10	1	0	1	1	30ACh
10	1	1	0	0	30B0h
10	1	1	0	1	30B4h
10	1	1	1	0	30B8h
10	1	1	1	1	30BCh

Continued next page

Table 20: Variable Attitude Identification Word (continued)

EE bits ab	#HPR (WP_{NB})	#HPR (WP_{BB})	#HPR (BP_{BB})	#HPR (WM_{BB})	Data Type ID
Instrument and Ship					
11	0	0	0	0	30C0h
11	0	0	0	2	30C4h
11	0	0	2	0	30C8h
11	0	0	2	2	30CCh
11	0	2	0	0	30D0h
11	0	2	0	2	30D4h
11	0	2	2	0	30D8h
11	0	2	2	2	30DCh
11	2	0	0	0	30E0h
11	2	0	0	2	30E4h
11	2	0	2	0	30E8h
11	2	0	2	2	30ECh
11	2	2	0	0	30F0h
11	2	2	0	2	30F4h
11	2	2	2	0	30F8h
11	2	2	2	2	30FCh

Table 21: Binary Variable Attitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VAID / Variable Attitude ID	Stores the Variable Attitude identification word (range 3040 to 30FC, see Table 20, page 80).
5-8	3,4	Heading Water/Bottom Ping Type 1	Stores the Heading value for the first Ping Type recorded. A Ping Type is defined based on the EE command setting and then on the NP, WP, BP, and BK commands. The EE command decides if the heading data for this Ping Type will be relative to the Instrument or Ship coordinate. The NP, WP, BP, and BK commands decide if the heading data for this Ping Type will be for the Narrow Bandwidth Water Ping, the Broad Bandwidth Water Ping, the Bottom Track Ping, or the Bottom Water Reference Layer Ping.
9-12	5,6	Pitch Water/Bottom Ping Type 1	Stores the Pitch value for the first Ping Type recorded. A Ping Type is defined based on the EE command setting and then on the NP, WP, BP, and BK commands. The EE command decides if the pitch data for this Ping Type will be relative to the Instrument or Ship coordinate. The NP, WP, BP, and BK commands decide if the pitch data for this Ping Type will be for the Narrow Bandwidth Water Ping, the Broad Bandwidth Water Ping, the Bottom Track Ping, or the Bottom Water Reference Layer Ping.
13-16	7,8	Roll Water/Bottom Ping Type 1	Stores the Roll value for the first Ping Type recorded. A Ping Type is defined based on the EE command setting and then on the NP, WP, BP, and BK commands. The EE command decides if the roll data for this Ping Type will be relative to the Instrument or Ship coordinate. The NP, WP, BP, and BK commands decide if the roll data for this Ping Type will be for the Narrow Bandwidth Water Ping, the Broad Bandwidth Water Ping, the Bottom Track Ping, or the Bottom Water Reference Layer Ping.

Continued next page

Table 21: Binary Variable Attitude Data Format (continued)

Hex Digit	Binary Byte	Field	Description
17-20	9,10	Heading Rate Water/Bottom Ping Type 1	Stores the Heading Rate value for the first Ping Type recorded. A Ping Type is defined based on the EE command setting and then on the NP, WP, BP, and BK commands. The EE command decides if the heading rate data for this Ping Type will be relative to the Instrument or Ship coordinate. The NP, WP, BP, and BK commands decide if the heading rate data for this Ping Type will be for the Narrow Bandwidth Water Ping, the Broad Bandwidth Water Ping, the Bottom Track Ping, or the Bottom Water Reference Layer Ping.
21-24	11,12	Pitch Rate Water/Bottom Ping Type 1	Stores the Pitch Rate value for the first Ping Type recorded. A Ping Type is defined based on the EE command setting and then on the NP, WP, BP, and BK commands. The EE command decides if the pitch rate data for this Ping Type will be relative to the Instrument or Ship coordinate. The NP, WP, BP, and BK commands decide if the pitch rate data for this Ping Type will be for the Narrow Bandwidth Water Ping, the Broad Bandwidth Water Ping, the Bottom Track Ping, or the Bottom Water Reference Layer Ping.
25-28	13,14	Roll Rate Water/Bottom Ping Type 1	Stores the Roll Rate value for the first Ping Type recorded. A Ping Type is defined based on the EE command setting and then on the NP, WP, BP, and BK commands. The EE command decides if the roll rate data for this Ping Type will be relative to the Instrument or Ship coordinate. The NP, WP, BP, and BK commands decide if the roll rate data for this Ping Type will be for the Narrow Bandwidth Water Ping, the Broad Bandwidth Water Ping, the Bottom Track Ping, or the Bottom Water Reference Layer Ping.
29-196	15-98	Ping Types 2-8 if used	Repeat of the previous 12 bytes for each Ping type. NOTE: Ping Types are defined in the order of NP, WP, BP, and BK. Ping Type 1 output will be the first command that is greater than 1. That is, if NP>1 and WP=0 then Ping Type 1 will be for the value for the Narrow Bandwidth Water Ping. If NP=0 and WP>0 then Ping Type 1 will be for the value for the Broad Bandwidth Water Ping. The first command setting in the order of NP, WP, BP, and BK that is greater than zero becomes Ping Type 1. Then based on the EE command this data may be relative to the instrument or to the ship. If both instrument and ship are selected by the EE command then the Ping Type 1 will be instrument and Ping Type 2 will be ship.

7.11 Binary Navigation Data Format

These fields contain the Navigation Data. This data is only recorded in the STA and LTA files created by the RDI Windows software program *VmDas*. The LSB is always sent first. See "Command Descriptions," page 6 for detailed descriptions of commands used to set these values.

Table 22: Binary Navigation Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the sum of velocities identification word (2000h).
5-6	3	UTC Day	This field contains the UTC Day.
7-8	4	UTC Month	This field contains the UTC Month.
9-12	5,6	UTC Year	This field contains the UTC Year, i.e. i.e. 07CF = 1999
13-20	7-10	UTC Time of first fix	UTC time since midnight; LSB = 0.01 seconds
21-28	11-14	PC Clock offset from UTC	PC Time – UTC (signed); LSB = milliseconds

29-36	15-18	First Latitude	This the first latitude position received after the previous ADCP ping.
			
			LSB=approx. 8E-8 deg (32-bit BAM)
			
			In the BAM (Binary Angular Measure) format, the most significant bit of the word has a weight of 180 degrees, and you keep dividing by 2 as you proceed to the right. The lease significant bit for a 32-bit BAM is about 8E-8 arc degrees ($180/2^{31}$), or just under 1 cm of longitudinal distance at the equator, where 1 arc minute = 1 Nautical mile. If you interpret the BAM word as an unsigned number, the range is 0 to (360-lsb) degrees, and if you interpret the BAM as a signed number, the range is –180 to (180-lsb) degrees. The least significant bit for a 16-bit BAM is about 0.0055 degrees ($180/2^{15}$). Some 32-bit BAM examples are:
			
			UNSIGNED
			`0x40000000   90 degrees`
			`0x80000000  180 degrees`
			`0xC0000000  270 degrees`
			`0xFFFFFFFF  360 degrees minus one LSB degrees`
			SIGNED
			`0x40000000   90 degrees`
			`0x80000000  minus 180 degrees`
			`0xC0000000  minus 90 degrees`
			`0xFFFFFFFF  minus one LSB degrees`

37-44	19-22	First Longitude	This is the first longitude position received after the previous ADCP ping. LSB=approx. 8E-8 deg (32-bit BAM)
45-52	23-26	UTC Time of last fix	Time since midnight UTC; LSB=1E-4 seconds

Continued next page

Table 22: Binary Navigation Data Format (Continued)

Hex Digit	Binary Byte	Field	Description
53-60	27-30	Last Latitude	This is the last latitude position received prior to the current ADCP ping. LSB=approx. 8E-8 deg (32-bit BAM)
61-68	31-34	Last Longitude	This is the last longitude position received prior to the current ADCP ping. LSB=approx. 8E-8 deg (32-bit BAM)
69-72	35,36	Avg Speed	Average Navigational Speed mm/sec (signed)
73-76	37,38	Avg Track True	Average True Navigational Ship Track Direction LSB=approx. 0.0055 deg (16-bit BAM)
77-80	39,40	Avg Track Magnetic	Average Magnetic Navigational Ship Track Direction LSB=approx. 0.0055 deg (16-bit BAM)
81-84	41,42	Speed Made Good (SMG)	Speed calculated between navigation positions. LSB=one mm/sec (signed) The Speed Made Good (SMG) and Direction Made Good (DMG) quantities are calculated from the navigation fixes that enter the system between ADCP outputs, and are calculated as follows: If: aLat(i) = the average of the latitudes of the nav fixes in interval i aLon(i) = the average of the longitudes of the nav fixes in interval i Ta(i) = the average of the time of validity of the nav fixes in interval i dLat = the difference in average latitude between averaging intervals dLon = the difference in average longitude between averaging intervals VelMGn (i) = the velocity made good in the North direction for interval i VelMGe (i) = the velocity made good in the East direction for interval i LatToDist (dLat) is a function that converts delta Latitude to a distance LonToDist (dLon) is a function that converts delta Longitude to a distance Smg (i) = speed made good in interval i Dmg (i) = direction made good in interval i Then: dLat = (aLat (i-1) – aLat (i)) dLon = (aLon (i-1) – aLon (i)) VelMgn (i) = LatToDist (dLat) / (Ta(i-1) – Ta(i)) VelMge (i) = LonToDist (dLon) / (Ta(i-1) – Ta(i)) Smg(i) = sqrt(VelMGn(i)^2 + VelMGe(i)^2) Dmg(i) = atan(VelMGe(i) / VelMGn(i))

Table 22: Binary Navigation Data Format (Continued)

Hex Digit	Binary Byte	Field	Description
85-88	43,44	Direction Made Good (DMG)	Direction calculated between navigation positions. LSB = approx. 0.0055 deg (16-bit BAM)
89-92	45,46	Reserved	Reserved for RDI use.
93-96	47,48	Flags	Describes the validity of the data. Each bit has represents a separate flag and has its own meaning 1=true, 0=false. The flag bits are defined as follows: bit 0 = Data updated bit 1 = PSN Valid bit 2 = Speed Valid bit 3 = Mag Track Valid bit 4 = True Track Valid bit 5 = Date/Time Valid bit 6 = SMG/DMG Valid bit 7 = Pitch/Roll Valid bit 8 = Heading Valid bit 9 = ADCP Time Valid bit 10 = Clock Offset Valid bit 11 = Reserved bit 12 = Reserved bit 13 = Reserved bit 14 = Reserved bit 15 = Reserved
97-100	49,50	Reserved	Reserved for RDI use.
101-108	51-54	ADCP Ensemble Number	This field contains the sequential number of the ensemble to which the data in the output buffer apply. Scaling: LSD = 1 ensemble; Range = 1 to 4,294,967,296 ensembles
109-112	55,56	ADCP Ensemble Year	This field contains the ADCP year, i.e. 07CFH = 1999
113-114	57	ADCP Ensemble Day	This field contains the ADCP day.
115-116	58	ADCP Ensemble Day	This field contains the ADCP month.
117-124	59-62	ADCP Ensemble Time	Number of seconds since midnight; LSB = 0.01 seconds
125-128	63,64	Pitch	Pitch angle. LSB = approx. 0.0055 deg (16-bit BAM). Pitch is positive when bow is higher than stern.
129-132	65,66	Roll	Roll angle. LSB =approx. 0.0055 deg (16-bit BAM). Roll is positive when the port side is higher than the starboard side.
133-136	67,68	Heading	Heading input. LSB =approx. 0.0055 deg (16-bit BAM)
137-140	69,70	Number of Speed Samples Averaged	The number of speed samples averaged since the previous ADCP ping.
141-144	71,72	Number of True Track Samples Avg	The number of True Track samples averaged since the previous ADCP ping.
145-148	73,74	Number of Magnetic Track Samples Avg	The number of Magnetic Track samples averaged since the previous ADCP ping.

Table 22: Binary Navigation Data Format (Continued)

Hex Digit	Binary Byte	Field	Description
140-152	75,76	Number of Heading Samples Averaged	The number of Heading samples averaged since the previous ADCP ping.
153-156	77,78	Number of Pitch/Roll Samples Averaged	The number of Pitch/Roll samples averaged since the previous ADCP ping.

7.12 Binary Reserved for RDI Format

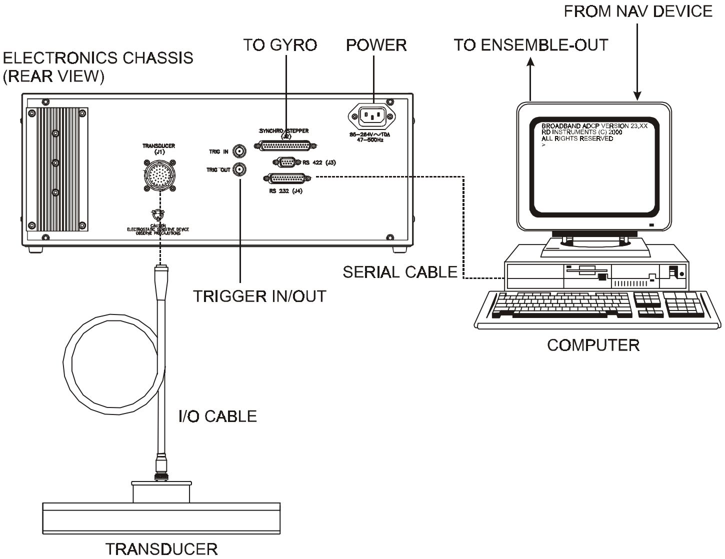
Table 23: Binary Reserved for RDI Format

Hex Digit	Binary Byte	Field	Description
1-28	1-14	Reserved for RDI's use	This field is for RDI (internal use only).

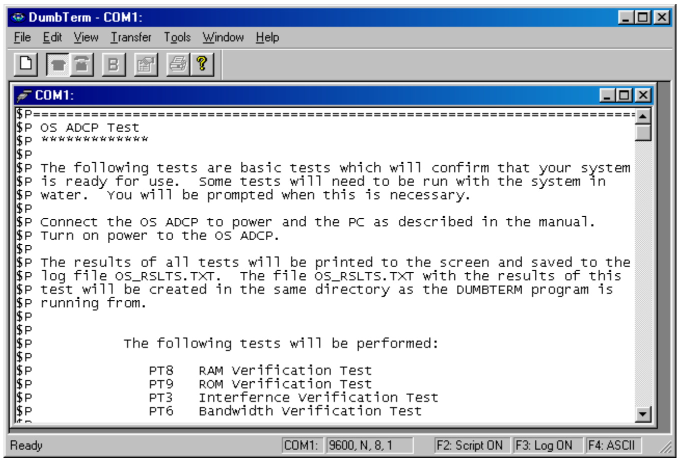
7.13 Binary Checksum Data Format

Table 24: Binary Checksum Data Format

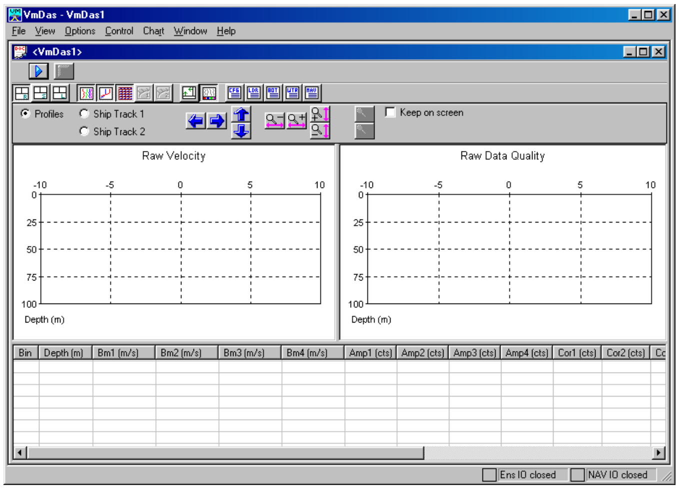
Hex Digit	Binary Byte	Field	Description
1-4	1,2	Checksum Data	This field contains a modulo 65536 checksum. The ADCP computes the checksum by summing all the bytes in the output buffer excluding the checksum.



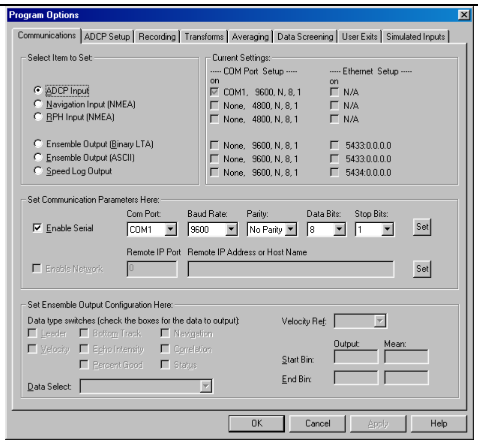
Step 1. Connect the Ocean Surveyor and computer as shown above.



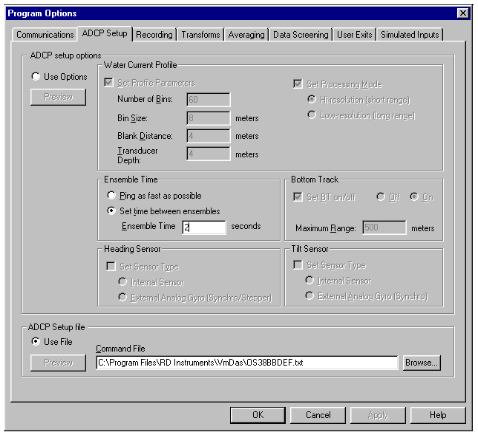
Step 2. Run the *DumbTerm* script file OStest.txt to verify the Ocean Surveyor is functioning properly.



Step 3. Start *VmDas*. On the **File** menu, click **Collect Data**. On the **Options** menu, click **Load**. Select the Default.ini file and click **Open**.



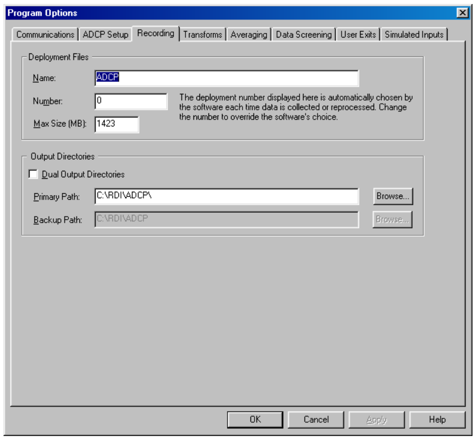
Step 4. On the **Options** menu, click **Edit Data Options**. Click the **Communications** tab and set the communications settings with the ADCP and NMEA ports.



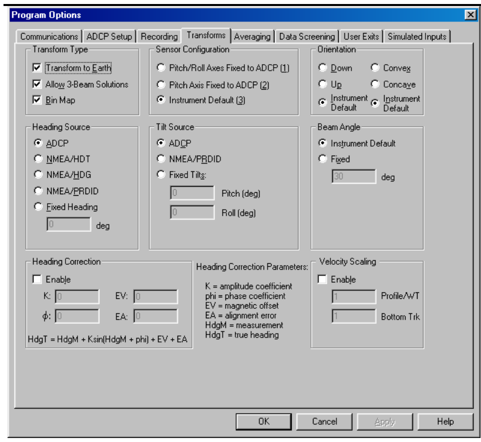
Step 5. Click the **ADCP Setup** tab. Set the **Ensemble Time** to the value shown below. Select the **Use File** button and choose a default command file for your ADCP, and load it into *VmDas* using the **Browse** button.

Ensemble Time

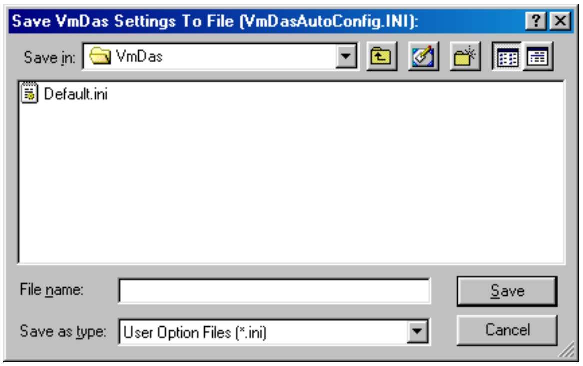
Frequency (kHz)	w Bottom Track (sec)	w/o Bottom Track (sec)
38	4	2
75	2	1
150	1	1



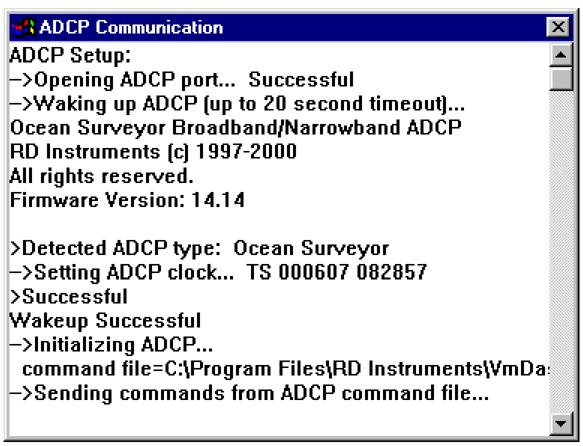
Step 6. Click the **Recording** tab. Set the deployment name and path to where the data files are recorded.



Step 7. Click the **Transforms** tab and verify the **Transform Type**, **Sensor Configuration**, **Orientation**, **Heading Source**, **Tilt Source**, **Beam Angle**, and **Heading Correction** are set to your input. Click **OK**.



Step 8. On the **Options** menu, click **Save As**. The options may be saved to a file for later retrieval.



Step 9. On the **Control** menu, click **Go** to begin collecting data. The ADCP Communication and NMEA window will open and show the commands from the command file being sent to the Ocean Surveyor and the Ocean Surveyor's response.

Ocean Surveyor Care

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

General Handling Guidelines

- Never set the transducer on a hard or rough surface. The urethane face may be damaged.
- Do not expose the transducer to prolonged sunlight. The urethane face may develop cracks. Cover the transducer face on the Ocean Surveyor if it will be exposed to sunlight.
- Do not scratch or damage the O-ring surfaces or grooves. All O-ring grooves and surfaces must be inspected for scratches or damages on every re-assembly. If scratches or damage exist, they must be sanded out using 400 to 600 grit sandpaper. If the damage cannot be repaired, contact RDI. Do not risk a deployment with damaged O-ring surfaces.
- Do not lift or support an Ocean Surveyor by the external I/O cable. The connector or cable will break.

Assembly Guidelines

- Always check that the I/O cable (wet end) O-ring is in place when connecting the I/O cable to the transducer. This O-ring has a tendency to fall out if the cable connector is dropped.
- Read the Maintenance book for details on Ocean Surveyor re-assembly. Make sure the top hat assembly O-rings stay in their groove when you re-assemble the Ocean Surveyor. Tighten the Top Hat hardware as specified. Loose, missing, or stripped Top Hat mounting hardware or damaged O-rings can cause the Ocean Surveyor transducer to flood.

Deployment Guidelines

- Read the *VmDas* User's Guide. This guide has a tutorial to help you learn how to use the software.
- Use the default Command Files (installed to the same directory as *VmDas*) to help setup the ADCP.

Ocean Surveyor Command Quick Reference Card

Ocean Surveyor Input Command Summary

	Command	Description
Misc.	?	Shows Command Menu
	<BREAK>	Interrupts or wakes up Ocean Surveyor and loads last settings used
	V	Display banner
Bottom Track	BAnnn	Amplitude Threshold (0 to 255 counts)
	BCnnn	Correlation Threshold (0 to 255 counts)
	BEnnnn	Error Velocity Threshold (0 to 9999 mm/s)
	BPn	Bottom-Track Pings (0 = disable, 1 to 999 = number of pings)
	BXnnnn	Maximum Tracking Depth (0 to 9999 dm)
Control	CBnnn	Serial Port Control (Baud Rate/Parity/Stop Bits)
	CFabcde	Flow Control (a = ensemble cycling, b = ping cycling, c= binary/ASCII, d = serial port, e = not used)
	CK	Keep Parameters as User Defaults
	CRn	Retrieve Parameters (0 = User, 1 = Factory)
	CS	Start Pinging
	CXn,n	Trigger Mode (In, Out)
Environment	EA±nnnnn	Heading Alignment (-179.99 to 180.00)
	ECnnnn	Speed of Sound (1400 to 1600 m/s)
	EDnnnnn	Depth of Transducer (0 to 65535 decimeters)
	EEnnnn nnnn	Attitude Data Output and Interpolation
	EF±nn	External Pitch/Roll Factor (-99 to 99)
	EHnnnnn,n	Heading Angle (heading (-179.99 to 180.00); frame (0 = instrument coordinates, 1 = ship coordinates))
	EI±nnnnn	Roll Misalignment Angle (-179.99 to 180.00)
	EJ±nnnnn	Pitch Misalignment Angle (-179.99 to 180.00)
	EP±nnnn, ±nnnn,z	Tilts (pitch (-179.99 to 180.00), roll (-179.99 to 180.00), frame (0 = instrument coordinates, 1 = ship coordinates))
	ESnn	Salinity (0 to 40 parts per thousand)
	ET±nnnn	Temperature (-5.00 C to +40.00C)
	EUn	Orientation (0 = Down, 1 = Up)
	EV±nnnnnn	Heading Bias (-179.99 to 180.00)
	EXnnnnn	Coordinate Transformations
	EZnnnnnnn	Sensor Source (c; d; h; p; r; s; t, u); (0 = manual, 1 = transducer, 2 = synchro)
Fault	LC	Clear Fault Log
	LD	Display Fault Log
	LL	Display Fault List
Narrow Bandwidth Water Profiling	NAnnn	False Target Amplitude Threshold (0 to 255 counts)
	NDabc def ghi	Data Out (a = velocity, b = power, c = echo intensity, d = percent good, e = status f to i = reserved)
	NEnnnn	Error Velocity Threshold (0 to 9999 mm/s)
	NFnnnn	Blanking Distance (0 to 9999 cm)
	NNnnn	Number of bins (0 to 128 bins)
	NPnnn	Number of Pings (0 to 999 pings)
	NSnnnn	Bin Size (1600 to 6400 cm for 38kHz, 800 to 3200 cm for 75kHz, 400 to 1600 cm for 150kHz)
Performance	PA	Runs Built-In tests
	PCn	Show Sensor Data (0 = help, 2 = sensor data)
	PDn	Data Stream Select (n = 0)
	PSn	Display System Parameters (0 = Sys Configuration, 1 = fixed leader, 2 = variable leader, 3 = reserved, 4 = ping sequence)
	PTn	Diagnostic Tests (0 = help, 3 = receive path, 5 = electronic wrap around, 6 = receive bandwidth)
Timing	TC	System Timer Value
	TEhh:mm:ss.ff	Time per Ensemble (hh = hours, mm = minutes, ss = seconds, ff = hundredths of seconds)
	TPmm:ss.ff	Time Between Pings (mm = minutes, ss = seconds, ff = hundredths of seconds)
	TSyymmddhhmmss	Set System Date and Time (Year/Month/Day, Hour: Minute: Second)

	Command	Description
Broad Bandwidth Water Profiling	WAnnn	False Target Amplitude Threshold (0 to 255 counts)
	WCnnn	Correlation Threshold (0 to 255 counts)
	WDabc de0 000	Profile Data Out (a = Velocity; b= Correlation; c = Intensity; d = percent good, e = Status)
	WEnnnn	Error Velocity Threshold (0 to 9999 mm/s)
	WFnnnn	Blanking Distance (0 to 9999 cm)
	WNnnn	Number of bins (1 to 128 bins)
	WPnnn	Number of Pings (0 to 999 pings)
	WSnnnn	Bin Size (80 to 6400 cm for 38kHz, 40 to 3200 cm for 75kHz, 20 to 1600 cm for 150kHz)
	WVnnn	Ambiguity Velocity (0 to 390 cm/s)

ADCP Factory Defaults (Highlighted commands should typically remain at the factory default value)

COMMAND	38.8 kHz	75 kHz	150 kHz
BAnnn	20	20	20
BCnnn	220	220	220
BEnnnn	1000	1000	1000
BPnnn	1	1	1
BXnnnn	20000	10000	05000
CBabc	411	411	411
CFabcde	11110	11110	11110
CXn,n	0,0	0,0	0,0
EA±nnnnn	0	0	0
ECnnnn	1500	1500	1500
EDnnnnn	0	0	0
EEnnnnnn	111111	111111	111111
EF±nn	1	1	1
EH±xxxx,y	0,0 (Stationary) 0,1 (Vessel)	0,0 (Stationary) 0,1 (Vessel)	0,0 (Stationary) 0,1 (Vessel)
EI±nnnnn	0	0	0
EJ±nnnnn	0	0	0
EP±xxxx, ±nnnn,z	0,0,0 (Stationary) 0,0,1 (Vessel)	0,0,0 (Stationary) 0,0,1 (Vessel)	0,0,0 (Stationary) 0,0,1 (Vessel)
ESnn	35	35	35
ET±nnnn	2100	2100	2100
EUn	0	0	0
EV±nnnnn	0	0	0
EXnnnnn	00000	00000	00000
EZnnnnnnn	1011101	1011101	1011101
NAnnn	255	255	255
NDnnnnnnnnn	111110000	111110000	111110000
NEnnnn	1000	1000	1000
NFnnnn	1600	800	400
NNnnn	050	050	050
NPnnn	000	000	000
NSnnnn	3200	1600	800
PDn	0	0	0
TEhhmmssff	00000000	00000000	00000000
TPmmssff	000300	000200	000100
WAnnn	255	255	255
WCnnn	120	120	120
WDnnn nnn nnn	111 110 000	111 110 000	111 110 000
WEnnnn	1000	1000	1000
WFnnnn [min]	1600	800	400
WNnnn	128	128	128
WPnnn	1	1	1
WSnnnn	3200	1600	800
WVnnnn	390	390	390

RD Instruments

Acoustic Doppler Current Profilers

Installation Guide

For Vessel Mount ADCPs

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P/N 954-6007-00 (November 1998)

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1. Introduction

This booklet is a guide for installing a RD Instruments (RDI) Vessel-Mounted Acoustic Doppler Current Profiler (VM-ADCP) aboard a vessel (ship). Use this section to plan your installation layout. You also can use this booklet to see what requirements you must consider before purchasing an ADCP. We recommend you distribute this booklet to your organization's decision-makers and installation engineers.

We are not experts in installing the ADCP aboard a ship. There are too many installation methods. We suggest you seek expert advice in this area because of its importance in ADCP performance. However, we can give you information about how others have installed their systems. In return, we do appreciate receiving information about your installation and the results.

2. VM-ADCP System Components

The standard VM-ADCP (Figure 1) is an AC-powered, two-part unit. It consists of a bronze transducer assembly mounted to the ship's hull and an electronics chassis you can place in the ship's lab. Several options are available.

The basic system includes:

- Transducer assembly - Contains the transducer ceramics and electronics. Standard acoustic frequencies are 75, 150, 300, 600, and 1200 kHz. See the outline drawings for dimensions and weights.
- Electronics chassis - Contains the processing electronics.
- Maintenance kit - Contains spare parts and basic tools needed for routine maintenance.
- VM-ADCP technical manual and user's guide.
- Waterproof dummy plug.

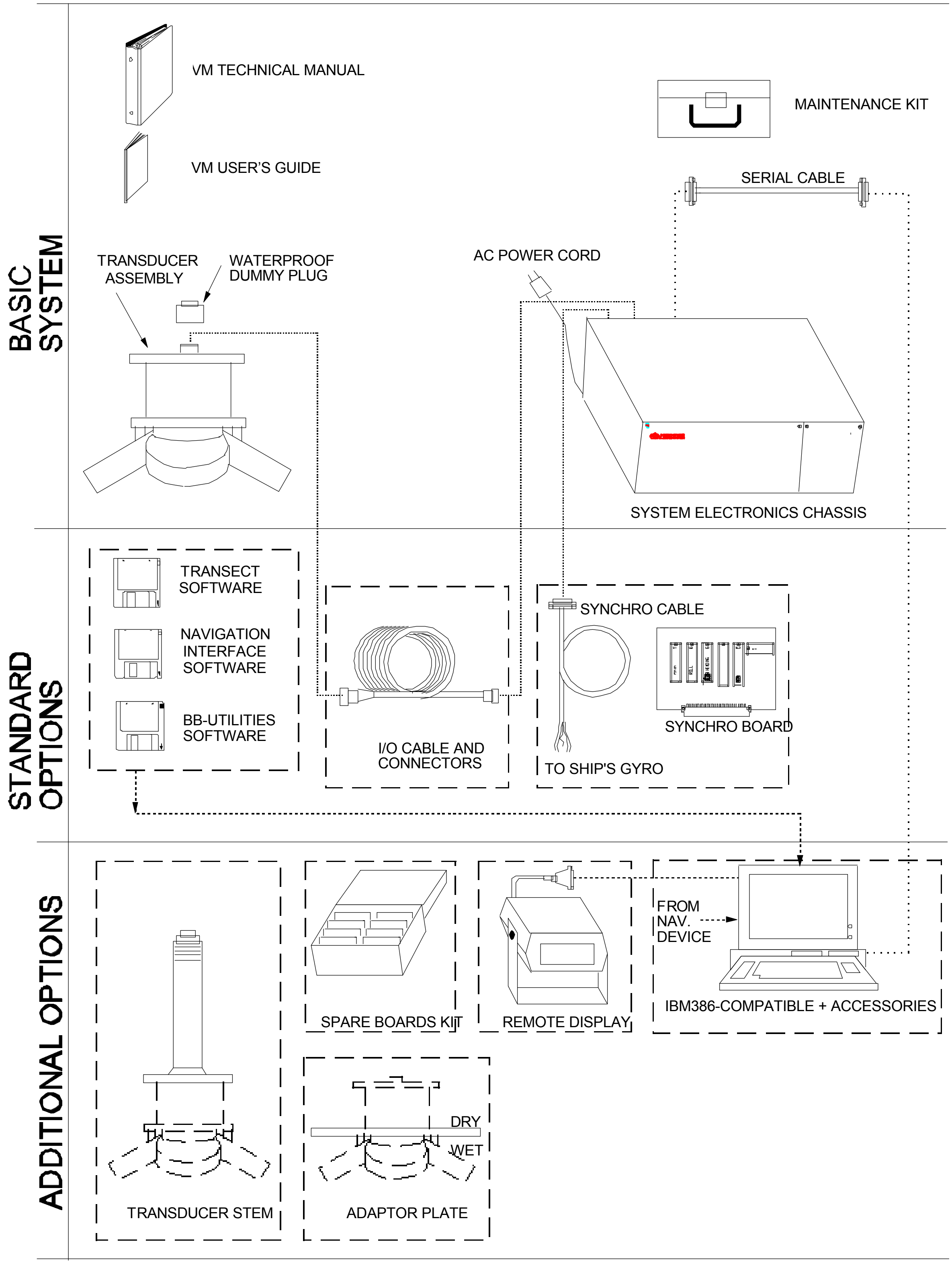


Figure 1. Typical Vessel-Mounted ADCP System

Standard options include:

- Input/Output (I/O) cables and connectors.
- Gyrocompass (gyro) interface - Connects the ship's gyro to the electronics chassis.
- *TRANSECT* Software - Controls the ADCP and displays its data through an IBM AT compatible computer.
- Navigation interface software - Connects a navigation device to *TRANSECT* through a serial cable to the host computer.
- BB-Utilities software - Several programs to help you set up the ADCP, talk directly to the ADCP, monitor the ADCP, list tabular data and calculate the speed of sound.

Additional options include:

- IBM AT-compatible computer - Controls the ADCP and displays its data, usually through our *TRANSECT* program. Table 4 lists the minimum computer requirements.
- Transducer stem - A bronze extension stem that allows through-the-hull transducer mounting using a gate valve. See the outline installation drawings for dimensions.
- Adapter plate - A bronze plate that lets you mount the transducer head so you can access its electronics from inside the ship. See the outline installation drawings for dimensions.
- Spare boards kit - Contains a complete set of spare printed circuit boards for a standard ADCP. The set does not include boards purchased as options.
- Remote display - The ADCP provides basic speed log data when using *TRANSECT*. You can remotely view this data through a computer-to-display serial interface.

3. Transducer Head Mounting Considerations

You must consider several potential problems before installing the transducer head assembly. Read this section before deciding where to install the transducer assembly. See the outline installation drawings (included in this guide) and Appendix-B in the VM-BBADCP Technical Manual for specifications on our standard VM-ADCP transducer heads.

3.1. Location

Ideally, you want to install the transducer head:

- Where it is accessible both internally (for access to transducer electronics) and externally (to remove biofouling).
- Where the I/O cable length is 100 m (328 feet) or less.
- Away from shipboard protrusions that reflect ADCP energy. Allow for a reflection-free clearance of 15° around each beam (see the outline installation drawings).
- Away from other acoustic/sonar devices, especially those operating at the same frequency (or harmonic) of the ADCP.

- Close to the ship's fore-to-aft centerline. As distance from the centerline increases, vertical accelerations caused by the roll of the ship also increase. These accelerations can cause additional uncertainties in ADCP velocity measurements.

3.2. Orientation

We recommend you mount the transducer head with Beam 3 rotated to a ship-relative angle of 45° (Figure 13 shows beam orientation). This causes the magnitude of the signal in each beam to be about the same. This improves error rejection, reduces the effect of ringing (see "Acoustic Isolation," page 14), and increases the ADCP's effective velocity range by a factor of 1.4. If you align Beam 3 at an angle other than zero, you must nullify this offset (see "Alignment Procedures (Generic)," page 24). You can do this using a direct command (Appendix-C) or through our *TRANSECT* program.

Use the ship's roll and pitch reference to mount the transducer head as level as possible. If the head is not level, depth cell (bin) mapping will be incorrect. Large misalignments can cause large velocity measurement errors. If you cannot mechanically make the transducer head level, you can use *TRANSECT* to enter offset values for roll and pitch. No direct commands are available for roll/pitch offsets. See "Alignment Procedures (Generic)," page 24.

3.3. Floating Objects

Our transducer assembly is sturdy, but we did not design it to withstand collisions with all floating objects. We strongly suggest you use one of the following.

3.3.1. Sea Chest

A sea chest (Figure 2 and Figure 3) is a fixture that surrounds and holds the transducer head, protecting it from debris in the water. The bottom of the sea chest must be open to seawater to allow the acoustic beams to pass through freely. If using a sea chest interests you, call us for the latest information. Ask for Application Note 7 - Conceptual Design of a Sea Chest for an RDI ADCP Transducer.

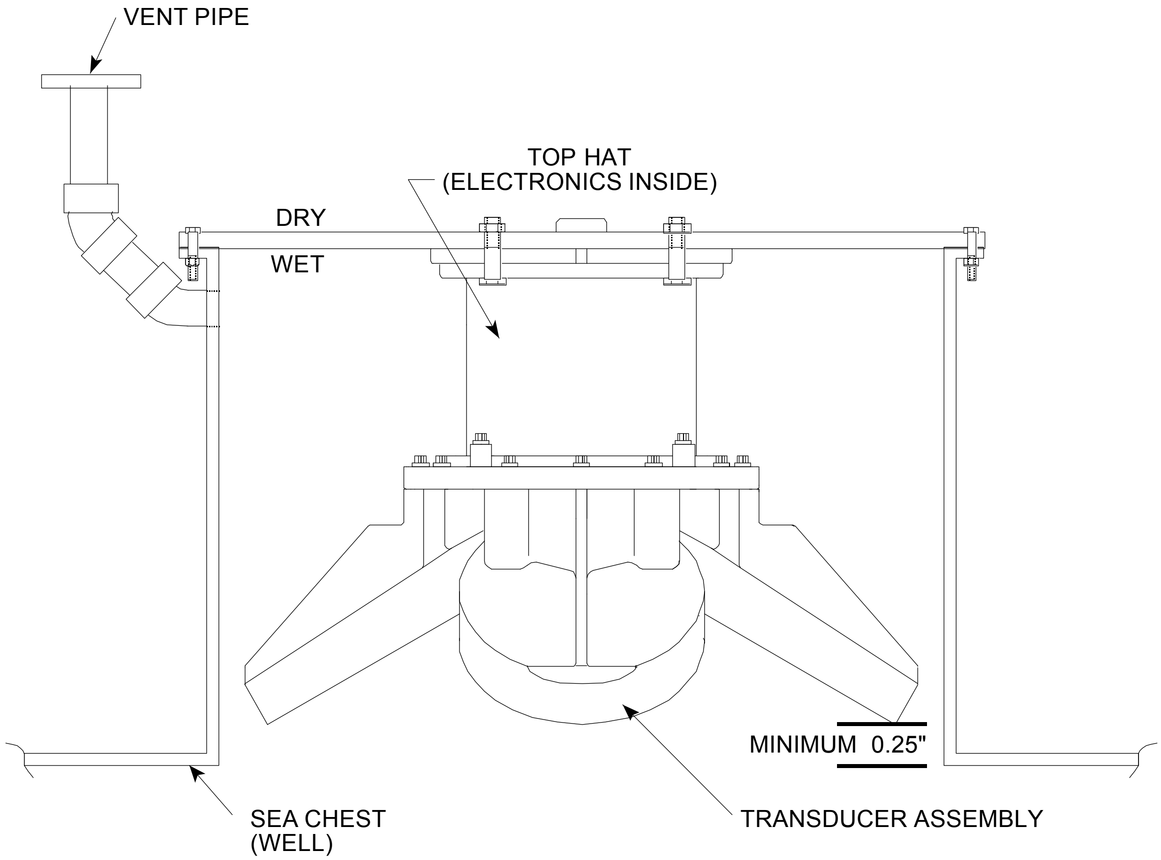


Figure 2. Sea Chest Mounted Transducer (Without an Adapter Plate)

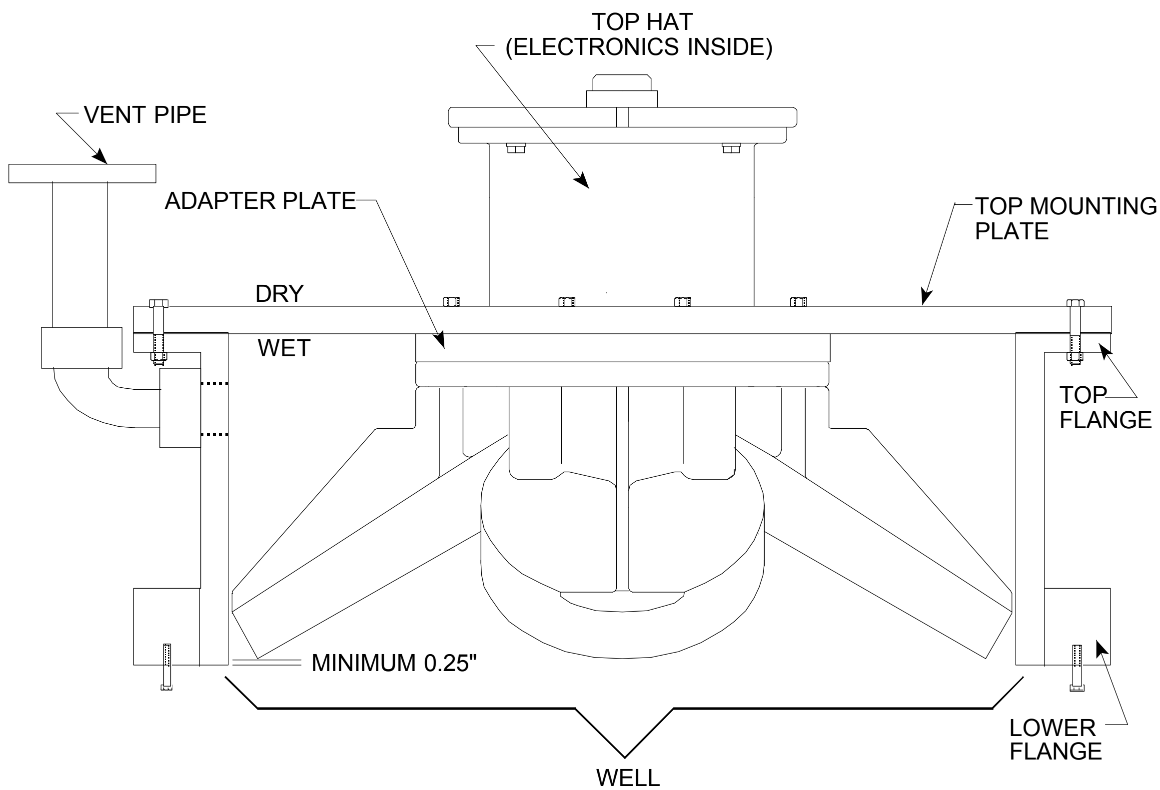


Figure 3. Sea Chest Mounted Transducer (With an Adapter Plate)

3.3.2. Fairing

A structure that produces a smooth outline and reduces drag or water resistance. The fairing also diverts floating objects away from the transducers. A fairing that is shaped like a tear drop, is slopped such that the leading edge (closer to the bow) is higher than the back edge, and extends below the hull (typically 12 inches) will divert the air bubbles away from the transducer faces. Figure 4 shows a design used by Texas A&M.

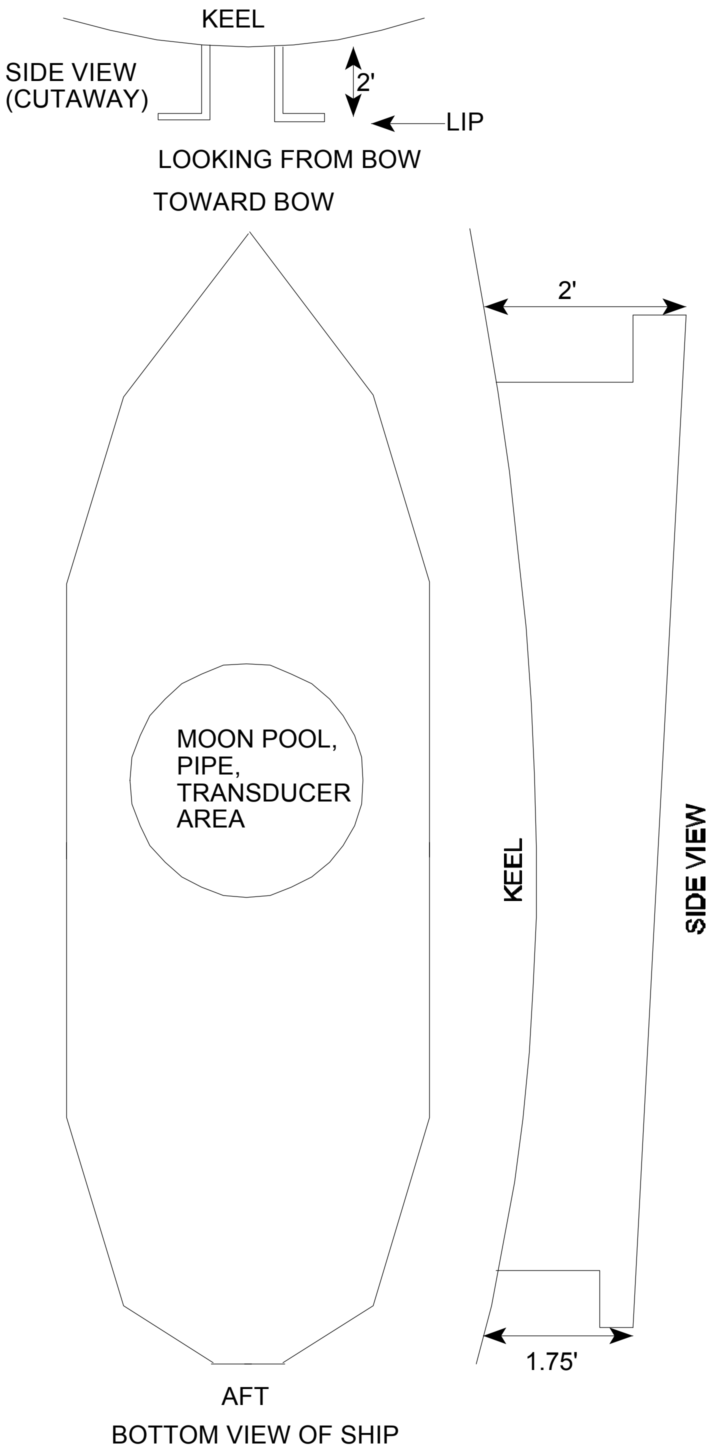


Figure 4. Fairing

3.3.3. Acoustic Window

RD Instruments does not know enough about use of acoustic windows to recommend their use in general. We are concerned about calibration errors that may arise from their use. While we do not fully understand windows, we do believe that windows can be used to produce overall performance improvements in vessel-mounted ADCPs. Additionally, if the ship operates where there is danger of barnacle damage or a high density of ice or other floating objects, then the use of an acoustic window is the only option.

It is theoretically possible to use a window successfully, however there are several pros and cons to consider before using an acoustic window.

Pros

- Well will not fill with air bubbles caused by the ship moving through the surface water, section 3.4.
- Flow noise is reduced, section 3.5.
- The well can be filled with fresh water to limit corrosion, section 3.6.
- Barnacles can not grow on the transducer faces. Barnacle growth is the number one cause of failure of the transducer beams, section 3.8.
- The transducer is protected from debris floating in the water.

Cons

- The range of the ADCP will be reduced because the window can and will absorb some of the transmit and receive energy, section 3.3.4.
- The transmit signal could be reflected into the well, causing the well to “ring” like a bell. This will cause the data being collected during the ringing to be biased. Some ships have reported a loss in range as great as 50 meters. The ringing may be dampened by applying sound absorbing material on the well walls (RDI does not have any recommendations for sound absorbing material), section 3.7.
- The transmit signal could be reflected off of the window and back into the other beams, section 3.3.4.

Although RDI does not specifically recommend the use of windows our experience has allowed us to put together some minimum specific recommendations:

Window orientation. The acoustic window should be flat and parallel to the transducer mounting plate. Note this is not an absolute requirement. However, if the water temperatures inside the window and outside the window are not the same, all four beams will be refracted and actual velocity components will be rotated into a new coordinate system. In particular, some of the horizontal velocity will appear as a vertical velocity.

Window material. Important acoustic properties of the window include acoustic refractive index (which should be as close as possible to that of water), insertion loss (which should be as small as possible) and speed of sound. There are two acoustic refractive indices: one for shear waves and one for plane waves. The acoustic refractive indices are simply the ratios of speed of sound in water to speed of sounds in the material. Insertion loss combines absorption and reflection of sound, and it depends on both the thickness and the material properties of the window. In particular, you should avoid using window thickness equal to odd multiples of shear mode quarter-waves (Dubbelday and Rittenmeyer, 1987; Dubbleday, 1986). Refer to Selfridge (1985) and Thompson (1990) for more information. Note that the speeds of sound in plastics decrease with increasing temperature and that causes the resonant frequencies to shift. This can be a large effect. Neither Selfridge nor Thompson has much information on the temperature coefficients of sound speeds.

Our experience has shown Low-Density-Poly-Ethylene (LDPE) to be a very good window for the NarrowBand (NB) ADCP and that Polycarbonate windows are very good for the Broadband (BB) ADCP. The thickness of the materials depends on the frequency you intend to use. Table 1 will help to choose the maximum thickness you should use. Note, one concern with window selection is that it be able to support the weight of the water inside the well once the ship is dry docked. RDI recommends that you always fill/drain the well at the same time that you are either filling/draining the dry dock area.

Table 1. Window Thickness

FREQUENCY	Narrowband	Broadband
38	N/A	3 inches
75	3 inches	2 inches
150	1 inch	1 inch
300	0.5 inches	0.5 inches
600	0.25 inches	0.25 inches
1200	0.25 inches	0.25 inches

Spacing between window and transducer. The primary geometrical factor in design of windows is the reflection of one beam into another beam, causing crosstalk between the beams. The distance from the window should be at least 0.25 inches and no more than 0.5 inches for optimal setup.

Window aperture. The window aperture must be sufficient to pass the beams without causing diffraction. If the window is placed next to the transducer, then the aperture diameter should be the same as the distance between transducer cup corners. If the window is placed away from the transducer, then the aperture should be larger than all four beams plus about one transducer ceramic diameter. Figures 5 through 9 provide the recommended aperture for both geometry's discussed in the above paragraph.

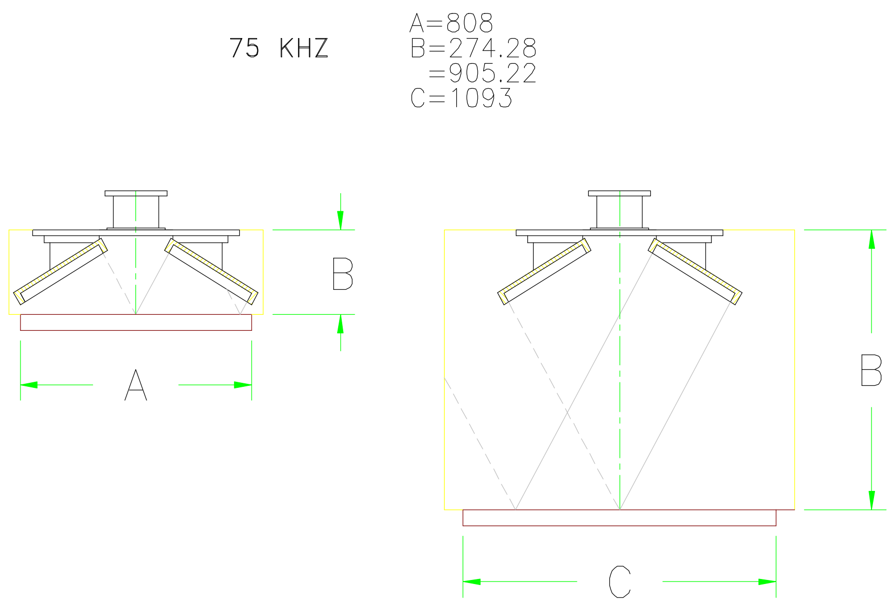


Figure 5. 75KHZ Dimensions

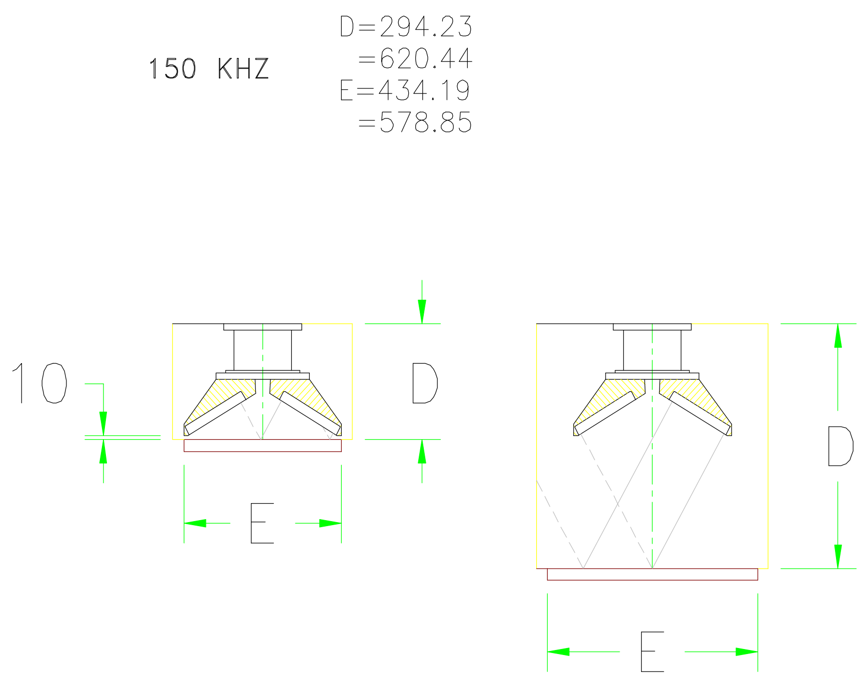


Figure 6. 150KHZ Dimensions

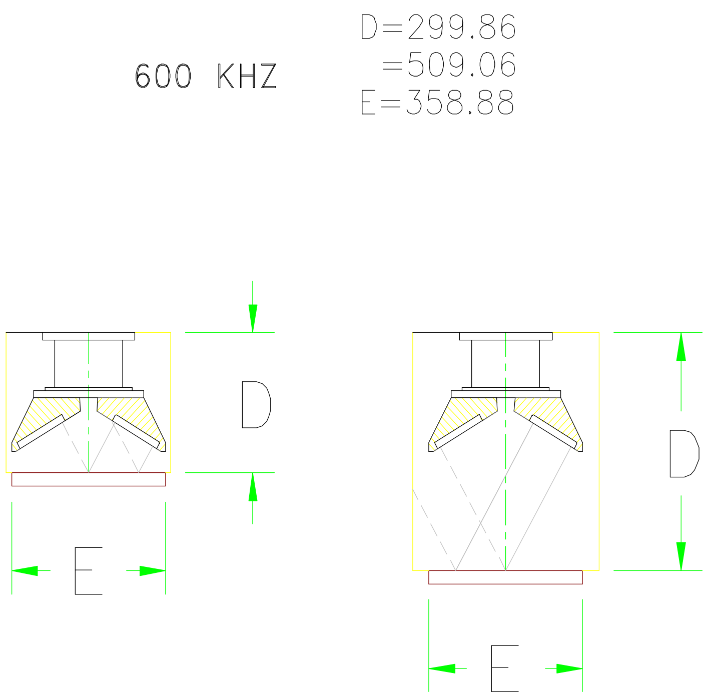


Figure 7. *600KHZ Dimensions*

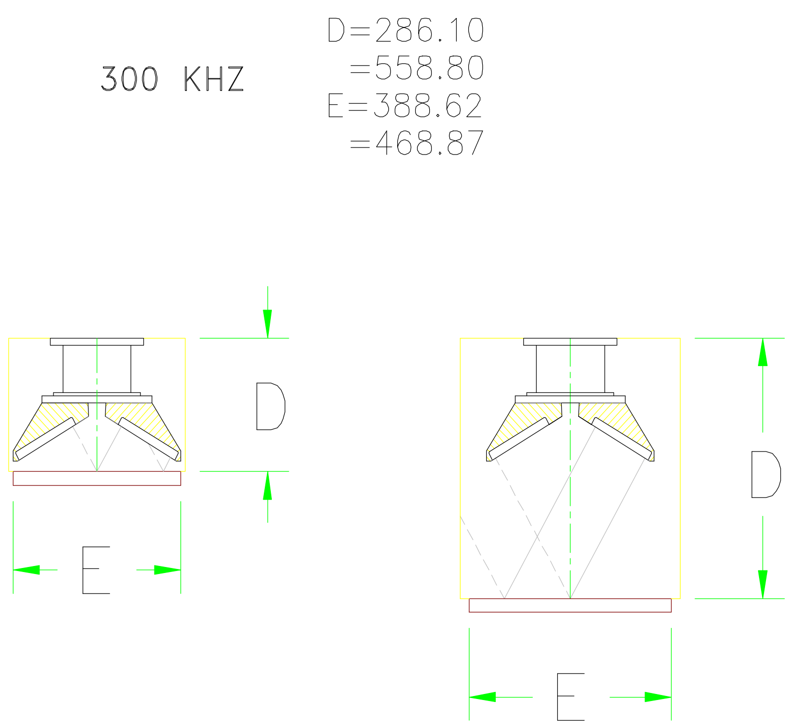


Figure 8. *300KHZ Dimensions*

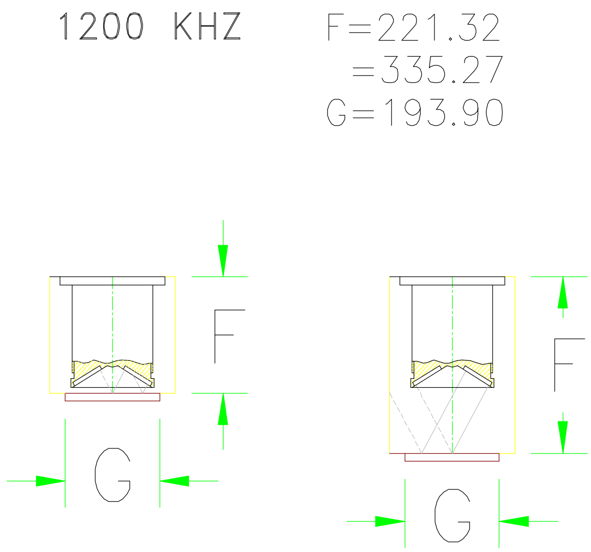


Figure 9. 1200KHZ Dimensions

Example

Our Japanese representative uses 0.25 inch thick Low Density Polethylene (LDPE). He then drills two 30mm holes in the window along the edges. The inside walls are painted with anti-fouling paint. This allows the water to be full of anti-foulant during the time the ship is docked, which is when the barnacle growth occurs. The holes allow the water to exchange when the ship is in motion and also allows for draining when the ship is dry docked (a 0.25” window will not support the weight of the water). He has never had a failure with the window, and has seen only a minimal loss in range (5-30 meters).

It is best if the window is parallel to the bottom edge of the transducer cups. The transducer cups are at a 30° angle. If the window is at an angle to the transducer, it will change the absorption. We do not have experience with different angles, but we have had customers use domes or have the window follow the contour of the ship bottom without real problems.

The optimum distance for the bottom of the transducer assembly from the window is 0.25 inches ±0.125 inches. Never allow the transducer to touch the window. The farther away the transducer cups are from the window, the more the sound is reflected off of one beam and then reflected into another beam.

Acoustically-absorbing sea chest liner. A sound absorbing material should be used inside the sea chest to minimize the effects of sound ringing within the sea chest. The material should be a minimum of one wavelength thick (include the sound speed of the absorbing material when calculating the size of a wavelength). Approximate wavelengths of sound in seawater are given below in Table 2. We do not have sufficient experience to recommend a specific absorbing material.

Table 2. Wavelength of sound in seawater (1500 m/s sound speed)

FREQUENCY (kHz)	WAVELENGTH (mm)
75	20
150	10
300	5
600	2.5
1200	1.25

Fluid in the sea chest. The sea chest should be filled with fresh water. Seawater can be used, but at the cost of increased corrosion. Seawater should not be circulated through the sea chest because it will encourage growth of biofouling organisms. The pressure within the sea chest should be adjusted to keep the window from bowing in and out, and thereafter, the volume should be kept constant.

Transducer calibration. The factor used to correct velocity for speed of sound variations should be based on the speed of sound of the fluid inside the sea chest. Changes of speed of sound resulting from temperature changes may be computed from the temperature sensor on the transducer.

3.4. Air Bubbles

Design your installation to minimize the volume of air bubbles in the path of the acoustic beams. Air bubbles attenuate (weaken) the signal strength and reduce the ADCP profiling range. Ships with a deep draft or a non-flat bottom have fewer problems with bubbles. Ways to reduce bubble flow vary with ship characteristics, but two options are available. Mount the transducers below or away from the bubble layer.

- The flow layer is usually within the first two feet below the hull. Bubbles can get trapped in this layer. Mounting the transducer head amidship on the fore-to-aft centerline may help. For ships with propulsion systems that make large amounts of bubbles, use a mounting technique that lets you lower the transducer head below the hull while under-way.

> **NOTE.** If you use locally-made or existing extension hardware instead of the hardware available from RDI, you may need to make an adapter plate to connect your hardware to our transducer head. Please call us for the exact dimensions and layout of our transducer head bolt holes for your system.

- Divert the bubble layer so it flows around the transducers - You can use fairings to alter the bubble flow. An acoustic window (see “Acoustic Window,” page 7) may help reduce the bubble problem, but can cause ringing (see “Acoustic Isolation,” page 14) and at-tenuation problems.

3.5. Flow Noise

Water flowing over the transducer faces increases the acoustic noise level, which decreases the profiling range of the ADCP. You can reduce the flow across the transducer faces with a sea chest, fairing, or acoustic window.

3.6. Corrosion and Cathodic Disbondment

Never attach anodes directly to the transducer head. Additional anodes or impressed voltage systems can cause the urethane to separate from the transducer cups (cathodic disbondment) or cause the material of the transducer to break down. Standard anode protection used for the ship should be installed outside of the well of the transducer head. Mounting of ship's standard anode protection outside of the transducer well will typically not cause any problems. Our transducers are made of a material that has shown to corrode very little over time when the above precautions are met. The corrosion can be further reduced if the well is covered with a window and then filled with fresh water.

3.7. Ringing

The ADCP transmits an acoustic pulse into the water. The main lobe of this pulse bounces off of particles in the water and the signals returned from these particles are used to calculate the velocity of the water.

As stated, the main lobe of the transmitted pulse is what we are using to process and calculate a velocity. The transmitted pulse, however, is made up of many side lobes off the main lobe. These side lobes will come in contact with metal of the transducer beam itself and other items in either the water or the well.

The energy from the side lobes will excite the metal of the transducer and anything bolted to the transducer. This causes the transducer and anything attached to it to resonate at the system's transmit frequency. We refer to this as "ringing".

If the ADCP is in its receive mode while the transducer is ringing then it will receive both the return signals from the water and the "ringing". Both of these signals are then processed by the ADCP. The ringing causes bias to the velocity data.

All ADCPs "ring" for some amount of time. Therefore, each ADCP requires a blanking period (time of no data processing) to keep from processing the ringing energy. Each ADCP frequency has a different typical ringing duration. The typical ringing period for each ADCP frequency is as follows; 75kHz is 6 meters, 150kHz ADCPs is 4 meters, 300kHz ADCPs is 2 meters, 600kHz ADCPs is 1.5 meters, and 1200kHz ADCPs is 0.8 meters. These typical ringing values are recommended as the minimum setting for all ADCPs using default setups.

It should be noted, on some installations the effects of ringing will last longer than the recommended settings above. For example, the effects of ringing will last longer if the transmit signal becomes trapped inside the transducer well. This can occur because the well itself is ringing with the transducer or when windows covering the opening of the well reflect the signal back inside the well.

The window causes the transmit signal to reflect back into the well due to the difference in impedance between the window and the water. When the transmit signal is reflected in the well it becomes trapped and this results in longer ringing periods. To keep from processing this signal, the blanking period must be increased.

Lining the inside walls of the well with a sound absorbing material aid in dampening the ringing effect. Regrettably, RDI has no specific material to recommend at this time.

3.8. Acoustic Isolation

Try to minimize the acoustic coupling between the transducer head and the ship. Without adequate acoustic isolation, the transducer output will “ring” throughout the ship and feeds back into the ADCP receive circuits. Ringing causes bias errors in water-track velocities and results in the loss of data in the closest depth cells (bins). Reflections inside a sea chest with an acoustic window also can cause ringing.

You can attain acoustic isolation several ways. At a minimum, use gaskets to isolate all contact points between the ship and the transducer head. Design your installation for:

- A minimum number of contact points between the transducer head and the ship.
- Minimal contact area.
- Single points of contact for positioning and support (when possible).

You also should try to separate the transducer head from the ship using intermediate connections. This is because direct connections transfer the most acoustic energy. Texas A & M used the following installation technique and had minimal ringing problems.

- Transducer head mounted to a thin steel plate
- Steel plate positioned with three pins set into mounting holes on the hull; pins isolated with gaskets
- Steel plate held in place with four I-beams welded to a frame
- Frame bolted to another frame and separated by gaskets
- Second frame bolted to the ship and separated by gaskets

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

- Mount the other acoustic devices as far apart as possible.
- Make sure neither the main lobes nor the side lobes of the acoustic devices point at the transducers, including acoustic reflections.
- Try not to operate devices that use the same frequency or a harmonic of the ADCP’s frequency.

3.9. Maintenance

Chapter 4 explains routine maintenance procedures. You rarely need access to the electronics inside the transducer head. However, one external maintenance item is important enough to mention here as it may affect how you install the transducer head.

Objects deployed within about 100 meters (328 feet) of the surface are subject to the buildup of organic sea life (biofouling). This means VM-ADCPs are subject to biofouling. Soft-bodied organisms usually cause no problems, but hard barnacle shells can cut through the urethane transducer face causing transducer failure and leakage into the ADCP.

The best-known way to control biofouling is cleaning the ADCP transducer faces often. However, in many cases this is not possible. The other alternatives include the use of a window or some sort of anti-foulant protection.

Some of our users have had success applying a thin coat (≈4 mm; ≈0.16 in.) of either a 50:50 mix of chili powder and Vaseline or chili powder and silicone grease to the transducer faces. The chili powder should be the hottest that can be found. Water flowing across the transducers will wash this mix away over time. The silicone mixture tends to last longer.

Some organizations may decide to use antifouling grease. However, most antifouling greases are toxic and may cause problems. Recent tests suggest antifouling grease may cause the urethane on the transducer faces to develop cracks. Warmer temperatures accelerate this effect.

The other method is to use antifoulant paint. At present, we recommend the following antifouling paint manufacturer and paint brand: Courtalds Finishes Interlux brand paints, US Telephone: 908-686-1300, Web Page: www.interlux.com. Contact RDI for preparation and application procedures for this and other antifoulant paints.

CAUTION.

1. Read the Material Safety Date Sheet before using any of the listed solvents and paints.
2. Some antifouling coatings may not be legal for use in all areas. Check with your local environmental agency before using the antifouling paint.
3. Do not arbitrarily use antifouling paints. Be aware that antifouling paints can accelerate the dezincification corrosion of brass. Once initiated, dezincificatioin will rapidly destroy the transducer.
4. RDI no longer recommends the use of Nopcocide for the prevention of biofouling. If using antifouling grease, remove it immediately after recovering the ADCP.
5. Antifouling grease is toxic. Read the product safety data sheet before using the grease. Wear gloves and a face shield when applying the grease. If the skin comes in contact with the grease, immediately wash the affected area with warm, soapy water.
6. When possible, do not coat the transducer faces with cuprous oxide or related paints that contain chemicals such as copper, chrome, or arsenic. These paints advance the corrosion of the transducer assembly and will cause the urethane to separate from the transducer cups.
7. All US Coastal States prohibit the use of tributyl-tins on boat hulls. The European Economic Commission has released a draft directive that would prohibit the use of many organo-tins after July 1989. We strongly recommend you obey your local laws.

3.10. Electronics Chassis Mounting Considerations

Place the electronics chassis (see “Outline Installation Drawings,” page 25) where there is access to the I/O cable, host computer, gyro interface cable, and navigation interface cable. You can place the rack-mountable chassis in a standard 19-inch cabinet. The chassis needs 90 to 260 VAC to operate (see “Power Considerations,” page 22). Allow enough room around the chassis for access, ventilation, and isolation from electronic and magnetic interference.

3.11. Cabling Considerations

Several cables connect to the VM-ADCP system (Figure 10 and Figure 11). Use care when routing these cables through bulkheads, deck plates, cable runs, and watertight spaces. Make allowances in cable length and engineering design plans for cable routing. When necessary, use strain reliefs on the cables.

The input/output (I/O) cable connecting the transducer head to the electronics chassis is about 2.22 cm (0.875 in.) in diameter. We deliver the cable with both connectors attached. The connectors are about 4.45 cm (1.75 in.) in diameter. The transducer-end connector is molded on, so you can use it below the waterline. The cable is custom-made in lengths up to 100 meters (328 feet). Route this cable so:

- You can install it with the connectors attached. NOTE: You can order the cable with the chassis-end connector removed. This allows easier cable routing, but requires you to solder the cable connections at your installation site. This is a difficult task.
- It does not have kinks or sharp bends.
- You can easily replace it if it fails.

Other cables that may need routing to the chassis include the computer interface and the gyro interface. Other cables that may need routing to the computer include the navigation interface and the remote display interface.

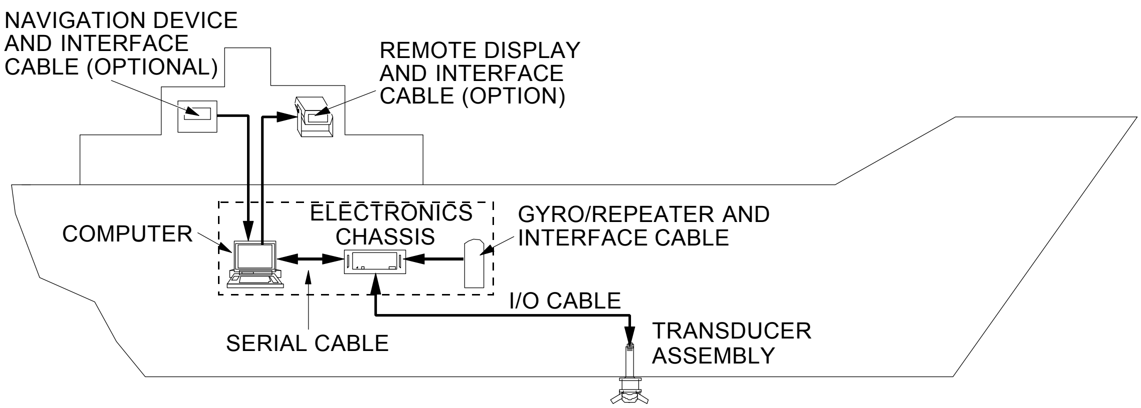


Figure 10. Typical VM-BBADCP Interface Cable Layout (Overview)

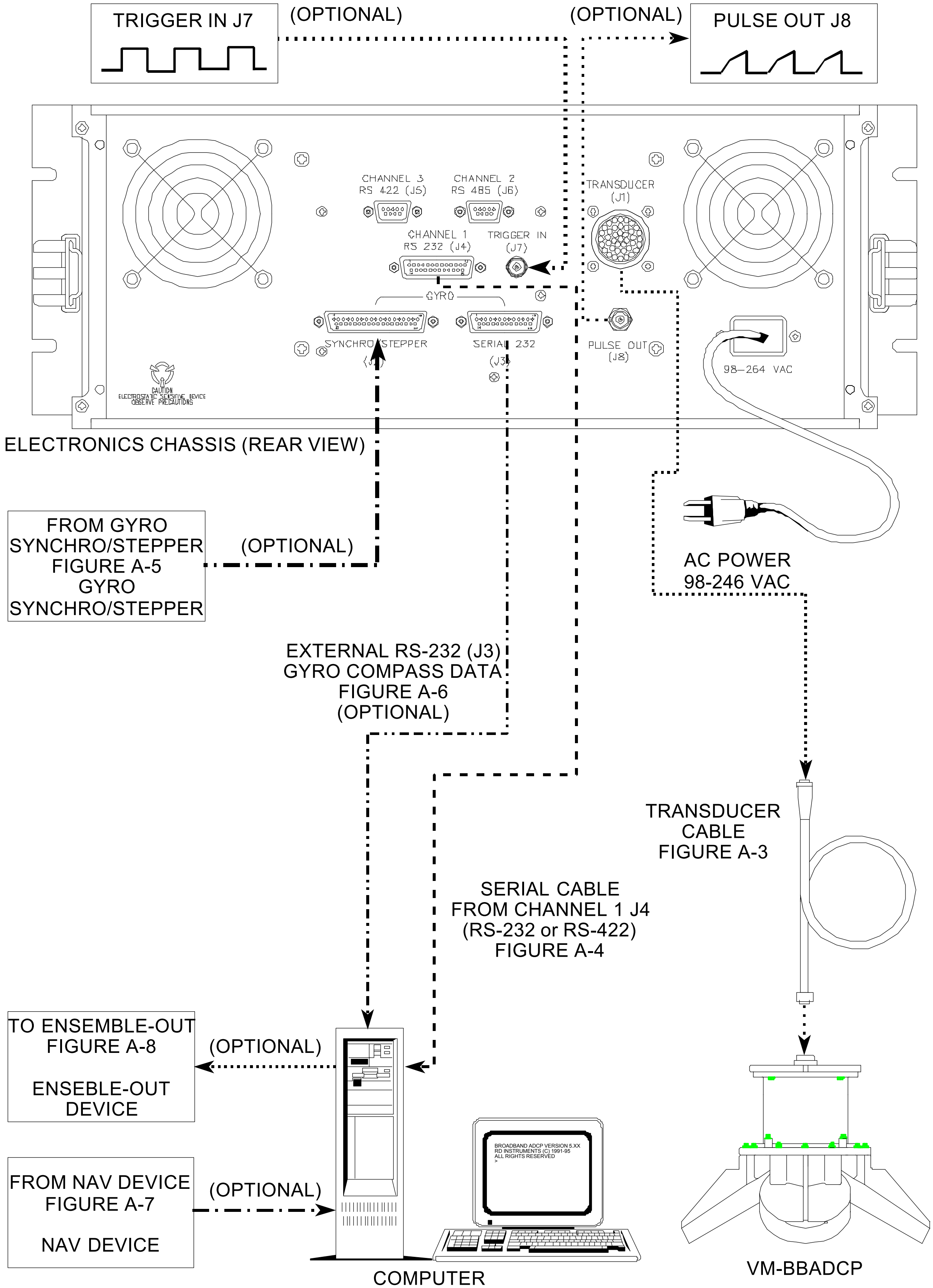


Figure 11. Typical VM-BBADCP Interface Cable Layout (Detail View)

3.12. Using Trigger-In

The *Trigger In* feature is controlled via an input pulse or DC level injected at the J7 B-N-C connector on the back of the VM Electronics chassis. The *Trigger In* feature is enabled by the CX command.

The *Trigger In* (J7) B-N-C connector uses the center post as the signal input. The outside of the B-N-C connector is used for ground.

The ADCP performs a cycle of reading sensors (known as overhead), transmitting, blanking, processing, and sleep for each ping. When the CX command is enabled (by any setting of CX other than CX0), the ADCP will enter a transmit trigger wait state just before the transmitting portion of the cycle. It is during this wait state that the *Trigger In* input is read by the ADCP. This results in the following caution:

The ADCP does not store trigger in inputs. This means that the ADCP will only acknowledge pulses it sees during the transmit trigger wait state. For example, if 3 trigger in pulses were sent to the ADCP in quick succession only the pulse that occurred during the transmit trigger wait state would be used. The other pulses would be ignored and lost.

The setting of the CX command tells the ADCP what type of input signal (either pulse or a DC level) will be sent as the trigger. The following are the available inputs:

Table 3. Trigger-In Input Signals

Command	Description
CX0	Turns off (disables) the Trigger-In input. This is the factory default setting.
CX1	Sets the ADCP to trigger transmit off of the rising edge of a pulse. The pulse must rise from 0 VDC (low) to 5 VDC (high) and stay high for at least 10 milliseconds.
CX2	Sets the ADCP to trigger transmit off of the falling edge of a pulse. The pulse must fall from 5 VDC (high) to 0 VDC (low) and stay low for at least 10 milliseconds.
CX3	Is a combination of both CX1 and CX2. It sets the ADCP to trigger transmit off of either the rising edge (low to high) of a pulse or the falling edge (high to low) of a pulse. The pulse must stay high/low for at least 10 milliseconds.
CX4	Sets the ADCP to trigger off a constant DC level input of 0 VDC to 0.5 VDC.
CX5	Sets the ADCP to trigger off a constant DC level input of 2.5 VDC to 5 VDC.

NOTE. Trigger-In is available only for systems using firmware version 5.46 or later and using the new electronics chassis back panel.

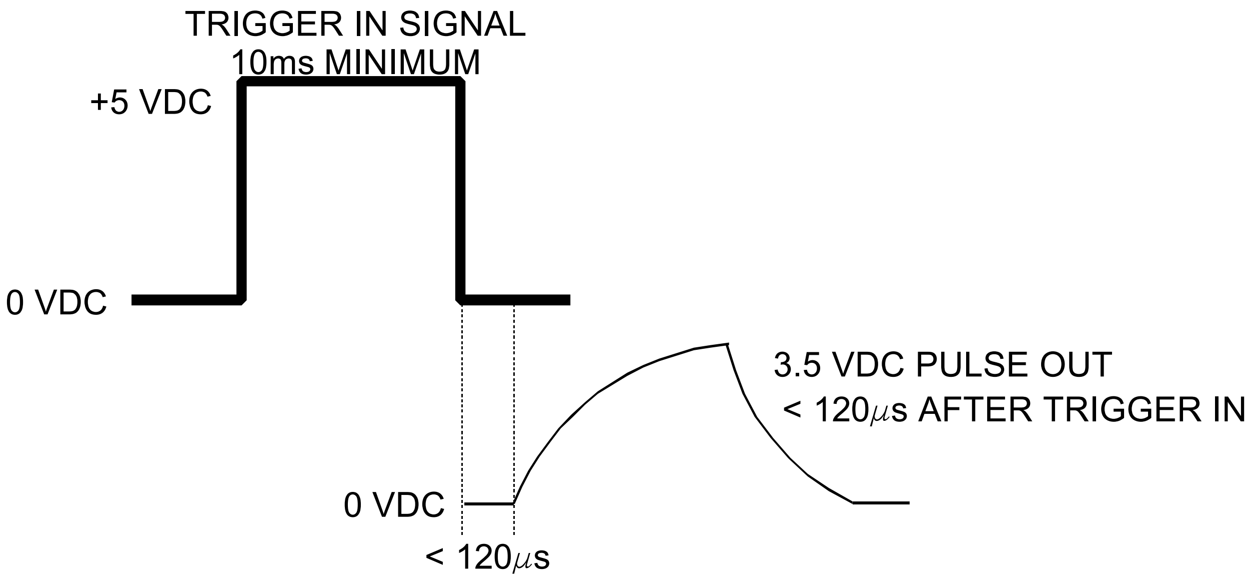


Figure 12. Trigger-In and Pulse-Out Timing

3.13. Using Pulse-Out

The *Pulse Out* feature is always available. No command is needed to enable or disable this feature. A pulse that rises from 0 VDC to 5 VDC is present at the J8 B-N-C connector on the back of the VM electronics chassis. This pulse rises to 5 VDC (high) at the beginning of the ADCPs transmit and stays high until the end of transmit. The pulse will return to 0 VDC at the end of transmit.

The *Pulse Out* (J8) B-N-C connector uses the center post as the signal output. The outside of the B-N-C connector is used for ground.

> **NOTE.** Pules-Out is available only for systems using firmware version 5.46 or later and using the new electronics chassis back panel.

4. Computer Considerations

We designed the VM-ADCP system to use an IBM AT-compatible computer. The computer controls the ADCP and displays its data, usually through our *TRANSECT* program. Table 4 lists the minimum computer requirements. You can control the ADCP using a dumb terminal or emulator program, but this method is difficult. Reserve this method for testing, troubleshooting, and special applications such as user-developed software.

When operating the ADCP through a computer, memory-resident programs (commonly called TSRs) and shared interrupts may cause problems. Some TSRs/interrupts may conflict with those used by the program controlling the ADCP. Loading the TSRs in a different order may help. If not, you may have to remove the TSRs.

We have not heard from anyone who has been completely successful in controlling the ADCP through a multi-tasking program (e.g., Microsoft Windows™) with our *TRANSECT* program. If you are using *TRANSECT*, you can set up the system to start automatically and begin pinging through configuration files. This allows the ADCP system to operate unattended.

Table 4. Minimum Computer Hardware Requirements

IBM AT-compatible computer with 80386 (or later) microprocessor
640 KB of memory
DOS 3.0 (or later)
Enhanced Graphics Adapter (EGA) with EGA monitor
One floppy disk drive and a 30-MB (or larger) hard disk drive
One serial port (COM1 or COM2)
Internal real-time clock with battery backup

5. Gyrocompass Interface Considerations

The ADCP does not contain any sensors for measuring heading, pitch and roll. The vessel must provide this information. There are 2 ways to interface sensor data such as heading, pitch, and roll information with the ADCP data, either by an analog signal input or by a serial ASCII input.

- Single- or multi-turn synchro heading outputs and single-turn synchro tilt sensor outputs for pitch and roll or
- Stepper heading outputs and single-turn synchro tilt sensor outputs for pitch and roll.
- Serial ASCII data input to the host computer running the RDI ADCP software that conforms to one of the following NMEA standards.
    - $_ _ HDT (NMEA 0183 standard of true heading only)
    - $_ _ HDM (NMEA 0183 standard of magnetic heading only)
    - $PRDID (RDI proprietary NMEA string supporting heading, pitch, and roll)

The analog input is read by a Gyro Interface board in VM ADCPs rack mounted electronics box. The advantage to these options is that gyro outputs are more accurate and more reliable than flux-gate heading sensors and pendulums. Table 5 lists the gyro interface options.

Use the RD-SIC-0 option when only stepper heading is available. Use the RD-SIC-1 option when either synchro or stepper heading is available. This option supports single-turn (1:1), multi-turn (36:1, 90:1, 360:1), and stepper voltage outputs from a ship's gyro or portable gyro. Use the RD-SIC-3 option with a gyro capable of resolving motion across the vertical plane (i.e., tilt synchro gyro). With the RD-SIC-3 option, you can use:

The Gyro Interface board uses up to three synchro-to-digital converter chips to configure the board for the synchro stator voltages, and DIP switches to configure the board for the turns ratio of a specific gyro. The Gyro Interface board supports a wide range of input synchro stator voltages by using a scaling-resistor pack and supports the common synchro frequencies (50, 60, and 400 Hz).

We usually configure the Gyro Interface board at the factory to customer specifications for synchro stator voltage and gyro turns ratio. Table 6 lists the acceptable standard configurations. For us to configure the board you must provide us with either the Stepper

Sometimes, though, the customer chooses to use a gyro other than the one originally specified. Because of the need to change the gyro interface configuration “in the field,” we provide technical information in Chapter 7 in the VM Technical Manual.

Table 5. Gyro Interface Options by Model

Inputs allowed	Natel chips	Typical use
1 (RD-SIC-0)	0	Stepper heading only
1 (RD-SIC-1)	1	Synchro/Stepper heading only
3 (RD-SIC-3)	3	Synchro/Stepper heading, AND Synchro-only pitch and roll

Table 6. Acceptable Gyro Interface Configurations

Synchro voltages (heading & tilt)	
Rotor	20 - 150 VAC
Stator	Most common - 11.8, 26.0, 50.0, and 90.0 VAC (other values are possible with scaling of resistors; see G-3)
Stepper voltages (heading only)	Most common - 35.0 and 70.0 VDC (others possible)
Line frequencies	Most common - 50, 60, and 400 Hz (others possible)
Turns ratios supported	1:1 - For heading, roll, and pitch
	36:1 - Heading only
	90:1 - Heading only
	360:1 - Heading only

6. Navigation Interface Considerations

If you are using our *TRANSECT* program, you can connect the ADCP system to an external navigation device (GPS, LORAN, STARFIX, etc.) through our NAVSOFT program. The specifications required of the navigation device follow. Call us for more information on this software package.

1. Data communication is one-way. This means the navigation device only sends data and does not need any information from the ADCP system.
2. Navigation data are ASCII strings of less than 256 characters. Each string must always begin or end in an exact and repeatable format. For example:
    - One line of data ending with a carriage return (CR), a line feed (LF), or a carriage return PLUS line feed (CRLF) sequence.
    - Several lines of data always start/end with the same characters, such as “$GPSSTART” and “$GPSSTOP.”
3. Navigation data must include TIME (hour, minutes, seconds) and LATITUDE/LONGITUDE (hemisphere, degrees, minutes, seconds). NAVSOFT also can support navigation inputs of SHIP SPEED (knots, cm/s, m/s, km/h, or ft/s) and SHIP DIRECTION (degrees).
4. The navigation device must send data using any combination of the following communications protocol.

- IBM PC/XT/AT-compatible serial port - COM1, COM2, COM3 (IRQ = 5, port address = $3E8), or COM4 (IRQ = 7, port address = $2E8)
- Baud rate - 300, 600, 1200, 2400, 4800, 9600 (XT/AT only), 19200 (AT only), or 38400 (AT only)
- Data bits - 7 or 8
- Stop bits - 1 or 2
- Parity - None, even, odd, high, or low

7. Power Considerations

The VM-ADCP system uses 90 to 260, 50-60 Hz power. The system draws about 100 watts. To operate properly, the VM-ADCP system must have "clean" power from regulated or spike-free source. Additionally, you can avoid many random or hard-to-define problems by connecting both the electronics chassis and the computer to the same power source.

8. Installation Procedures (Generic)

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

1. On receipt of system, look for a red READ ME FIRST binder. If included with the system, it may contain last-minute information.
2. Before installing the system, test the transducer head and electronics chassis right out of the shipping container. Do the following.
3. All power to the system DISCONNECTED.
4. Review "Power Considerations," page 22.
5. Connect the I/O cable from the electronics chassis to the ADCP.
6. Connect the serial I/O cable from the computer to the electronics chassis.
7. Connect the power cable to the electronics chassis and apply power to the system (Appendix-A in the VM Technical Manual).
8. Follow testing procedures in Chapter 5 in the VM Technical Manual. Test the BBADCP. If errors occur, use Chapter 6 to troubleshoot.
9. Prepare the system for shipboard installation. Disconnect all power to the system. Disconnect all interface cables.
10. Review "Transducer Head Mounting Considerations," page 3. Install the transducer head. Mechanically align the system (see "Alignment Procedures (Generic)," page 24).

CAUTION. Take steps to prevent leaks through the hull and gate valves.

11. Review the "Electronics Chassis Mounting Considerations," page 15. As necessary, do the following.

12. Install the Synchro Interface board in the chassis (Chapter-7 in the VM Technical Manual).
13. Check all switch settings (Chapter-9).
14. Install the electronics chassis.
15. Review “Computer Considerations,” page 19. Install the computer.
16. Install the optional remote display.
17. Review “Cabling Considerations,” page 16. As necessary, route and connect the following cables:
18. Transducer to chassis (J1) interface cable.
19. Gyro to chassis (J2) cable.

⚠ **CAUTION.** Signals may be present.

20. Navigation to computer cable.

⚠ **CAUTION.** Signals may be present.

21. Remote display to computer cable.
22. As necessary, load the software on the computer’s hard drive. See Chapter 1 and the README files for each program.
23. Test the ADCP. If errors occur, use Chapter 5 and 6 in the VM Technical Manual to troubleshoot.
24. Run *TRANSECT*. Set up communications. See the *TRANSECT* User’s Manual.
25. Align the system through software (see “Alignment Procedures (Generic),” page 24).
26. Configure *TRANSECT*. See the VM User’s Guide, *TRANSECT* User’s Manual and the Primer for help on configuring *TRANSECT*.
27. Do in-port and underway testing. Include the following checks.
28. Water-track (range, flow noise, repeatability)
29. Bottom-track (range, accuracy)
30. Ringing and interference (cross-coupling, other pingers, noise)
31. Transducer alignment (“Alignment Procedures (Generic),” page 24)

9. Alignment Procedures (Generic)

The mechanical alignment of the transducer head is important to ADCP data accuracy. Mechanically mount the head as close as possible to your reference point. This is usually with Beam 3 at 0° or 45° relative to the ship's fore-to-aft centerline. You also must mount the transducer head as level as possible using the ship's roll and pitch references. Review "Transducer Head Mounting Considerations," page 3 for alignment considerations.

TRANSECT uses the transducer misalignment value to align the ADCP's north reference (Beam 3) to the north reference of an external gyro/compass. Ships use the bow as the north reference.

With the ADCP aboard a vessel, the mechanical alignment of the transducer head (Beam 3) is usually aligned with the ship's fore-to-aft centerline (0°) or rotated 45° clockwise. To conceptually determine the misalignment angle, visually hold the ADCP still and turn the ship gyro's north reference to match the ADCP's north reference. For example, if Beam 3 is pointing at the bow (Figure 13), the misalignment angle is zero (transducer misalignment = 0). If Beam 3 is pointing 45° to starboard (Figure 13), you must turn the ship a +45° to align the two north reference points (transducer misalignment = +45). Conversely, if Beam 3 is pointing 45° to port, you must turn the ship a -45° to align the two reference points (transducer misalignment = -45).

The value entered for transducer misalignment corrects ADCP velocity and bottom-track data for display during data collection and post-processing. The data saved to the raw data files will *not* contain the correction for the transducer misalignment entry. The data saved to the processed data files does contain data corrected for the transducer misalignment angle. When playing back raw data, you must be sure to use a configuration file that has the correct transducer misalignment value.

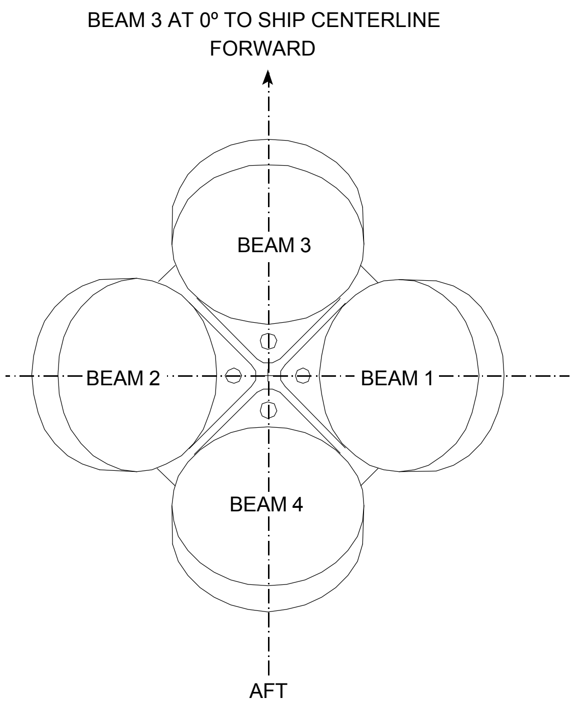


Figure 13. Transducer Misalignment Reference Points

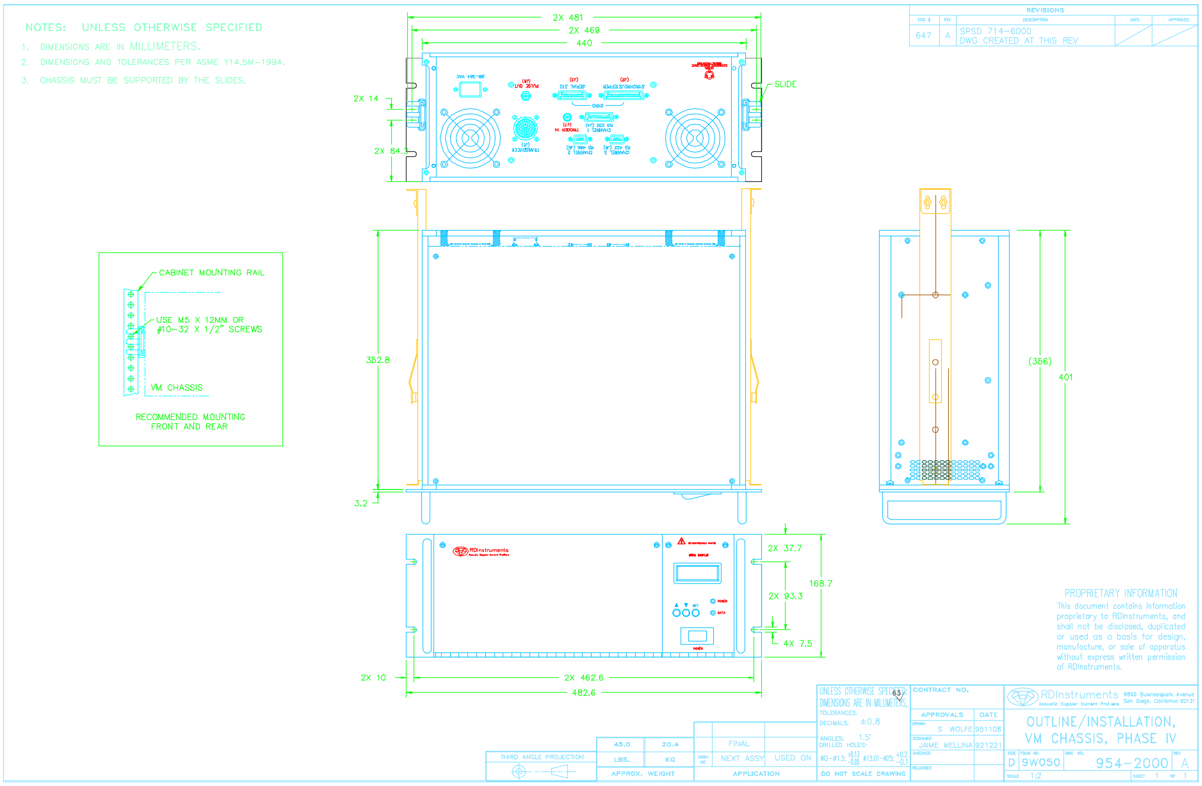
10. Outline Installation Drawings

The following drawings show the standard VM-BBADCP dimensions and weights.

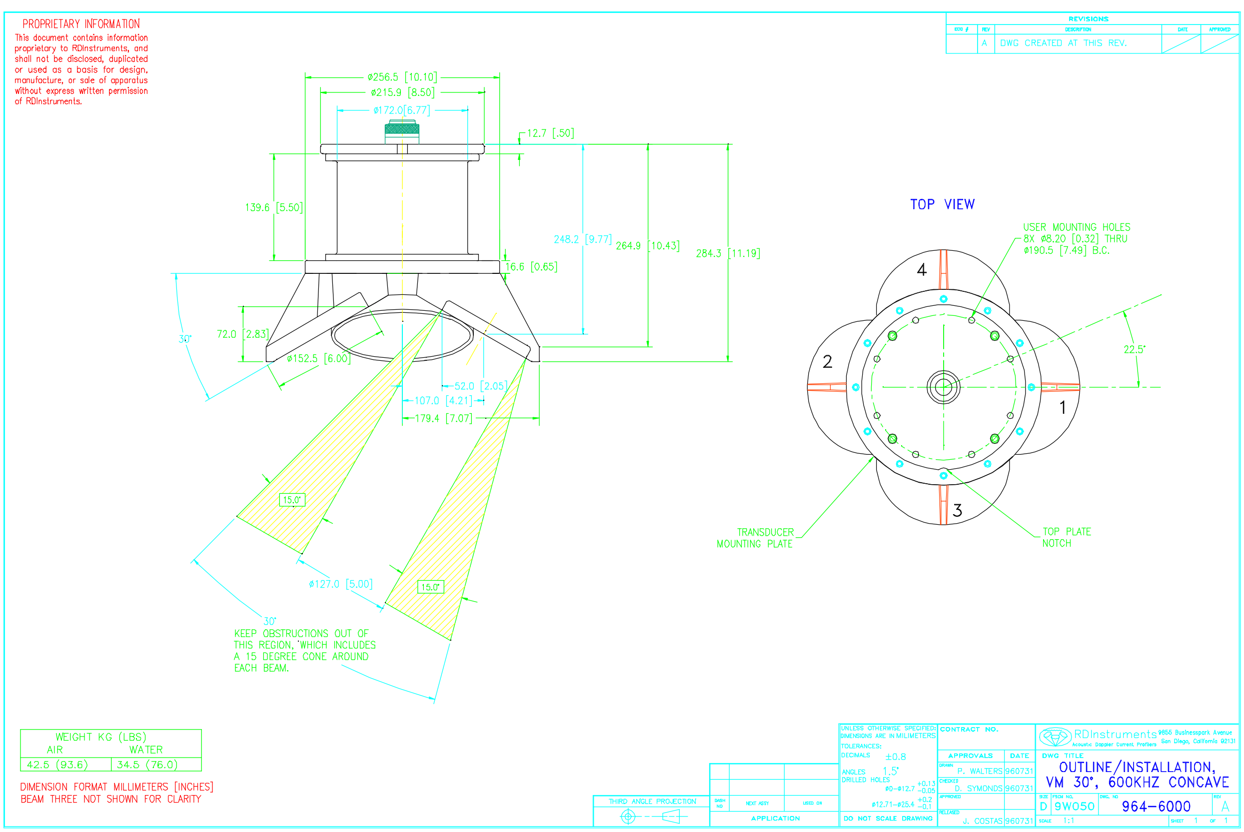
Table 7. Outline Installation Drawings

Description	Drawing #
VM Electronics Chassis	954-2000
VM 600kHz 30° Concave	964-6000
VM 300kHz 30° Concave	964-6001
VM 150kHz 30° Concave	964-6002
VM 75kHz 30° Concave	964-6003
VM 300/600kHz 30° Concave, small ceramic	964-6004
VM 300/600kHz 20° Concave, small ceramic	964-6005
VM Adapter Plate ∅311.15	964-6006
VM Adapter Plate ∅438.15	964-6007
VM Adapter Plate ∅546.10	964-6008
VM Stem	964-6009
VM 150kHz 20° Concave	964-6010
VM 600kHz 20° Concave	964-6011
VM Adapter Plate ∅546.10 (modified)	964-6012
Ocean Surveyor Electronics Chassis	96A-6000
Ocean Surveyor 38kHz Oval	96A-6001
Ocean Surveyor 38kHz	96A-6002
Ocean Surveyor 75kHz	96A-6003
Ocean Surveyor 150kHz	96A-6004

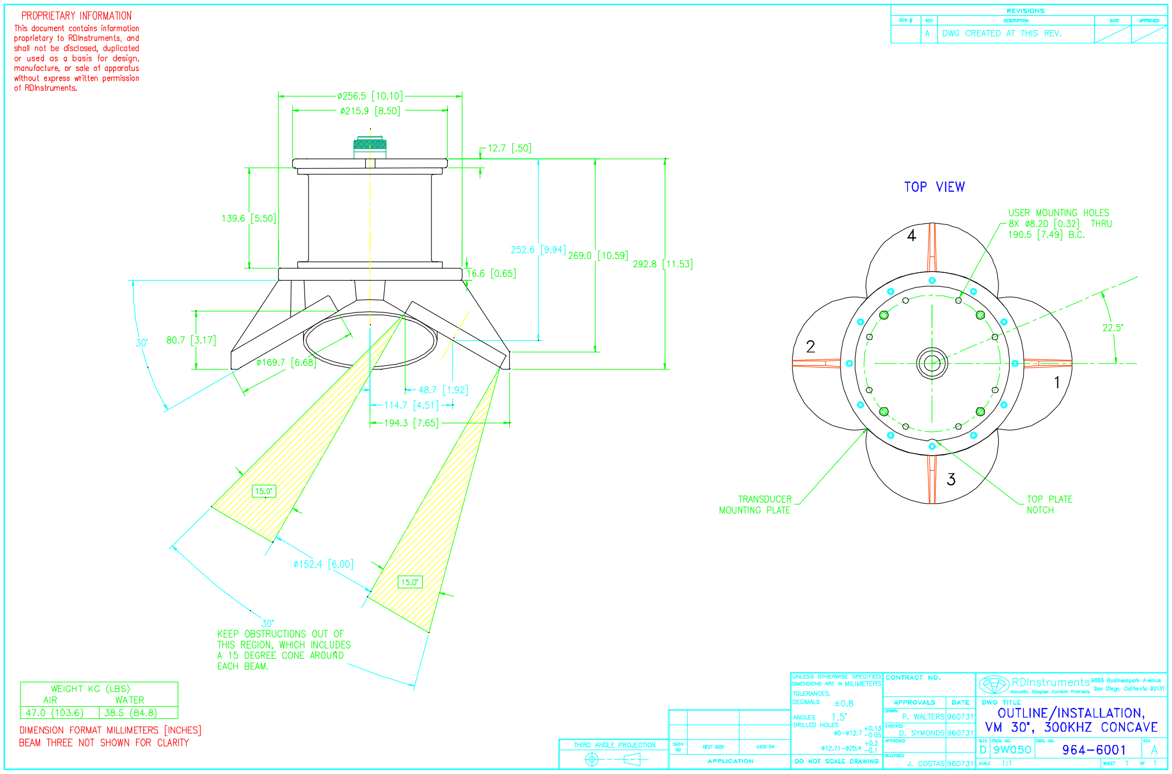
10.1. 954-2000



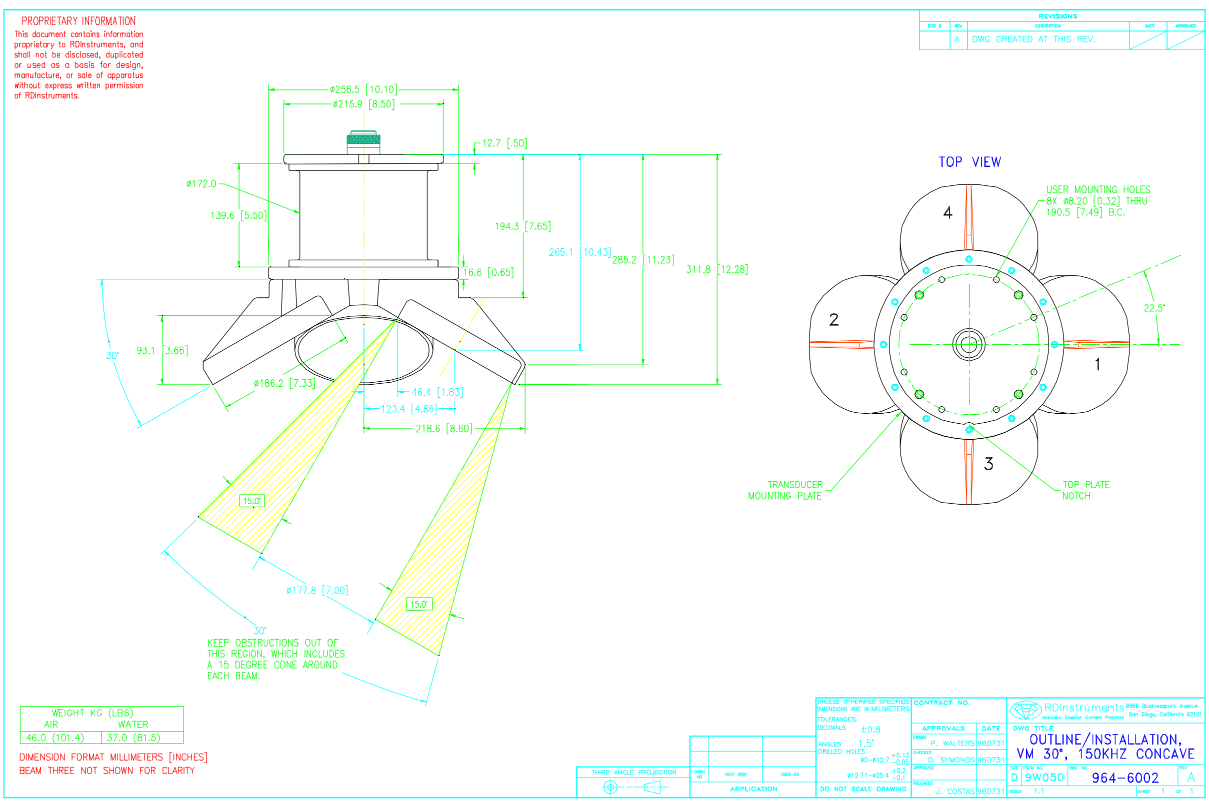
10.2. 964-6000



10.3. 964-6001



10.4. 964-6002



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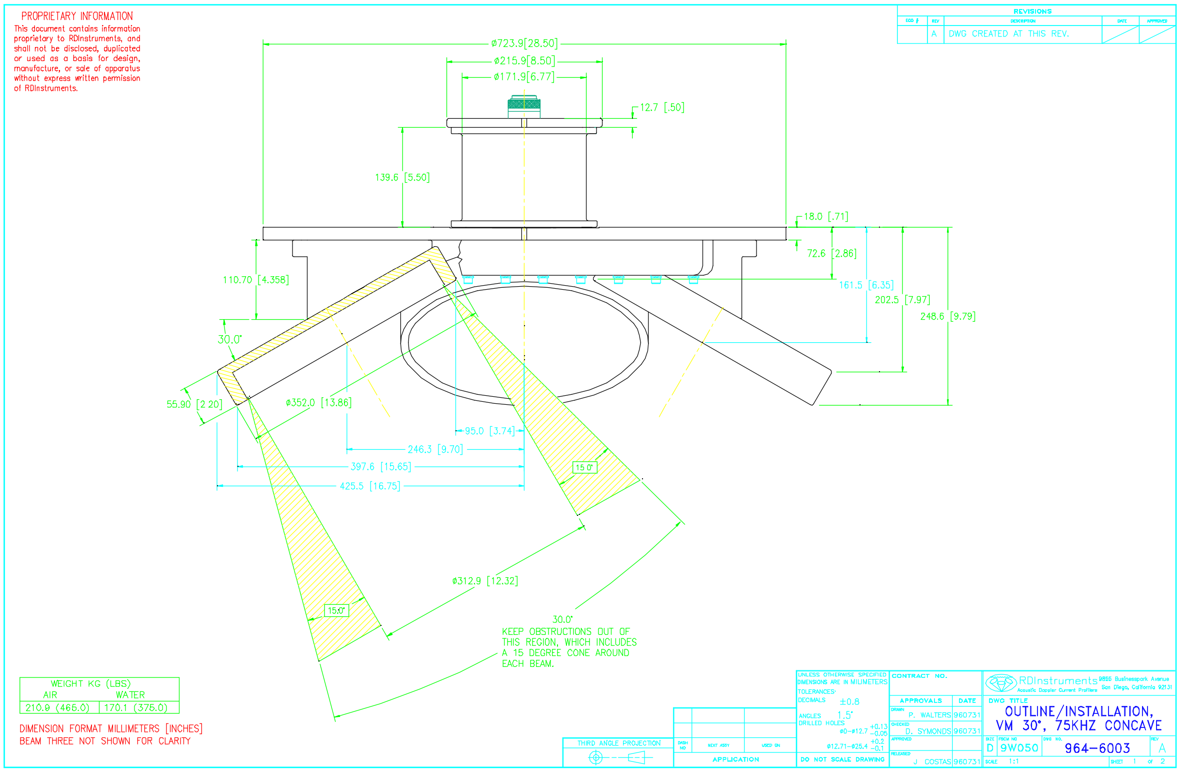
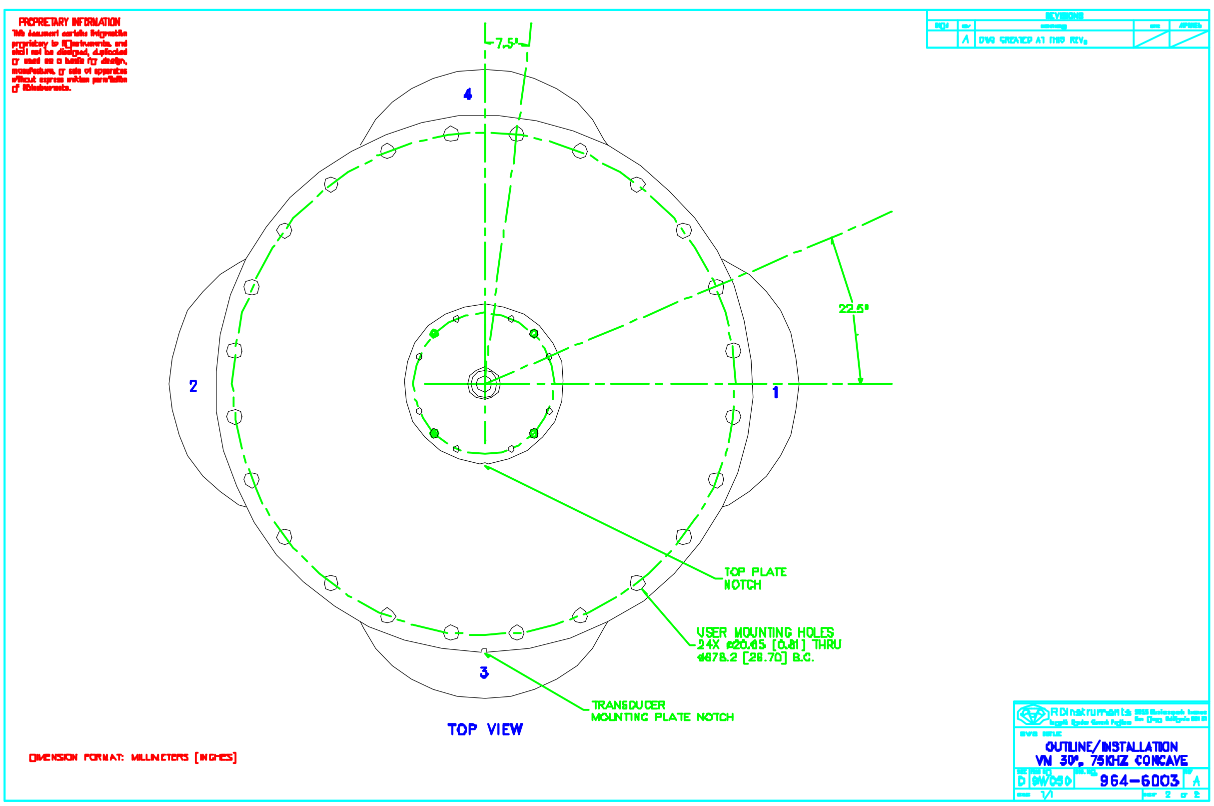


10.6. 964-6003 (page 2)



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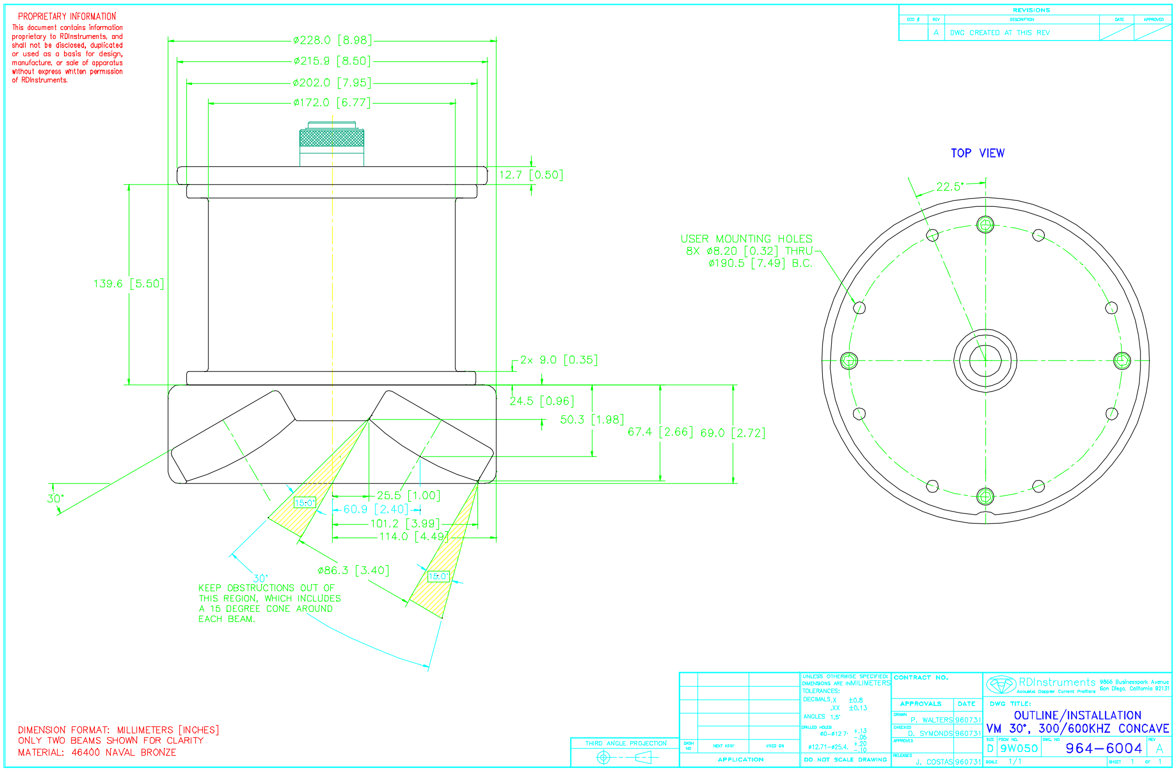

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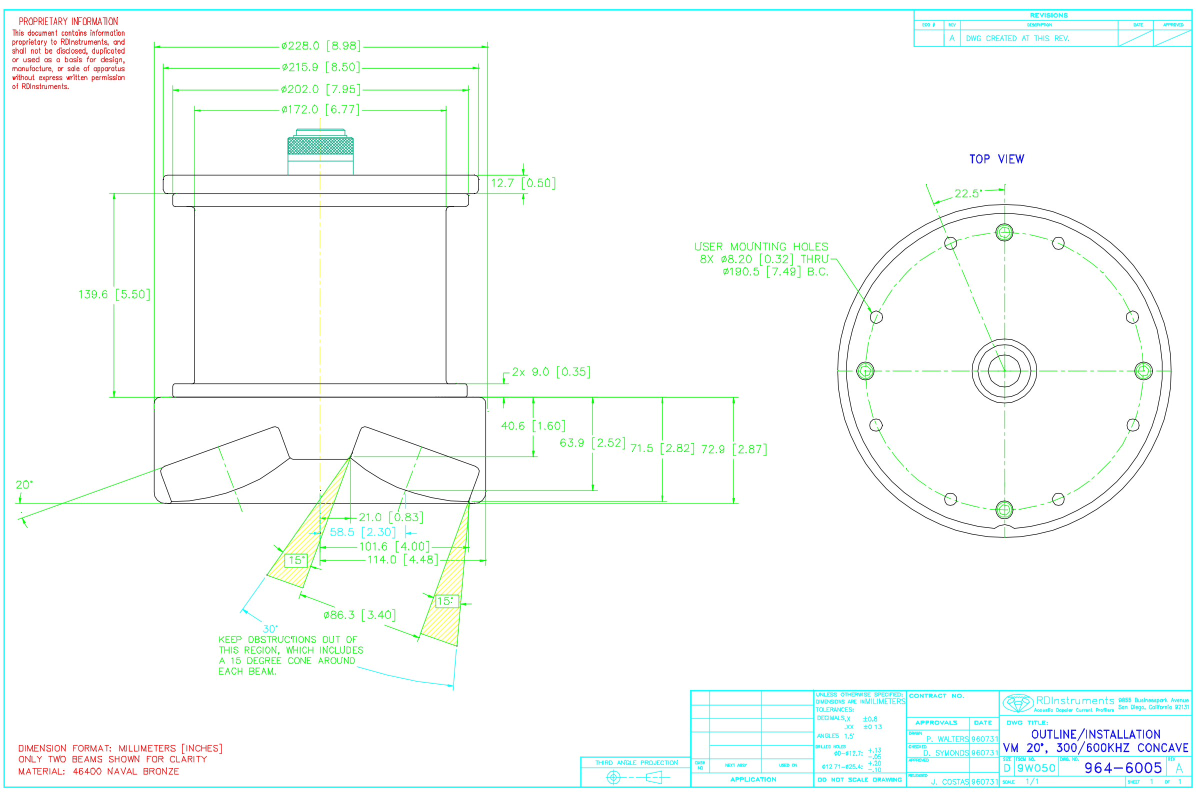

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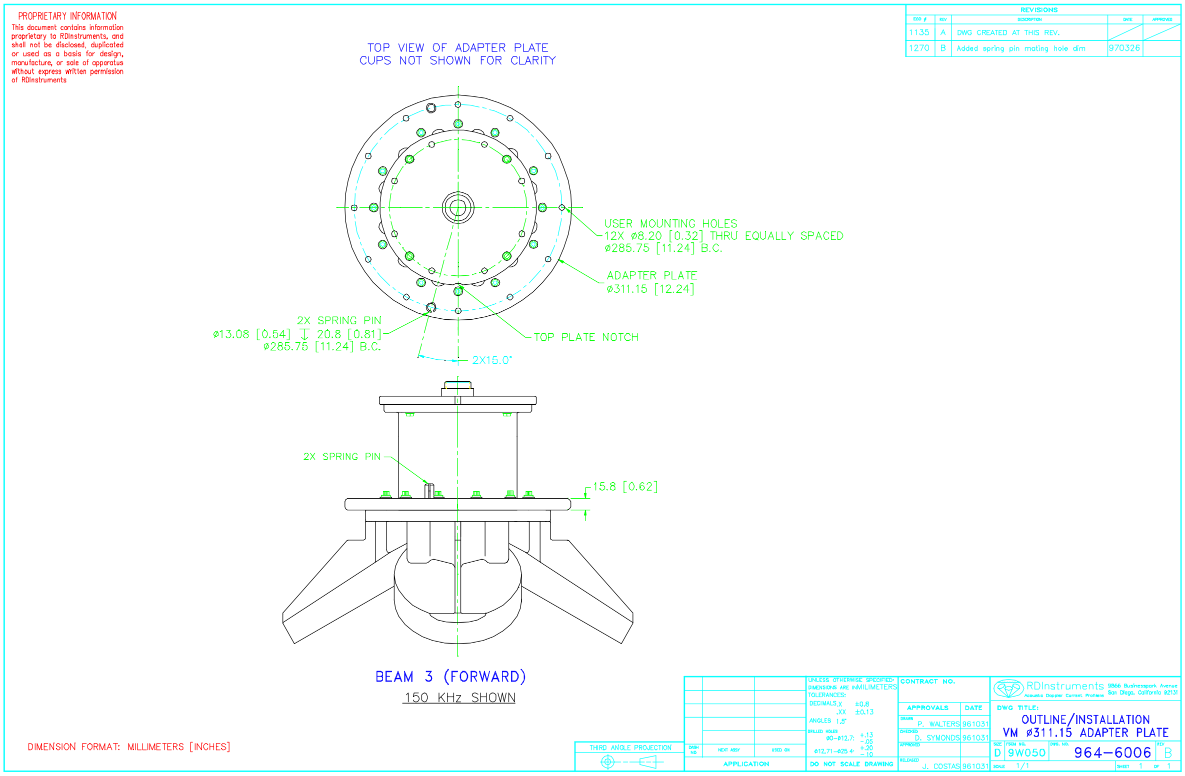

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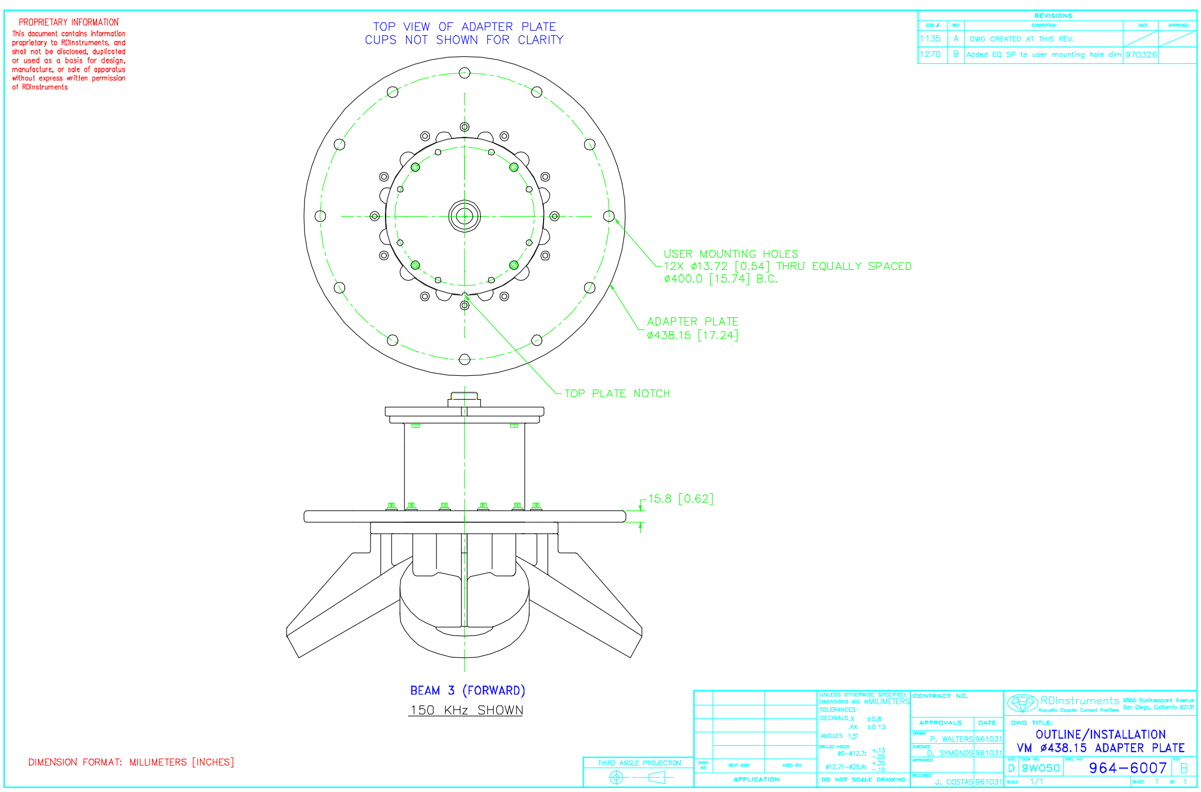

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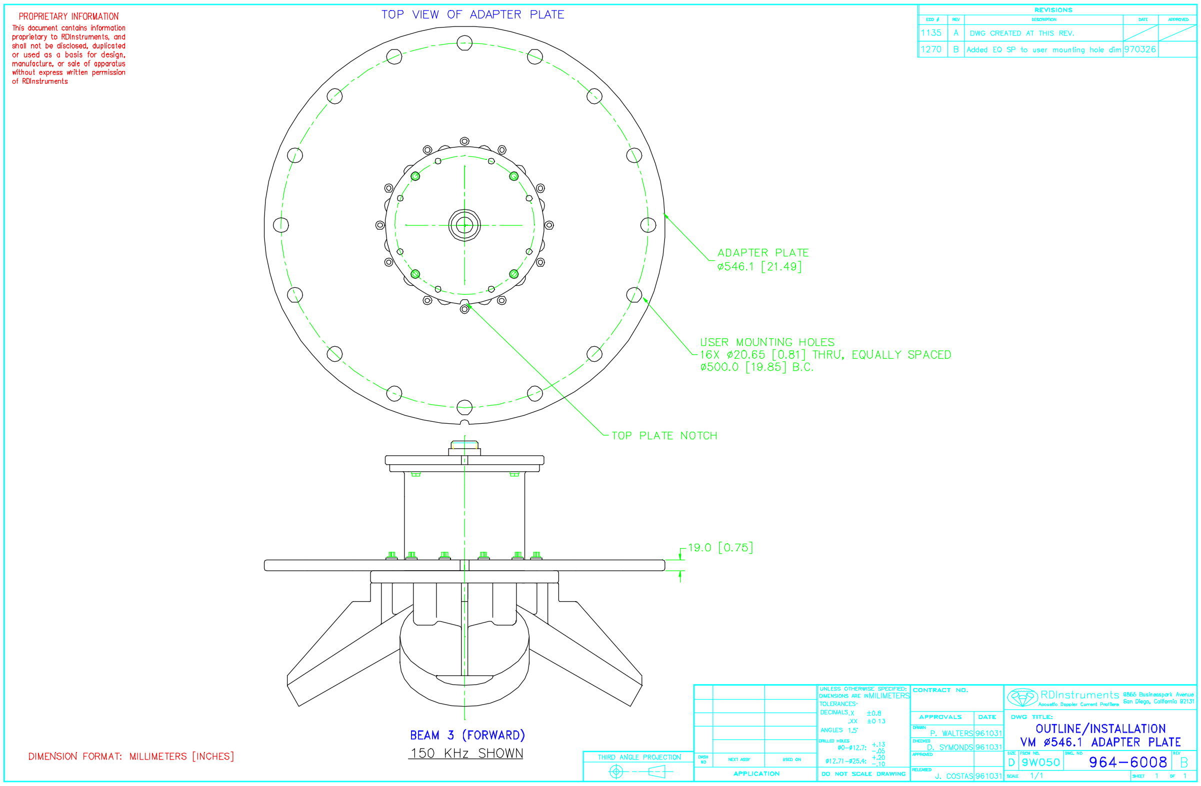

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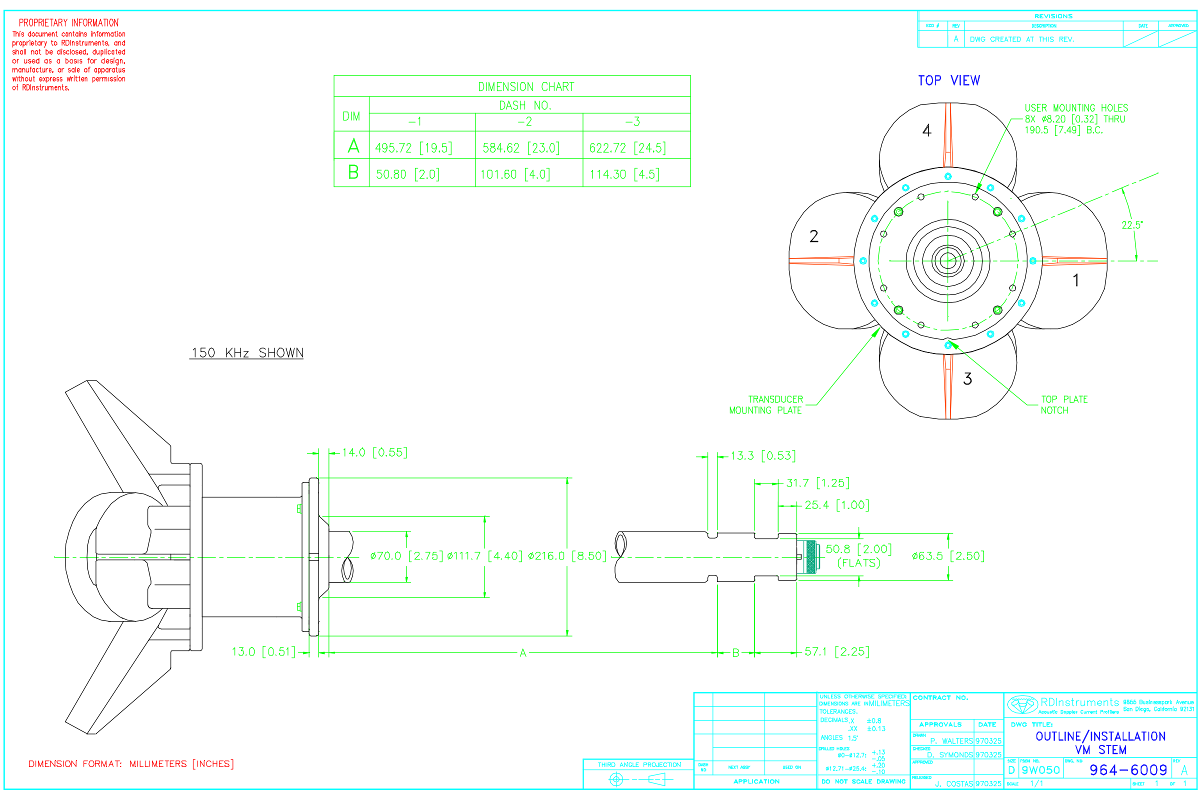

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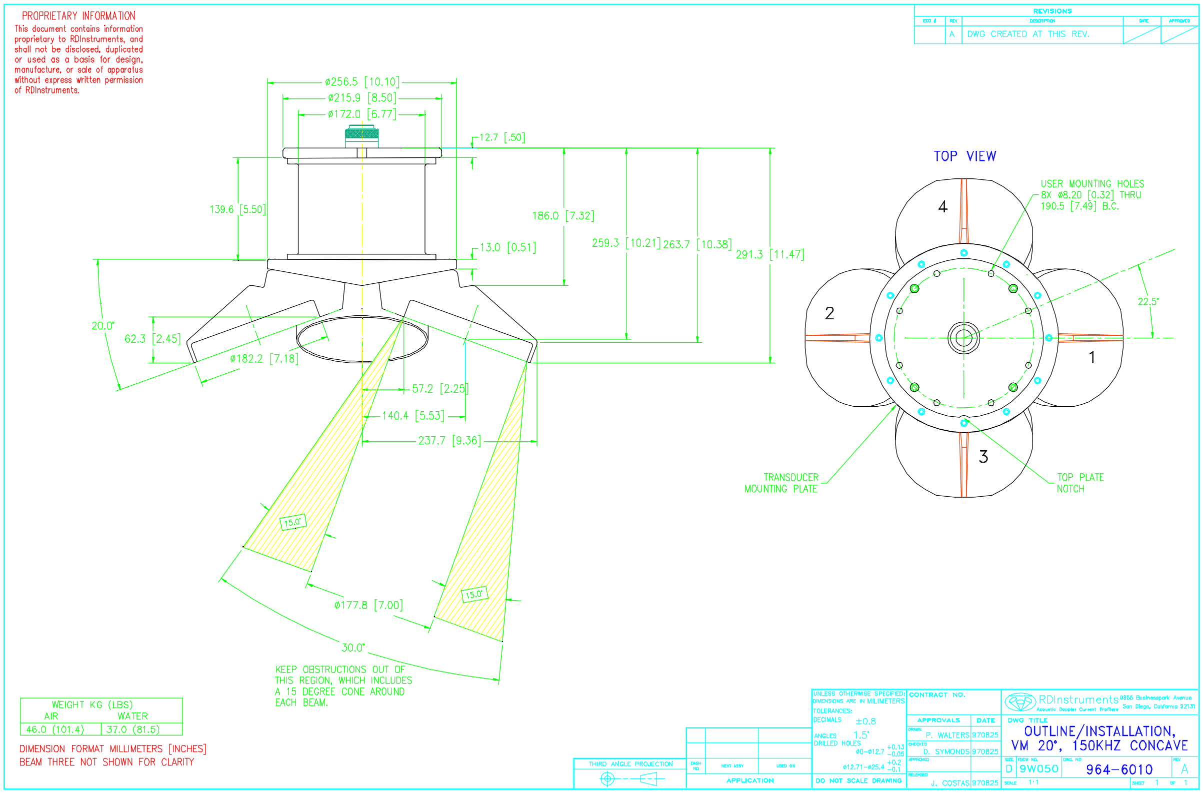

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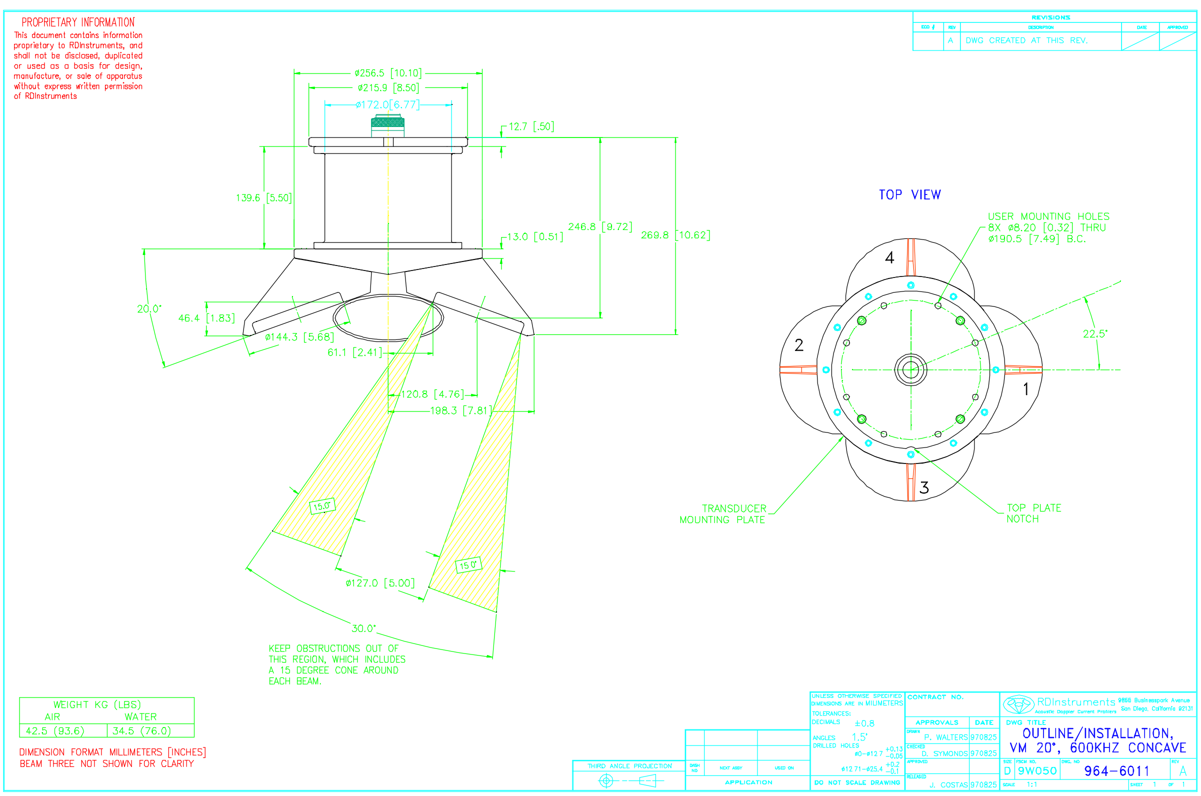

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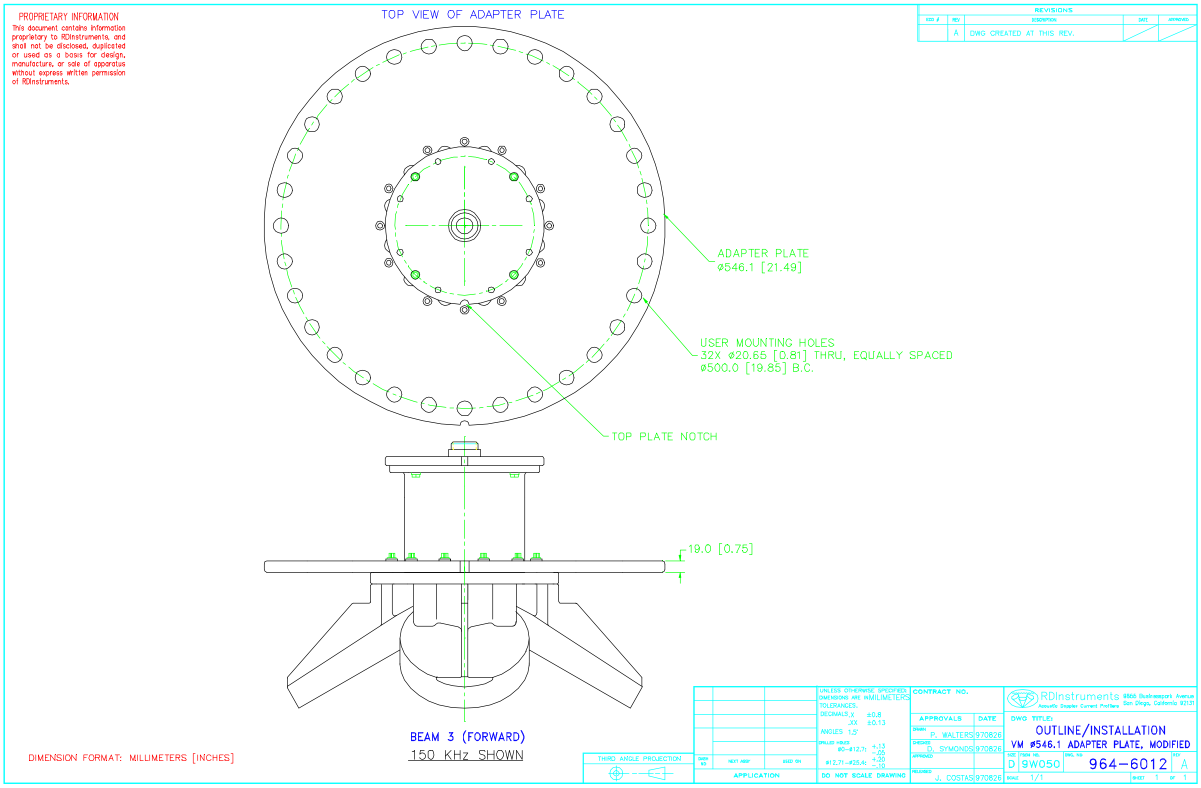

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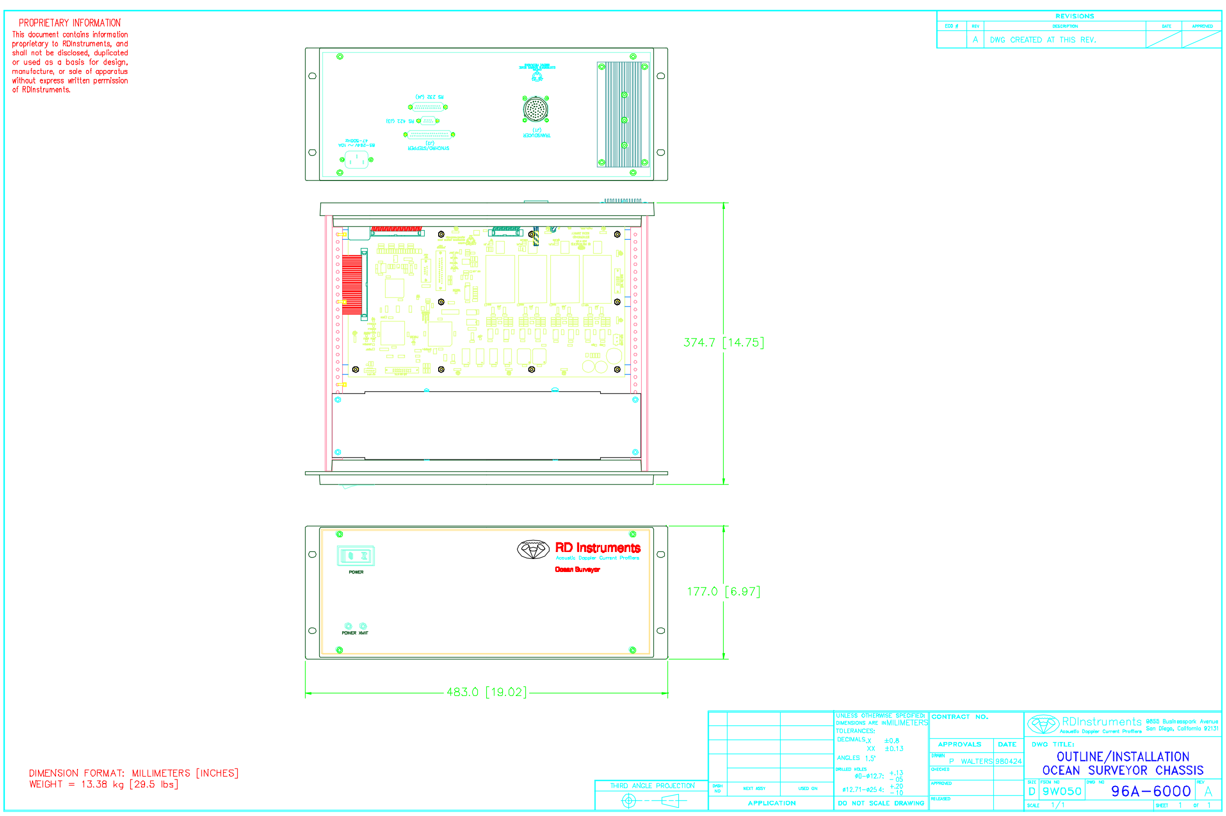

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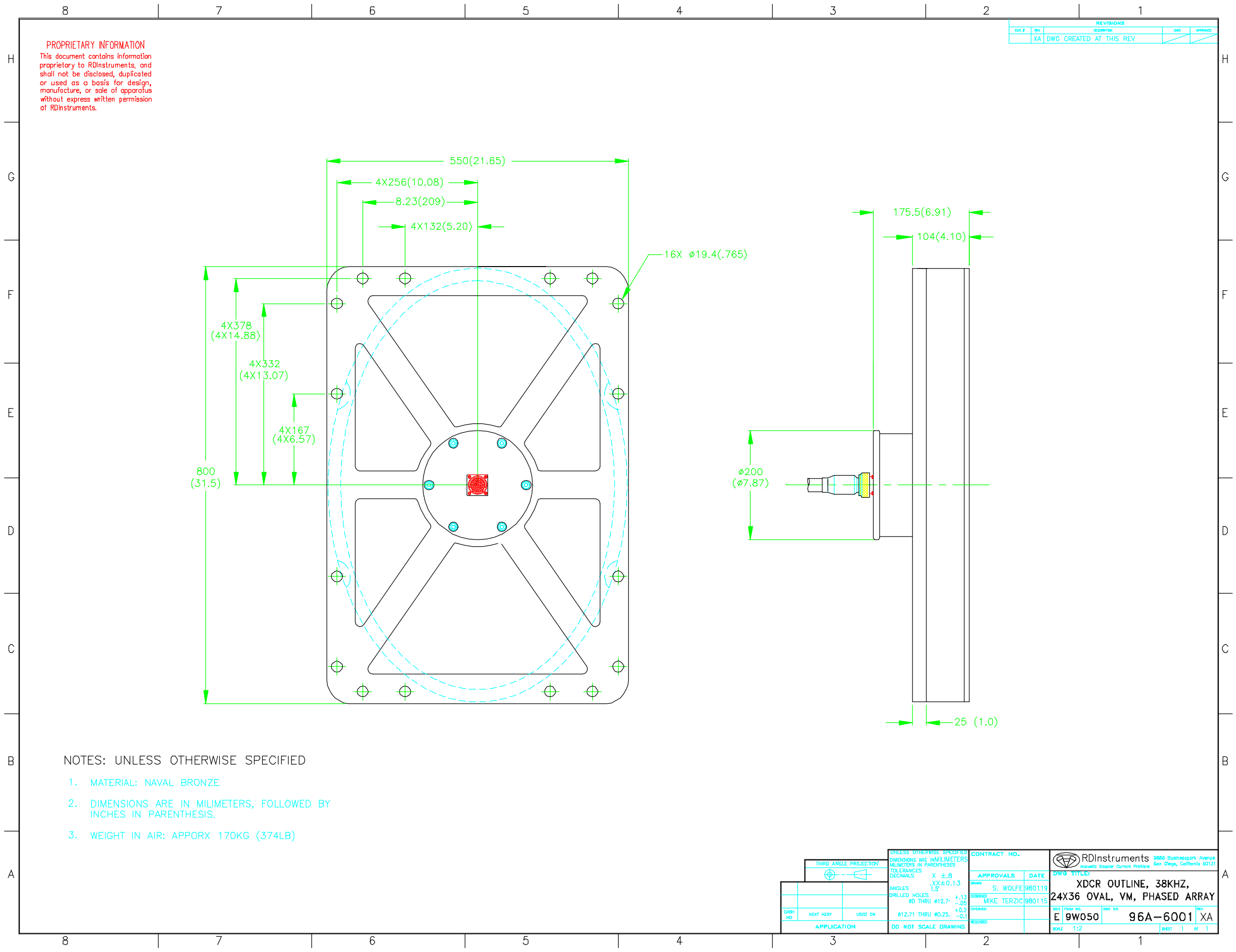

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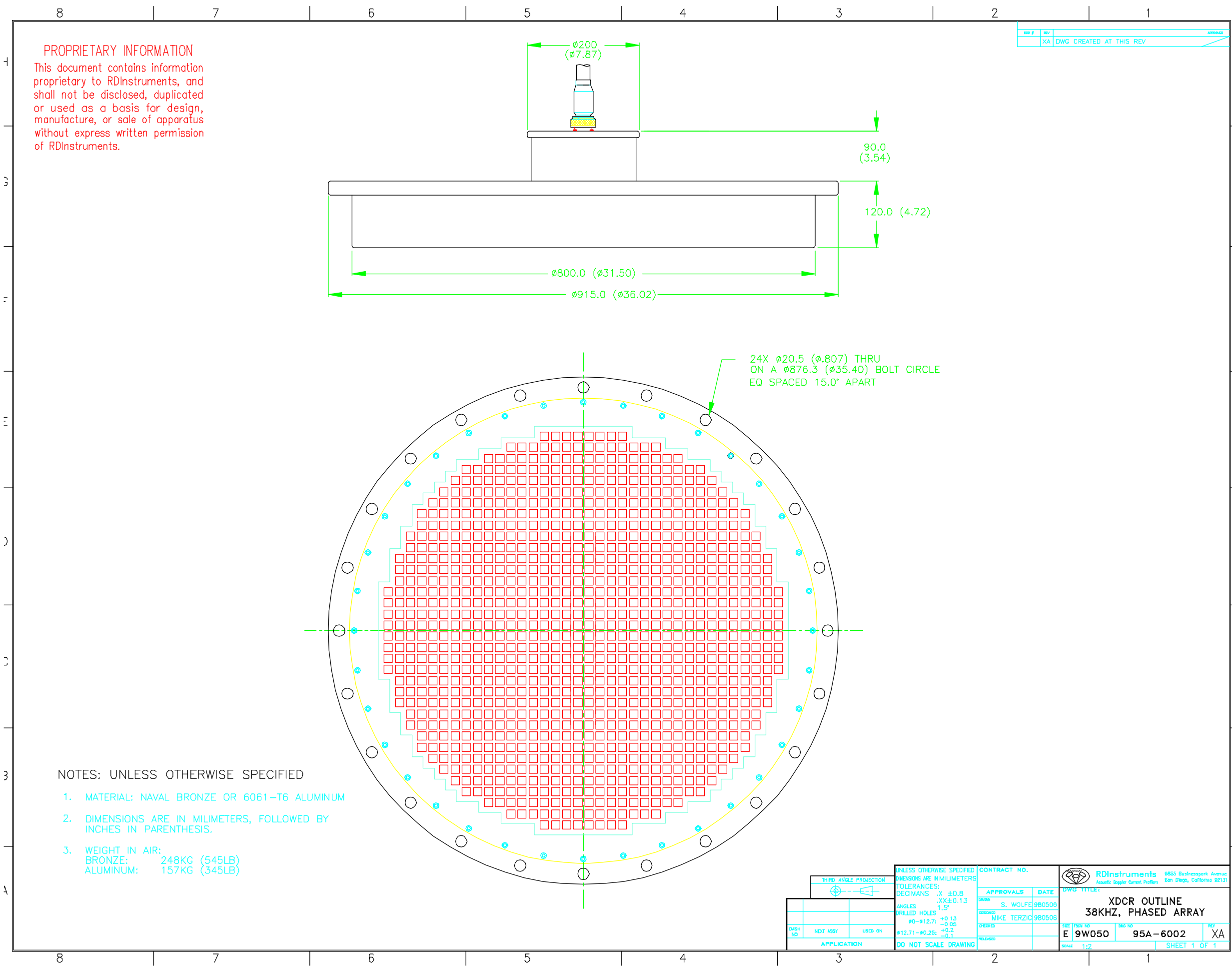

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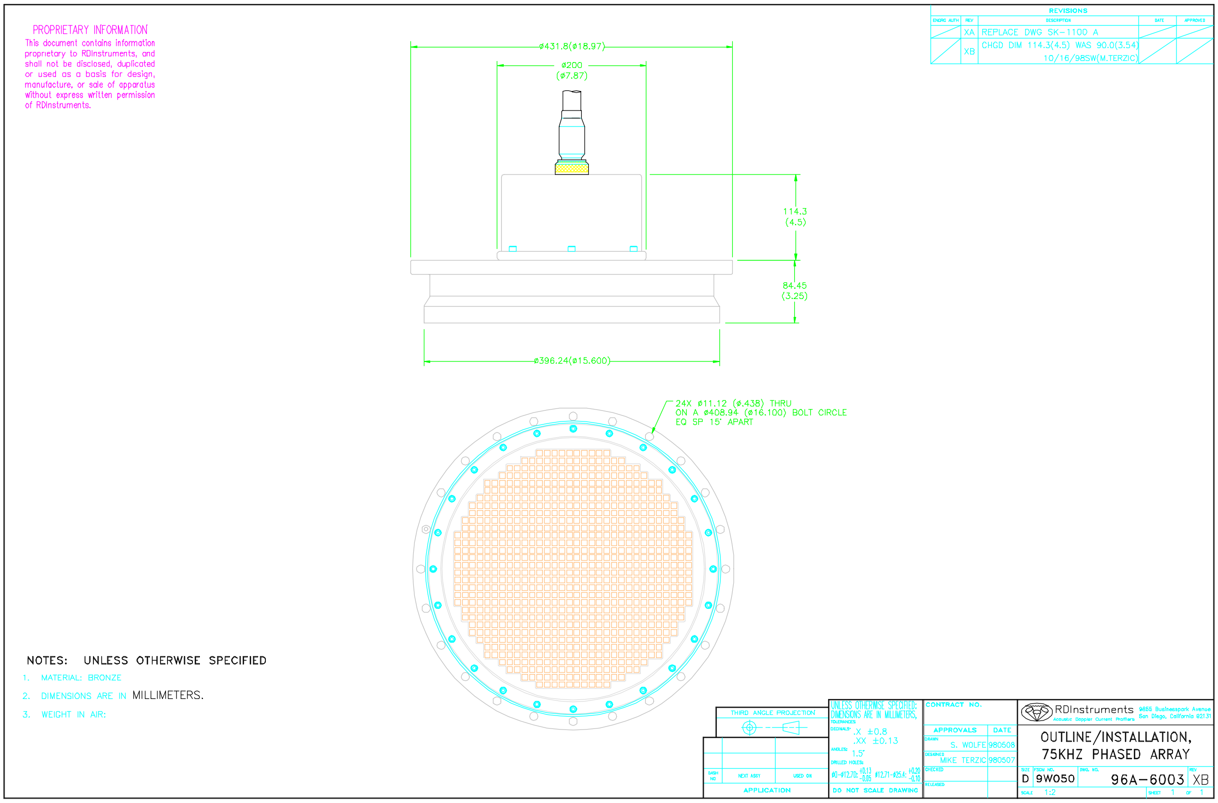

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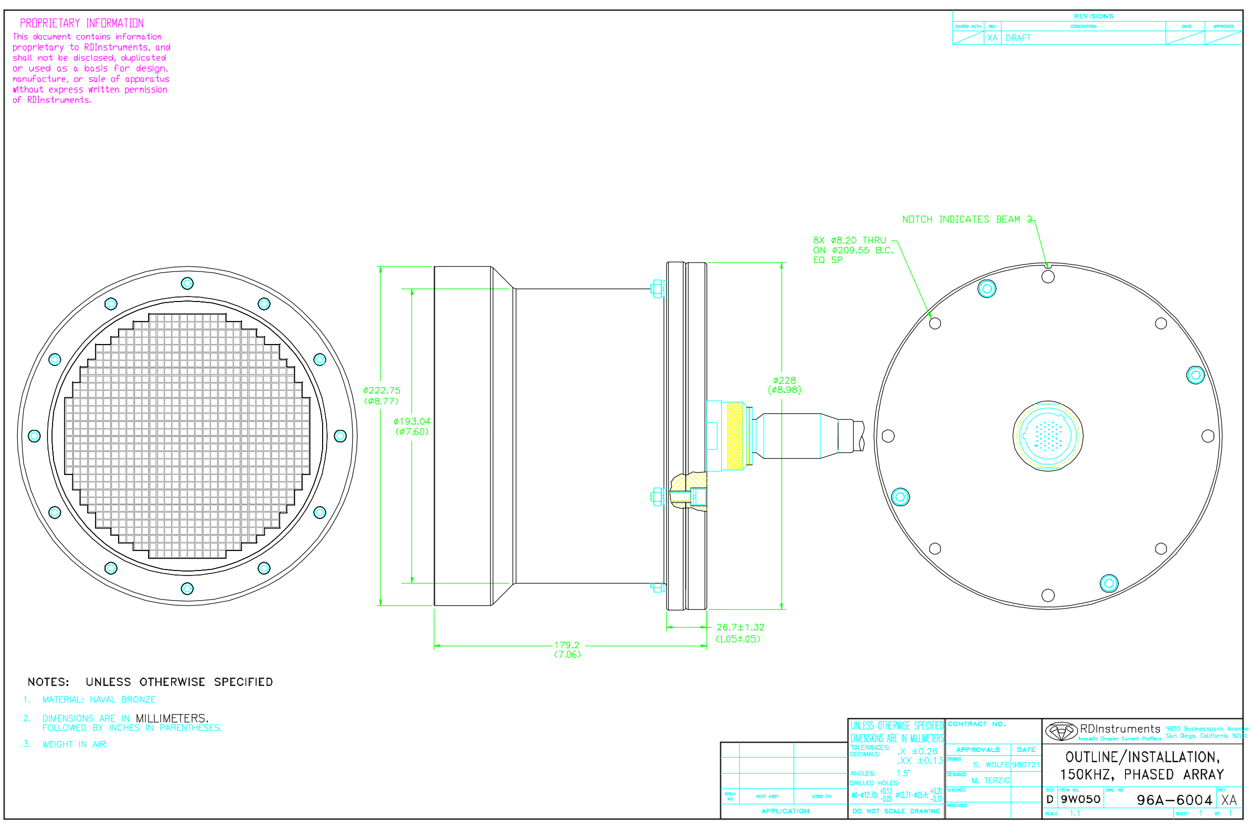
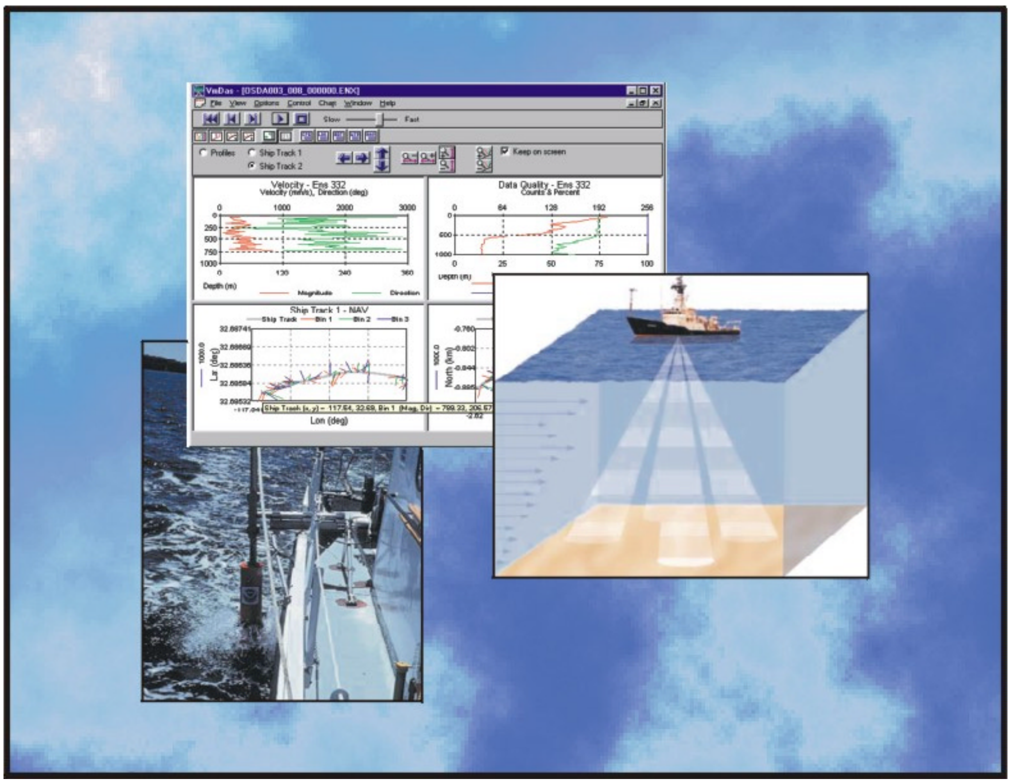


VmDas
User's Guide



P/N 95A-6015-00 (March 2001)

RD Instruments
Acoustic Doppler Solutions

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VmDas User's Guide

1 Introduction

VmDas is a software package for use with RDI Vessel Mount Acoustic Doppler Current Profilers. This software package supports the Broadband, Workhorse, and Ocean Surveyor PD0 Binary Output Data Formats for data collection and replay.

> **NOTE.** This guide covers version 1.2.0.7 or higher.

1.1 System Requirements

VmDas requires the following:

- Windows 95® (see "Using Windows 95," page 2), Windows 98®, or Windows NT 4.0® with Service Pack 4 installed (see "Using Windows NT," page 2)
- Pentium class PC 233 MHz (350 MHz or higher recommended)
- 32 megabytes of RAM (64 MB RAM recommended)
- 6 MB Free Disk Space plus space for data files (A large, fast hard disk is recommended)
- One Serial Port (two or more High Speed UART Serial Port recommended)
- Minimum display resolution of 800 x 600, 256 color (1024 x 768 recommended)

- CD-ROM Drive
- Mouse or other pointing device
- An Ethernet card if network I/O is desired

NOTE. *VmDas* can use up to six serial ports in some configurations.

1.1.1 Using Windows 95

To use *VmDas* with Windows 95 you must have the ws2_32.dll file installed on your computer. To determine if you have this file, click **Start**, **Find**, **Files or Folders**. In the **Named** box, type **ws2_32.dll** and click **Find Now**. If the file is included on your system, then proceed with the *VmDas* software installation. If the file is not on your computer, do the following.

a. Go to http://www.Microsoft.com/windows95/downloads/

b. It is highly recommended that you download and install all of the critical and recommended updates, and the service releases for Windows 95.

c. Scroll down the list of files on the Windows95 download page and select the **Windows Socket 2 Update** link. Click the **Download Now** button. This will download the **w95ws2setup.exe** file. Double-click the file to install it.

d. You will also need to download and install the **Microsoft DUN 1.3 and Winsock2 Year 2000 Update**. Use the link on the **Windows Socket 2 Update** page to get the **y2kvdhcp.exe** file. Double-click the file to install it (install the **w95ws2setup.exe** file first if you have not already done so).

1.1.2 Using Windows NT

You must have Windows NT 4.0® Service Release 4 or higher installed before attempting to install *VmDas*. *VmDas* cannot install on the computers running Windows NT 3.0 or earlier versions.

1.2 Software Installation

To install *VmDas*, do the following.

a. Insert the compact disc into your CD-ROM drive and then follow the browser instructions on your screen. If the browser does not appear, complete Steps "b" through "d."

b. Click the **Start** button, and then click **Run**.

c. Type **<drive>:launch**. For example, if your CD-ROM drive is drive D, type **d:launch**.

d. Follow the browser instructions on your screen.

2 Turnkey Mode

When *VmDas* is started in the turnkey mode, a message box appears to prompt the user to start collecting data. After 30 seconds, or on confirmation, *VmDas* begins collecting data automatically.

Syntax – *VmDas*.exe /autostart

For example, if a computer operating system has *VmDas* with the /autostart switch in the startup folder, *VmDas* will open with a message box asking if it is OK to start collecting data when the computer is started. The user clicks **OK** or waits 30 seconds for the message box to time out. *VmDas* will close the message box, open a document in data collect mode, and begin collecting data. If the user clicks **Cancel**, *VmDas* exits.

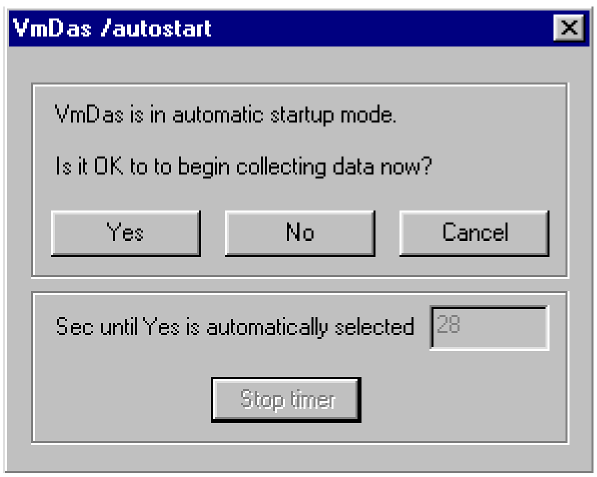


Figure 1. Autostart Dialog

NOTE. Turnkey mode only works on startup. Once data collection has started, *VmDas* reverts to normal operation. It will not enter turnkey mode again until closed and restarted with the /autostart switch. If a second document is opened with the **File**, **Collect Data** menu, the user must use the **Control**, **Go** menu item to start data collection. It will not happen automatically.

3 Quick Start Guide

The *VmDas* User's Guide is divided into two main sections:

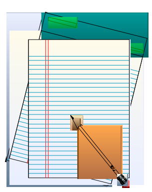
1. Quick Start Guide to collecting data with *VmDas*
   - Simple instructions to begin collecting data
2. *VmDas* Tutorial
   - Create a User Option file
   - Collecting data
   - How to reprocess data
   - How to play back a data file

Making accurate profile measurements is less difficult than you probably believe now. You will soon see that you need to use only a few keystrokes on the computer to collect data in the field.

Please take the time to read this entire manual. It will be useful to have the ADCP and a computer available to follow along. You may also want to keep the ADCP Technical manuals handy for reference when you want more detail.

3.1 ADCP Setup

Step 1. Connect the ADCP and computer as shown in your ADCP Technical Manual. If you have not already installed *VmDas* and the RDI Tools CD, do so as outlined in "Software Installation," page 2.



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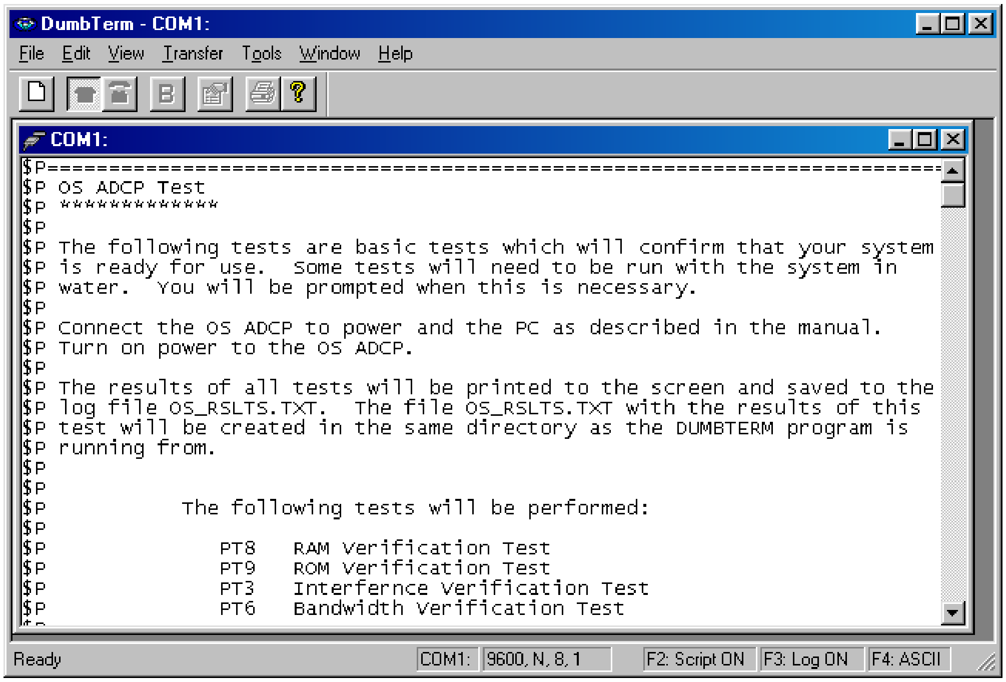
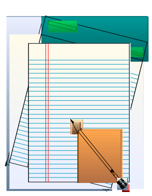
3.2 Test the ADCP



Step 2. Run *DumbTerm* to verify the ADCP is functioning properly. Select a script file from the table below. The results of the tests will be saved to an ASCII text log file in the same directory as the *DumbTerm* is running from.

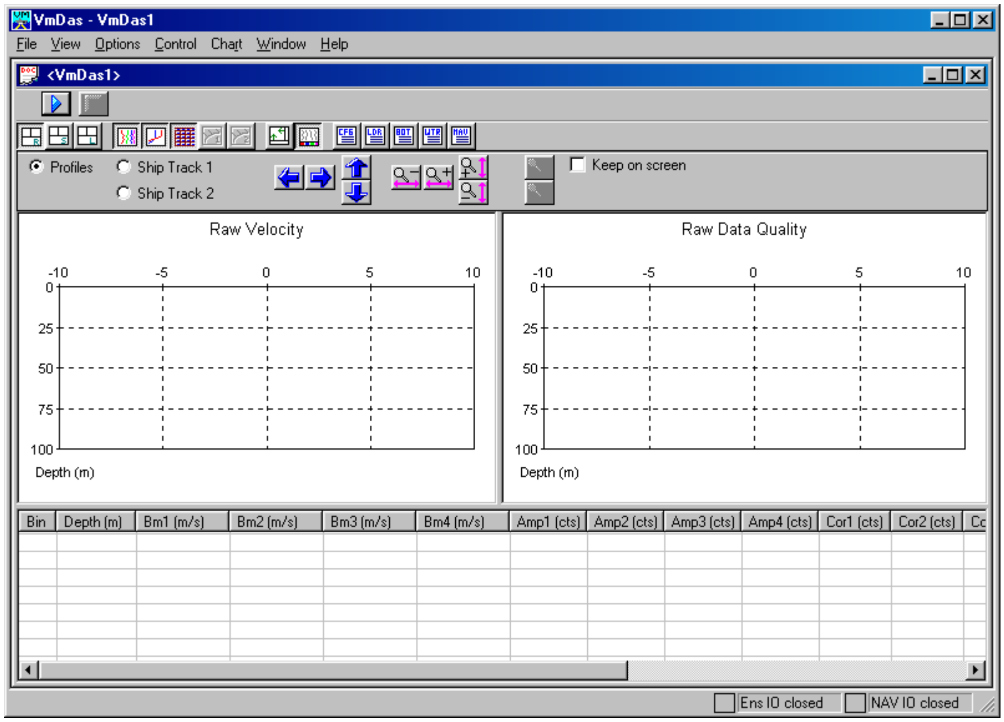
Script File Name	ADCP Type	Results Saved to
testBB.txt	Broadband	BB_RSLTS.txt
testOS.txt	Ocean Surveyor	OS_RSLTS.txt
testWH.txt	Workhorse	WH_RSLTS.txt

These text files (*.txt) were copied into the same directory as *DumbTerm* when you installed the RDI Tools software CD sent with your system.



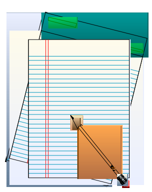
Use this area for notes.

3.3 Start *VmDas*



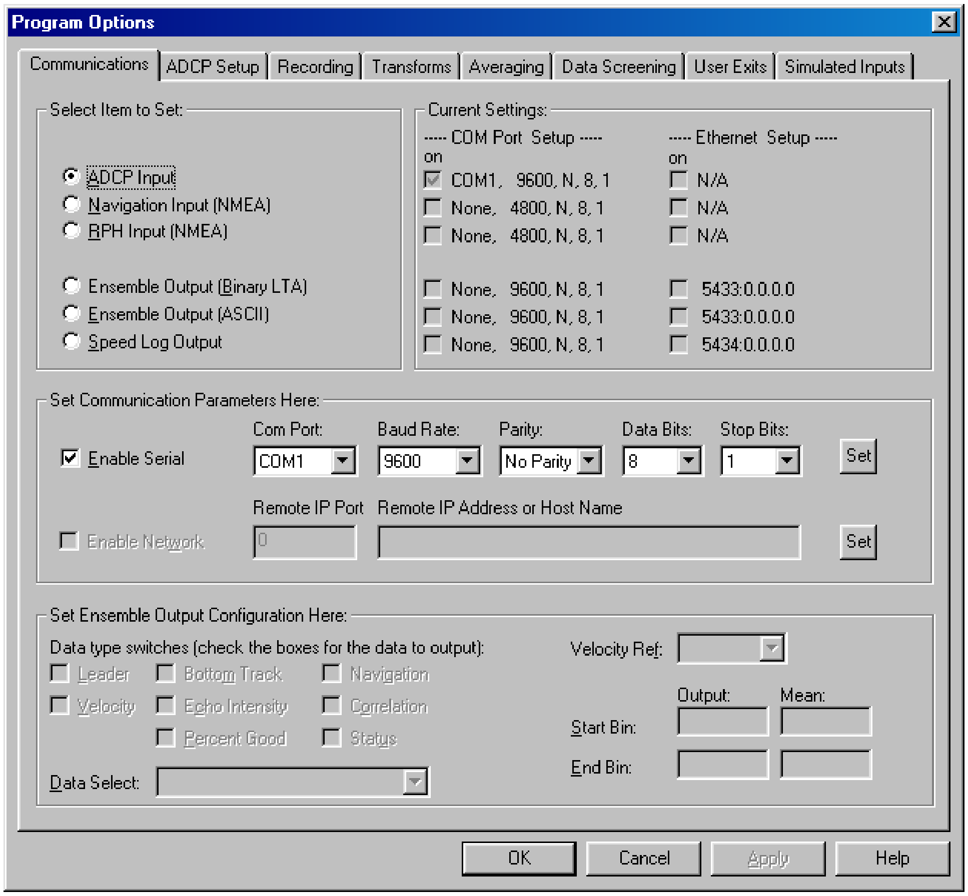
Step 3. Start *VmDas*. On the **File** menu, click **Collect Data**.

On the **Options** menu, click **Load**. Select the Default.ini file and click **Open**. This will set *VmDas* to the factory default options.

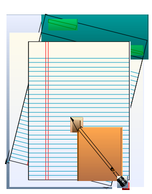


Use this area for notes.

3.4 Setup Communications

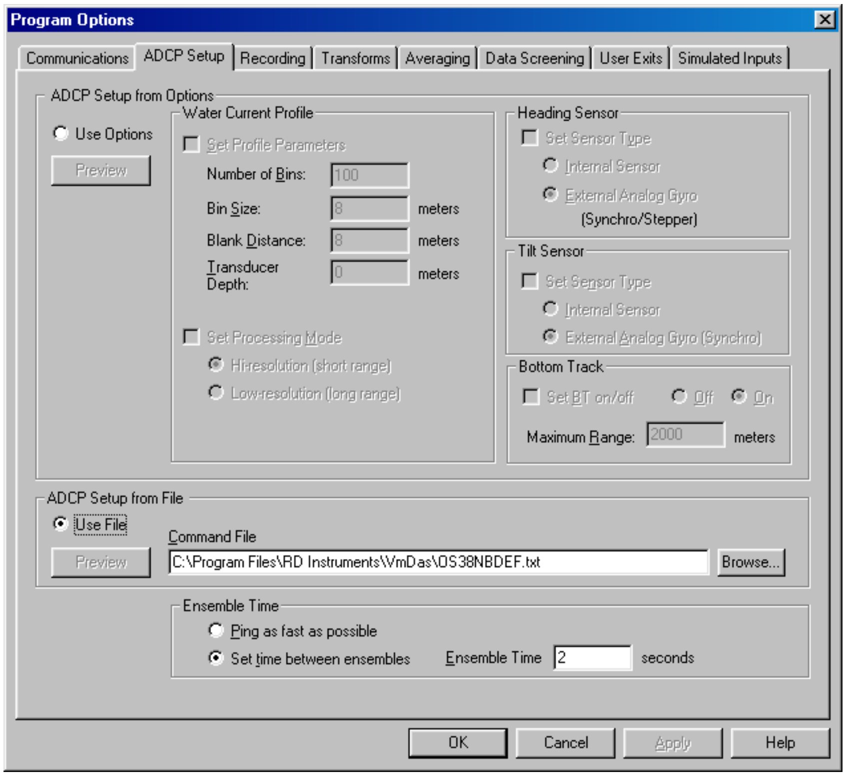


Step 4. On the **Options** menu, click **Edit Data Options**. Click the **Communications** tab and set the communications settings with the ADCP and NMEA ports.



Use this area for notes.

3.5 Load a Command File



Step 5. Click the **ADCP Setup** tab. Use the **ADCP Setup** tab to setup the ADCP. Set the **Ensemble Time** to the value shown in Table 1.

Table 1: Ensemble Time

Frequency (kHz)	With Bottom Track (sec)	Without Bottom Track (sec)
38	4	2
75	2	1
150	1	1
300		
600	Select **Ping as Fast as possible**	
1200		

For this Quick Start example, select **Use File** in the **ADCP Setup file** area. Use Table 2 to choose a command file for your ADCP, and load it into *VmDas* using the **Browse** button. These text files (*.txt) were copied into the same directory as *VmDas* when you installed it from the CD sent with your system.

Table 2: Example User Option Files

File Name	Description
OS38BBDEF	Default setup for an OS 38kHz ADCP in the highest precision (broad bandwidth) but reduced range profiling mode.

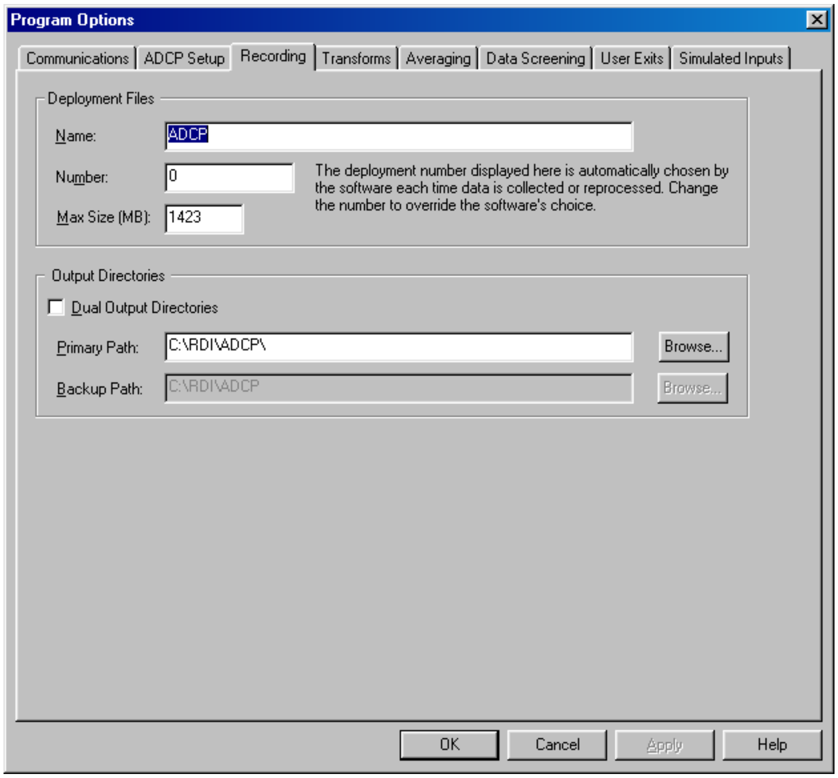
File Name	Description
OS38NBDEF	Default setup for an OS 38kHz ADCP in the lowest precision (narrow bandwidth) but extended range profiling mode.
OS75BBDEF	Default setup for an OS 75kHz ADCP in the highest precision (broad bandwidth) but reduced range profiling mode.
OS75NBDEF	Default setup for an OS 75kHz ADCP in the lowest precision (narrow bandwidth) but extended range profiling mode.
OS150BBDEF	Default setup for an OS 150kHz ADCP in the highest precision (broad bandwidth) but reduced range profiling mode.
OS150NBDEF	Default setup for an OS 150kHz ADCP in the lowest precision (narrow bandwidth) but extended range profiling mode.
BB75DEF	Default setup for a BB 75kHz ADCP to provide the most range with the optimal precision.
BB150DEF	Default setup for a BB 150kHz ADCP to provide the most range with the optimal precision.
BB300DEF	Default setup for a BB 300kHz ADCP to provide the most range with the optimal precision.
BB600DEF	Default setup for a BB 600kHz ADCP to provide the most range with the optimal precision.
WH300DEF	Default setup for a Workhorse 300kHz ADCP to provide the most range with the optimal precision.
WH600DEF	Default setup for a Workhorse 600kHz ADCP to provide the most range with the optimal precision.
WH1200DEF	Default setup for a Workhorse 1200kHz ADCP to provide the most range with the optimal precision.

NOTE. These text files (*.txt) were copied into the same directory as *VmDas* when you installed it from the software CD sent with your system.

NOTE. These files have been setup for shipboard use. They can also be used for stationary systems (such as Oil Rig platforms) but you must first open the file (right click on file and select open) and modify the EZ command from EZ1020001 to EZ1111111. This new setting will enable the use of the internal heading, pitch, and roll sensors.

Use this area for notes.

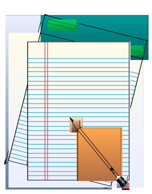
3.6 Set Recording Options



***Step 6*.** The Recording property page allows you to set the deployment name and path to where the data files are recorded.

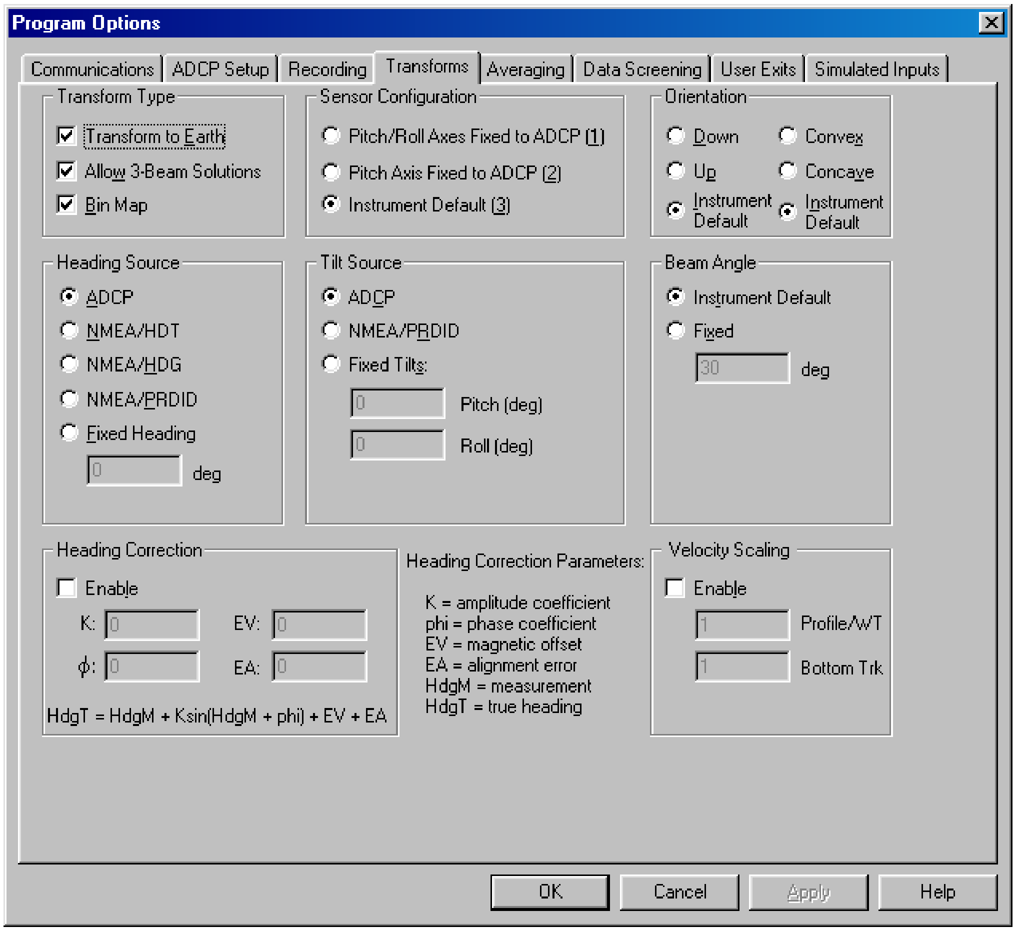
Enter a name in the **Name** box that identifies your deployment. This name will be used as part of the filename for each file that is part of this deployment (see "File Naming Conventions," page 73). For testing, "Test" or "Practice" are good choices.

In the **Primary Path** box, enter the drive and directory where you would like to store the files of collected data. Use the **Browse** button or enter the path manually.



Use this area for notes.

3.7 Setup the Transforms Screen



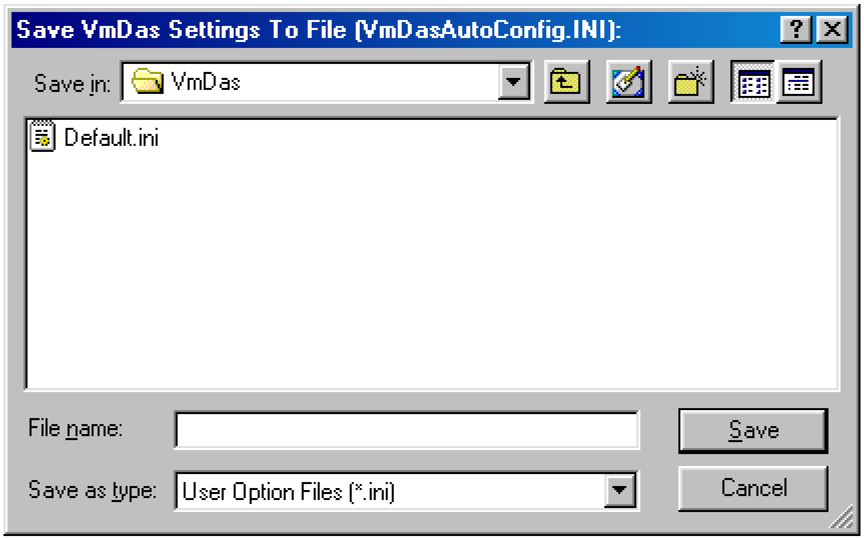
Step 7. Click the **Transforms** tab and verify that all selections in the **Transform Type** are checked. Set the **Sensor Configuration**, **Orientation,** and **Beam Angle** to **Instrument Default**. The **Heading Source** and **Tilt Source** should be set to **ADCP.** Set the **Heading Correction** to your input. The **Velocity Scaling** should be disabled.

Click **OK** to save the changes made to the **Program Options** tabs.

NOTE. If you have the vessel's gyro connected to the electronic chassis or your ADCP has an internal compass, then select **ADCP**. If you have heading data coming into the serial port on the computer, select **NMEA/HDT** or **NMEA/HDG** depending on your device output.

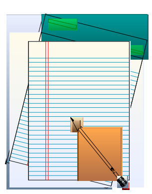
Use this area for notes.

3.8 Save the User Option File



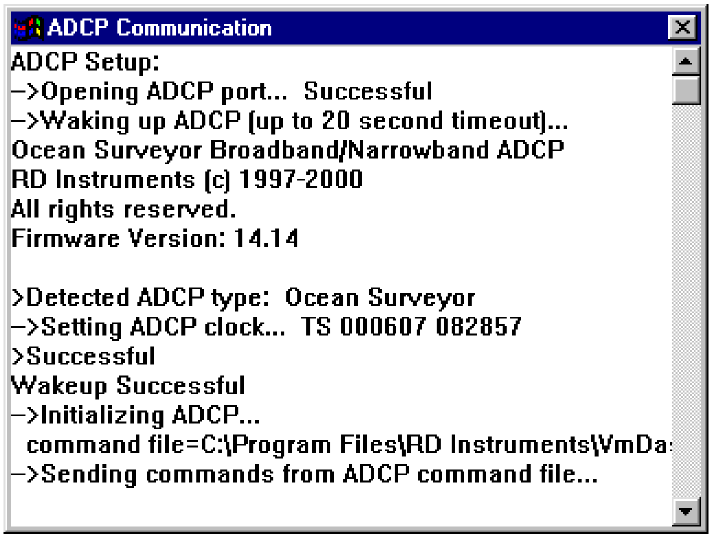
Step 8. On the **Options** menu, click **Save As**. The options may be saved to a file for later retrieval. You may wish to save several sets of options, to be used as starting points for different deployments. Option files that are created this way may have any name you choose.

NOTE. The *.ini file includes the path to the command (*.txt) file you choose. This allows you to create a *.ini file for each command file or have different *.ini files with different processing parameters (averaging screens, etc.) pointing to the same command file.



Use this area for notes.

3.9 Collect Data



Step 9. On the **Control** menu, click **Go** to begin collecting data. The ADCP Communication window will open and show the commands from the command file you selected (see "Load a Command File," page 8) being sent to the ADCP and the ADCP's response. Once all of the commands have been captured to the *.LOG file, the window will close automatically. See "VmDas ADCP Initialization," page 42 for details on how the ADCP commands are generated and sent to the ADCP.

> **NOTE.** You can review the ADCP Communication window by selecting **View**, **ADCP Communication**.

Use this area for notes.

4 *VmDas* Tutorial

The first section of this User's Guide presented a Quick Start to collecting data. The default Command files presented in that section will work for most conditions. There may be specific sites where you will need to create your own User Option files and Command files (see "Command Files," page 40) if you want to change some of the sampling parameters. The tutorial will go through a step-by-step procedure for creating a site-specific User Option file for collecting data. The tutorial will also go through the reprocessing data (see "Reprocessing Data with VmDas," page 49) and data playback (see "Playback a Data File," page 50).

CAUTION. If you edit the default command files with a text editor, be sure to back them up first, and save the file in plain text format when you have finished editing. Extra formatting characters inserted for other document file formats will make the file unreadable by *VmDas*.

4-1 Creating a Data Option File

In the following, you will be creating a Data Option file that will be used to program both the ADCP and *VmDas* software processing.

The *VmDas*, *WinADCP*, and *RDI Tools* software should be installed on your computer as outlined in "Software Installation," page 2. Connect the ADCP to a computer as shown in the ADCP Technical Manual, and apply power to the ADCP.

a. Start *VmDas*. Click **File**, **Collect Data**.

b. Click **Options**, **Load**. Select the Default.ini file. Select **Open**.

c. Click **Options, Edit Data Options.** See "Data Options Screens," page 23) for details on each tab. Once you have set all the parameters, click **OK** to exit the **Edit User Options** screens. When **OK** is clicked, *VmDas* checks the new options for consistency. For example, it is not allowed to use the same serial port twice on the **Communications** tab. If *VmDas* finds an error, it will display an error message box and refuse to close the **Edit Data Options** dialog box. You may either correct the error(s), or use **Cancel** to abandon all changes to the options.

d. Save the Data Option file by clicking **Options**, **Save As**. Enter a file name for the *.ini file that you have just created. This *.ini file will save the setup in all of the tabs including the path to the command text file. You can use this same method in case you wish to create several different setup files for the same machine. As an example, you could create a command text file that has a 6-meter bin size. You might save this to a text file with the name BB150BIN6M.TXT and call the *.ini file 6METER.INI. You could then create another command file and *.ini file with a 16-meter bin size with the same concept. Then when you want to actually use the proper command file you just have to select the *.ini file you intend to use.

4.1.1 Setting up Data Options

When data collection or data reprocessing is started, the current data options tell *VmDas* how to collect and process data.

- Data options are not used for playing back data. Editing them is not allowed in playback mode.
- *VmDas* stores current data options. They persist until changed, even if *VmDas* is closed and restarted.
- If the current set of data options is not satisfactory, they must be changed before starting data collection or data reprocessing. Once collection or reprocessing has started, it must be stopped before changes can be made.
- Current settings can be viewed at any time when a mode is selected.
- The current data options can be replaced with a set of data options stored in an *.INI, *.VMO, or *.VMP file. The current options can be edited.

Saving Data Options

When the current data options are changed, the old version is overwritten. To keep from losing a set of options, they should be stored in a file by clicking **Options**, **Save As**.

- The **Save As** option is available only when options have been edited but not saved in a file.
- Choose a file name that suggests the purpose of this set of data options. *VmDas* will add the INI extension to the name. No extension should be supplied by the user.
- Whenever data collection starts, the current data options are automatically saved in a VMO file.
- Whenever reprocessing starts, the current data options are automatically saved in a VMP file.
- All of these files are stored as standard Windows INI files. They are easy to read with a text editor. Editing them directly is not recommended.

Error Messages

Some options or combinations of options are illegal. *VmDas* detects some of these bad settings and refuses to allow them to be saved or used.

- Clicking **OK** or **Apply** on the **Edit Data Options** dialog box causes *VmDas* to do a consistency check and save the new settings as the current data options if no errors are found.
- The check is also done when starting data collection.
- If an error is found, a message describing the error will pop up and no changes will be saved. The user can either correct the problem, or cancel editing and lose all changes made.

Loading Data Options

On the **Options** menu, click **Load**. By default, only INI files are displayed. VMO files can be displayed by choosing them in the **Files of type** box. To display VMP files, choose all files in the **Files of type** box.

NOTE. To return to the factory default setting, select the Default.ini file.

View the Current Data Options

On the **Options** menu, click **View Data Options**. The same dialog opens as when editing, but no changes can be made. You can view the data options in the Playback mode.

4.1.2 Setting up Display Options

The Display Options determine how data is displayed.

- They can be set for modes that display data (playback and collect).
- They can be changed at any time when one of those two modes is active, whether or not data is being played or collected.
- Graphs or charts may be erased and re-plotted because of changes to these options, but it makes no change to the data itself.
- In reprocess mode, data is not displayed, so there are no settings to determine how it is displayed.

Edit Display Options

Click **Options**, **Edit Display Options** to display a tabbed dialog box from which you can change the display options. Click the **Reference** tab to select the display units, or the velocity reference to use for profiles. Click the **Ship Track** tab to select the ship position source and the profile bins to use for the current stick plots.

Reference Tab

When you click the **Reference** tab (Figure 2) in the **Display Options** dialog box, the following display units and velocity reference settings are displayed and may be changed.

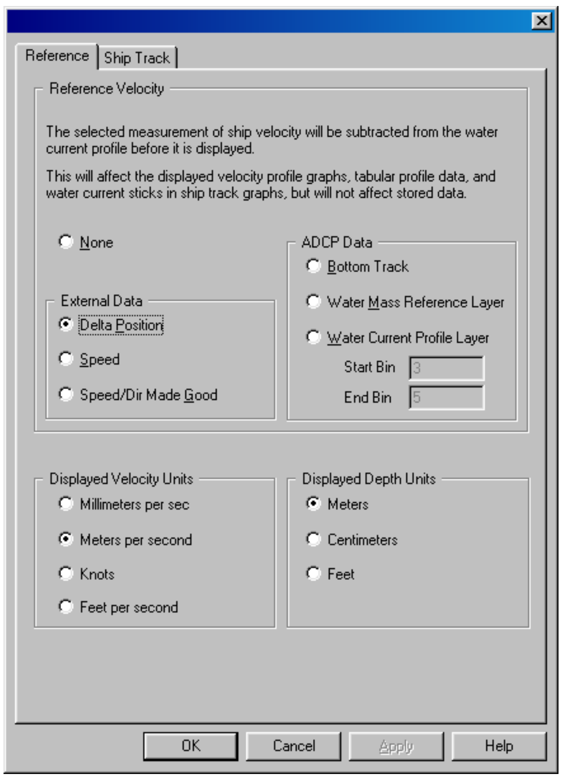


Figure 2. Reference Tab

Velocity Reference - Choose between **None**, **Bottom Track**, **Water Mass Reference Layer**, **Water Current Profile Layer**, **Delta Position**, **Speed**, and **Speed/Dir Made Good**.

- **Water Mass Reference Layer** refers to the water reference layer output that some ADCP instruments output along with the bottom track data. This layer is only available from the BroadBand and WorkHorse ADCPs. This data is collected and recorded by these ADCPs only when the BK command is set to collect Water Mass

Layer and the BL command has been set to select the section of water that will be measured to record a speed through the water. This speed through the water is stored in a separate location in the bottom track data. Enabling this feature will reference all of the profile velocities to this recorded speed through the water. This feature is typically enabled only when the bottom track is not possible and navigation data will not be collected.

- The **Water Current Profile Layer** is setup as a totally independent water layer to reference the averaged data in either the STA or LTA files. The user should set this to a number of consecutive bins that will represent only the vessel motion (i.e. that has as little real water motion as possible). The **Start** and **Stop** bins selected will all be averaged together to produce a single speed through the water. This speed through the water is stored in a separate location in computer RAM. If not used it is discarded and not recorded. Enabling this feature will reference all of the profile velocities to this recorded speed through the water. This feature is only used when there is no bottom track or navigation data available.
- **Delta Position** calculates a reference velocity as delta position divided by delta time, where the position data is obtained from the NMEA GGA message. The position used in the calculation is the last GGA position received in each ADCP data interval.
- **Speed** calculates a reference velocity from speed and direction, obtained from the NMEA VTG message, by resolving them into East and North components.
- **Speed/Dir Made Good** calculates a reference velocity from speed-made-good and direction-made-good, which is in turn calculated from the averages of position and time, as received in the NMEA GGA messages, for each ADCP data interval.

Velocity Units - Choose between millimeters per second, meters per second, knots, or feet per second for all displayed velocity data.

Depth Units - Choose between meters, centimeters, or feet for all displayed depth data.

Ship Track Tab

When you click the **Ship Track** tab (Figure 3) in the **Display Options** dialog box, the following settings are displayed and may be changed.

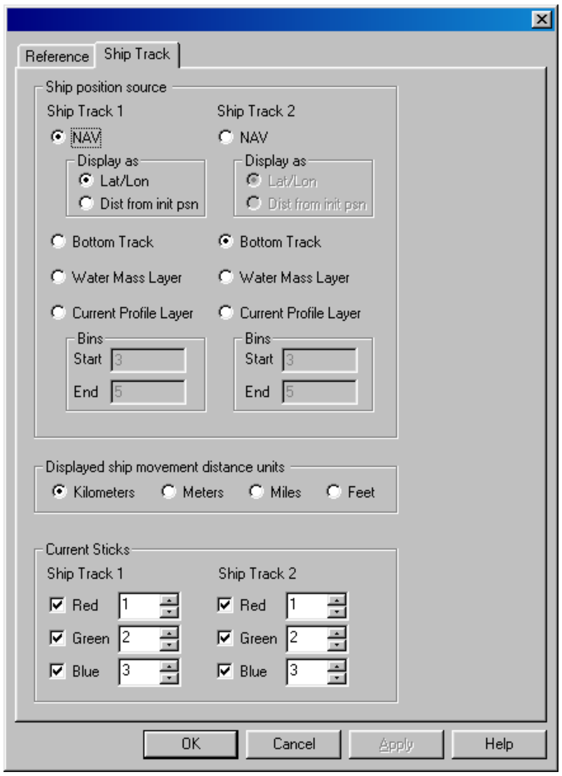


Figure 3. Ship Track Tab

Ship Position Source - For each ship track plot, choose between **NAV**, **Bottom Track**, **Water Mass Reference Layer**, and **Current Profile Layer**.

- If **NAV** is selected, the last NMEA GGA position received in each ADCP data interval is used to calculate the ship track, and can be displayed as a Lat/Lon position, or as a distance from the initial position. The initial position is the first valid GGA position received that also is the last position received within an ADCP data interval.
- If **Bottom Track** is selected, the ADCP bottom track velocity data are integrated to calculate a ship track.
- If **Water Mass Reference Layer** is selected, the ADCP water reference layer data are integrated to calculate a ship track. This layer is only available from the BroadBand and WorkHorse ADCPs. This data is collected and recorded by these ADCPs only when the BK command is set to collect Water Mass Layer and the BL command has been set to select the water depths to collect a speed through the

water. The delta speed and delta time between consecutive averaging intervals is then used to calculate a distance traveled and direction and plotted on the Ship Track graph. This feature is typically enabled only when the bottom track is not possible and navigation data will not be collected.

- If **Current Profile Layer** is selected, the layer velocity is defined to be the average of the range of profile bins selected as the velocity reference, and that velocity is integrated to calculate a ship track. This layer is setup as a totally independent water layer to reference the averaged data in either the STA or LTA files. The user should set this to a number of consecutive bins that will represent only the vessel motion (i.e. that has as little real water motion as possible). The **Start** and **Stop** bins selected will all be averaged together to produce a single speed through the water.

The delta speed and delta time between consecutive averaging intervals is then used to calculate a distance traveled and direction and plotted on the Ship Track graph. This feature is typically enabled only when there is no bottom track or navigation data available.

> **NOTE.** If **Bottom Track**, **Water Mass Reference Layer**, or **Current Profile Layer** is selected, the ship track is shown as a distance from the initial position, where the initial position is 0,0.

Chart units for distances - Choose between Kilometers, Meters, Miles (statute), or Feet.

Current Sticks - Choose to display up to three current sticks at each ship position, and select which profile bin each stick represents.

> **NOTE.** Changes made to the **Ship Track** tab may require that the ship track be re-plotted. *VmDas* will issue a warning before accepting these changes. If the ship track must be re-plotted, the ship track is erased. Plotting continues from the current position.
>
> When collecting data, this means it is a good idea to settle on desired configurations early. Once erased from the display, the Ship Track cannot be redisplayed until the deployment files are played back.

Change Chart Properties

Whenever you right-click on any profile plot, a pop-up property menu (Figure 4) is displayed from which you can change many attributes for the profile graphs.

Profile Plots

- *How do I manually set the ranges for the plot axes?* Select the **Axes** tab. On the right, click the tab that contains the attribute that you want to change for the axis, in this case **Scale**. On the left, click on the label of the axis you want to change. On the right, enter new numbers for **Max** and **Min** and click **OK** or **Apply**.
- *How do I put symbol markers on my data points?* Select the **Chart Styles** tab. On the right, click the **Symbol Style** tab. On the left, click on the label for the series you want to mark (i.e. **Style1**, **Style2**, etc.). Click the box labeled **Shape** and select a shape for the symbol. Click the box labeled **Size** to set the size of the symbol. Click the **Name** box to set the desired color for the symbol. Click **OK** or **Apply**. Note that from the **Chart Styles** tab you can also set the line width, pattern, and color of each line in the graph.

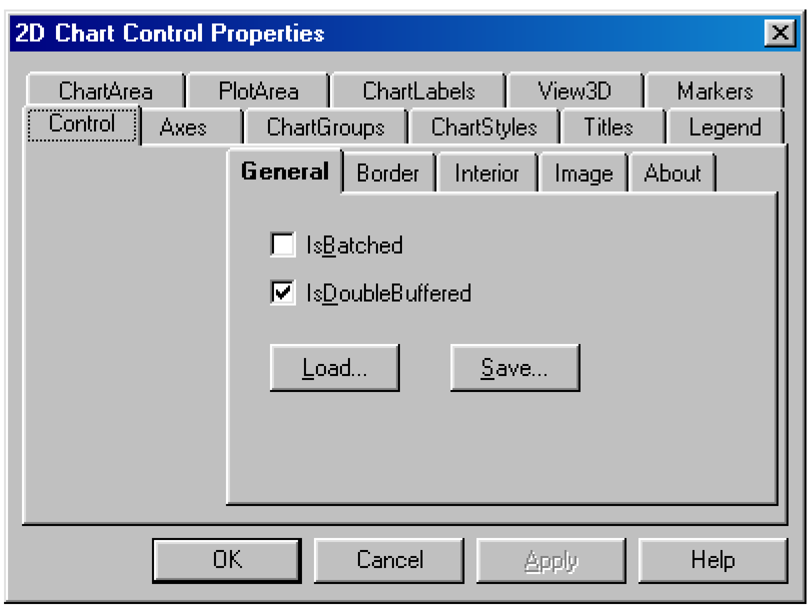


Figure 4. Chart Control Properties

Ship Track Plots

- *How do I manually set the ranges for the plot axes?* Right-click the ship track plot and click on **Properties** (Figure 5). Click the **Plot Area** tab. Manually enter values for **Left**, **Right**, **Top**, and **Bottom**. On this property page, you may also change the font, turn on or off the grid lines and set their style, and change the aspect ratio method. Click **OK**.

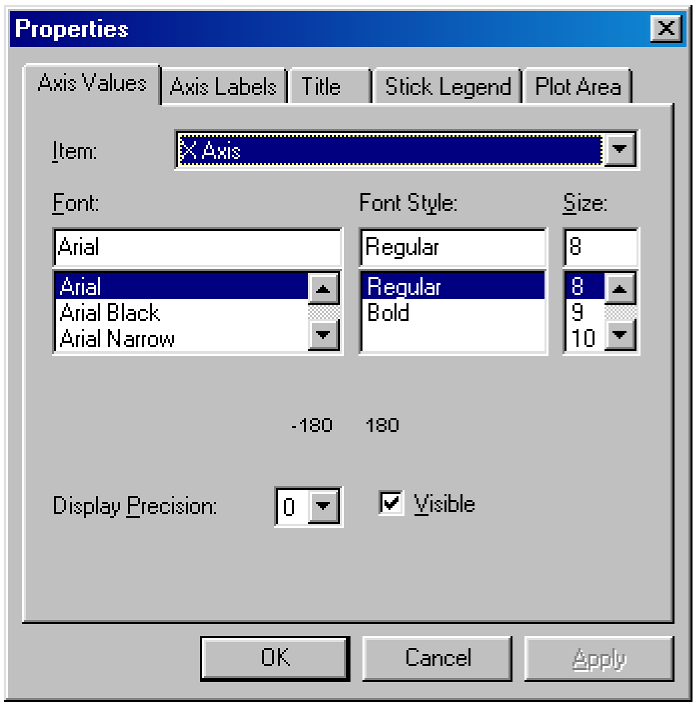


Figure 5. Ship Track Properties Dialog

4.2 Data Options Screens

Click **Options**, **Edit Data Options** to display a tabbed dialog box from which you can change the program options.

- Communications (see “Communication Tab,” page 24)
- ADCP Setup (see “ADCP Setup Tab,” page 27)
- Recording (see “Recording Tab,” page 29)
- Transforms (see “Transforms Tab,” page 31)
- Averaging (see “Averaging Tab,” page 33)
- Data Screening (see “Data Screening Tab,” page 35)
- Users Exits (see “Users Exits Tab,” page 37)
- Simulated Inputs (see “Simulated Inputs Tab,” page 39)

4.2.1 Editing the Data Options

On the **Options** menu, click **Edit Data Options** to display a tabbed dialog box. Data Options can be edited only when collect or reprocess mode is selected, and collection or reprocessing is _not_ in progress.

- Clicking **OK** or **Apply** causes *VmDas* to do a consistency check and save the new settings as the current data options.
- If an error is found, a message describing the error will pop up and no changes will be saved. The user can either correct the problem, or cancel editing and lose all changes made.
- Editing data options saves them as the current options, not in a file (see “Saving Data Options,” page 15).

NOTE. If the save to a file step is skipped, the new current options still persist until changed, even if *VmDas* is closed.

4-2.2 Communication Tab

When you click the **Communications** tab in the **Program Options** dialog box, the following communications settings are displayed and may be changed to match the communication parameters to those of the device you have connected to the computer.

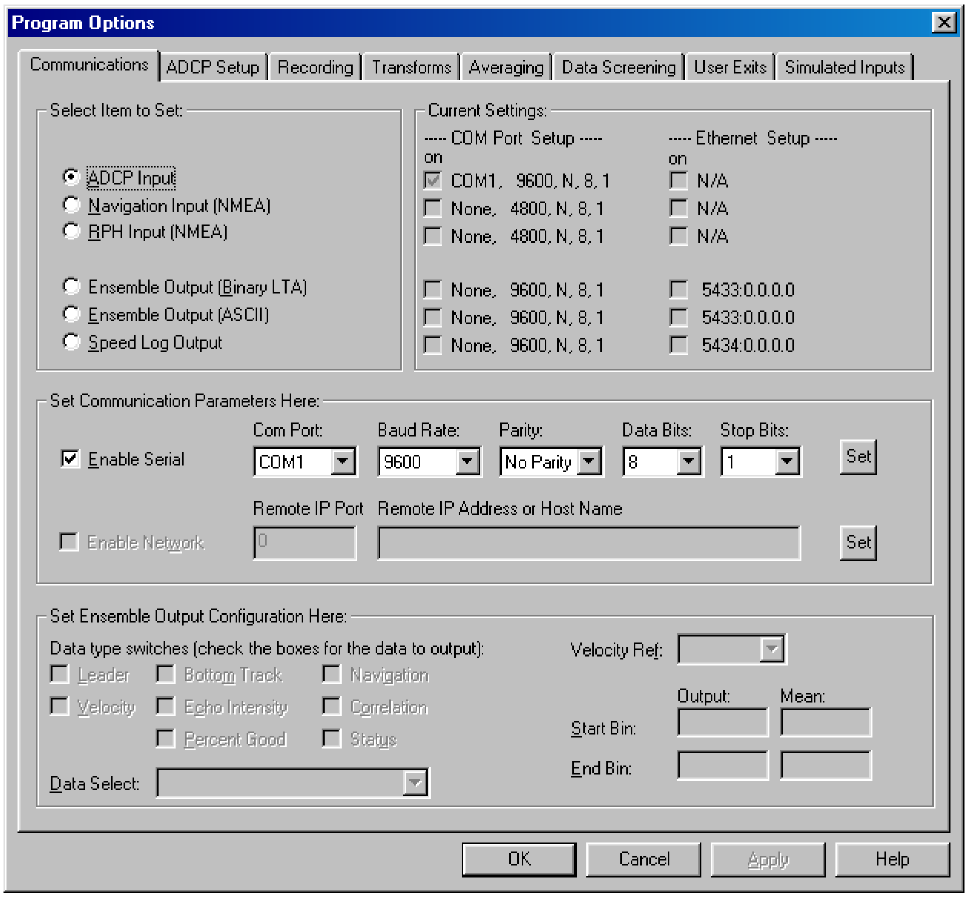


Figure 6. Communications Tab

VmDas can collect data from one to three input serial ports. When collecting data, ensembles must be read from the ADCP input port. The Navigation and RPH input ports can collect NMEA data if desired. If both NMEA ports are used see "Reading NMEA Data," page 55 for details on which sentences are accepted at which port.

Enabling an input port instructs *VmDas* to listen for data at that port, to log all data received to a file, and to generate error messages if data is not received. *VmDas* enforces some rules for input port options.

- Duplicate or invalid COM ports cannot be specified for active ports.

- If options on the **Transform** page use NMEA data, at least one input port must be configured to accept it.
- If only one NMEA port is enabled, it must be the Navigation port.

VmDas can write data to up to three output serial ports and up to three TCP/IP ports.

VmDas can provide up to three optional real time outputs through serial ports, Ethernet ports, or both.

Enabling an output port instructs *VmDas* to write data to that port whether or not anyone is listening.

Ensemble Output (Binary LTA) provides long term averaged ensembles. This output is a copy of the LTA output file.

Ensemble output (ASCII) converts binary ensembles to an ASCII format. If this port is enabled, the data to be written must be selected in the **Set Ensemble Output Configuration Here** box.

Speed Log Output produces NMEA messages containing ship speed information from short term averaged data.

Set Ensemble Output Configuration Here

The settings in the **Set Ensemble Output Configuration Here** box are needed only if **Ensemble Output (ASCII)** is enabled.

- **Data Select** - *VmDas* produces several output files with binary ensembles. **Data Select** chooses one of these files as the source of ensemble data for ASCII output. Some of the data in the binary source will be extracted, converted to an ASCII format (See "Output ASCII Ensemble Data," page 61), and written out the output port.
- **Data Type Switches** - Select the type of data to send to the ensemble-out device during data collection. Check the appropriate checkbox for each type of data you want sent to the ASCII ensemble-out port. The **Navigation** box will have no effect if the **Data Select** box contains ENR. **Navigation** data comes from NMEA inputs. The navigation and ensemble data are merged to produce ENX, STA, and LTA files. Navigation data is not present in the raw ENR files.
- **Velocity Switch** - If the **Velocity** box is checked, the **Start Bin** and **End Bin** boxes in the **Output** column set the bins that will be added to the ASCII ensemble velocity data.
- **Velocity Ref** - If the **Velocity** box is checked, the **Velocity Ref** box can be used to remove ship velocity from the velocity profile. Other velocities, such as bottom track, are not changed.

  If **Velocity Ref** is set to **None**, velocities are unchanged.

If **Velocity Ref** is set to **Bottom**, the velocity from the bottom track field, if present, is subtracted from the velocity of each bin.

If **Velocity Ref** is set to **Mean**, the average velocity of a water layer is subtracted from the velocity of each bin. The **Start Bin** and **End Bin** boxes in the **Mean** column select the bins that make up the water layer.

- **Mean Start/End Bin** - Lets you select the bin (depth cell) range for the Mean velocity reference.
- **Output Start/End Bin** - Lets you select the portion of the ADCP profile (depth cell range) to send to the ASCII ensemble-out port.

NOTE. If the start and end bins are out of range (e.g., the ADCP ensemble contains 40 bins, and you set the Output Start Bin = 1 and the Output End Bin = 50), *VmDas* automatically adjusts the output bin range to the ADCP ensemble (i.e., Output End Bin = 40).

Suggested Setting.

The parameters set in the ADCP input port should match the ADCP wakeup serial port settings. RDI recommends that the ADCP wakeup serial port settings be set at 9600 BAUD, no parity, 8 data bits, and 1 stop bit.

The Navigation Input and RPH input ports read NMEA data. The NMEA 0183 standard specifies 4800 BAUD, no parity, 8 data bits, and 1 stop bit. Never the less, many ships use 9600 BAUD, and some may use faster rates.

NOTE. Advanced users can change the ADCP serial port parameters with a command file. Those parameters are used only while collecting data. When data collection stops, the serial port settings the ADCP uses will return to their wakeup values.

VmDas automatically changes the PC serial port when the ADCP serial port changes.

4.2.3 ADCP Setup Tab

Use this dialog box to setup the ADCP. Select either **Use Options** to set the ADCP commands on this tab or select **Use File** to use a command file.

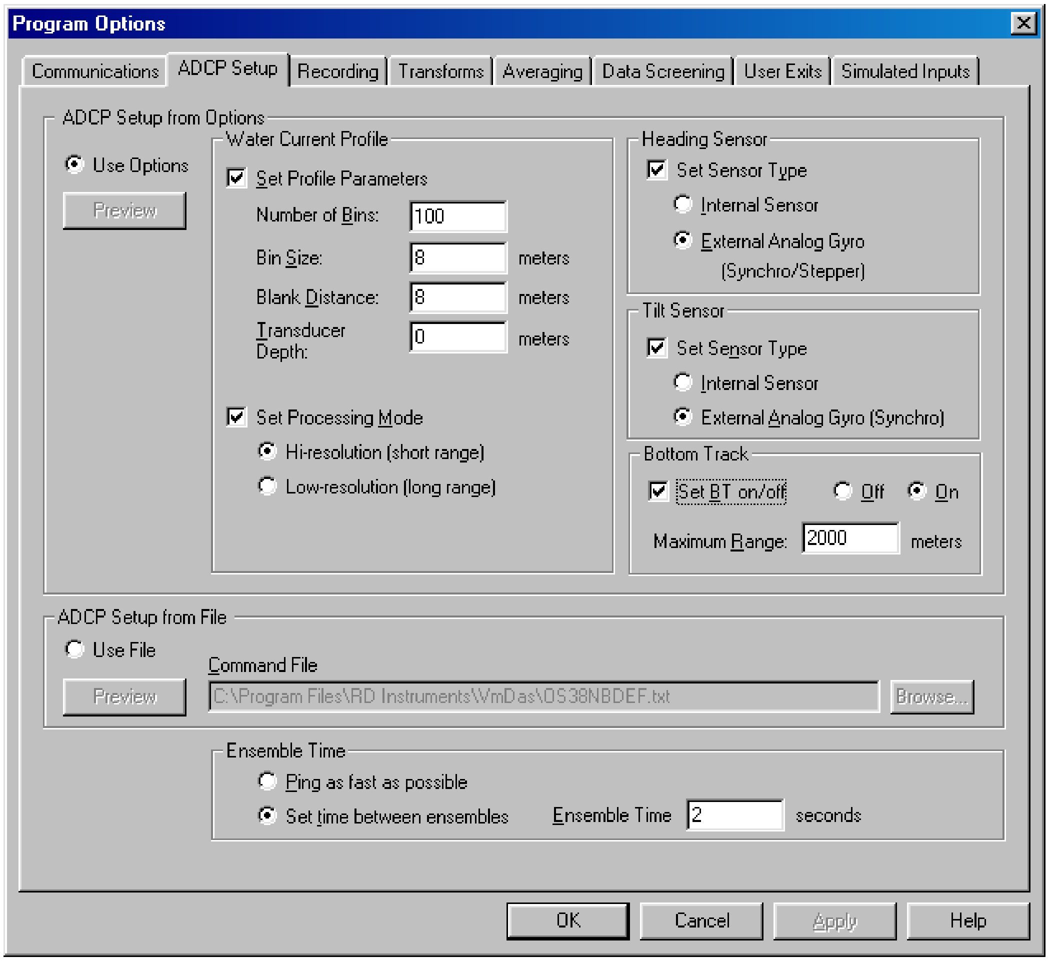


Figure 7. ADCP Setup Tab

Ensemble Time is set on this tab for both **Use Options** and **Use File**. Select the **Set time between ensembles** button to specify a ping interval (see Table 1, page 8). Select the **Ping as fast as possible** button to let the processing and I/O time dictate the ping rate.

NOTE. See "*VmDas* ADCP Initialization," page 42 for details on how the ADCP commands are generated and sent to the ADCP.

To set the ADCP commands using this dialog box, select the **Use Options** button.

- Select the **Set Profile Parameters** box in the **Water Current Profile** section to set the following parameters; **Number of Bins** (WN), **Bin Size** (WS), **Blank Distance** (WF), and **Transducer Depth** (ED).
- Select the **Set Processing Mode** box to switch between high and low resolution modes.
- Select the **Set BT on/off** box to enable or disable bottom track pings (BP1) and set the maximum search range (BX command).
- Select the **Heading Sensor Set Sensor Type** box in this section to switch between using the ADCP's internal sensor or an external analog gyro (synchro/stepper) (EZ command).
- Select the **Tilt Sensor Set Sensor Type** box in this section to switch between using the ADCP's internal sensor or an external analog gyro (synchro) (EZ command). When this box is not checked, the default ADCP setup will be used.

To set the ADCP commands using a command file, select the **Use File** button. Enter the name of an ADCP command file in the **Command File** box, or click the **Browse** button to navigate to a file using a **File Open** dialog box. This should be a text file with one ADCP command per line, and can have any valid ADCP commands. The contents of this file will be sent to the ADCP during initialization.

Suggested Setting for First Time Users.

Select the **Use File** button in the **ADCP Setup file** area and click the **Browse** button under the **Command File** window. Select one of the default command files (see "Load a Command File," page 8 and "Command Files," page 40) and click **Open**.

Set the **Ensemble Time** as shown in Table 1, page 8.

NOTE. The ADCP automatically increases the Time per Ensemble if ((WP + NP + BP) x TP > the setting in **Set time between ensembles** box).

4.2.4 Recording Tab

The Recording property page allows you to set the deployment name and path to where the data files are recorded.

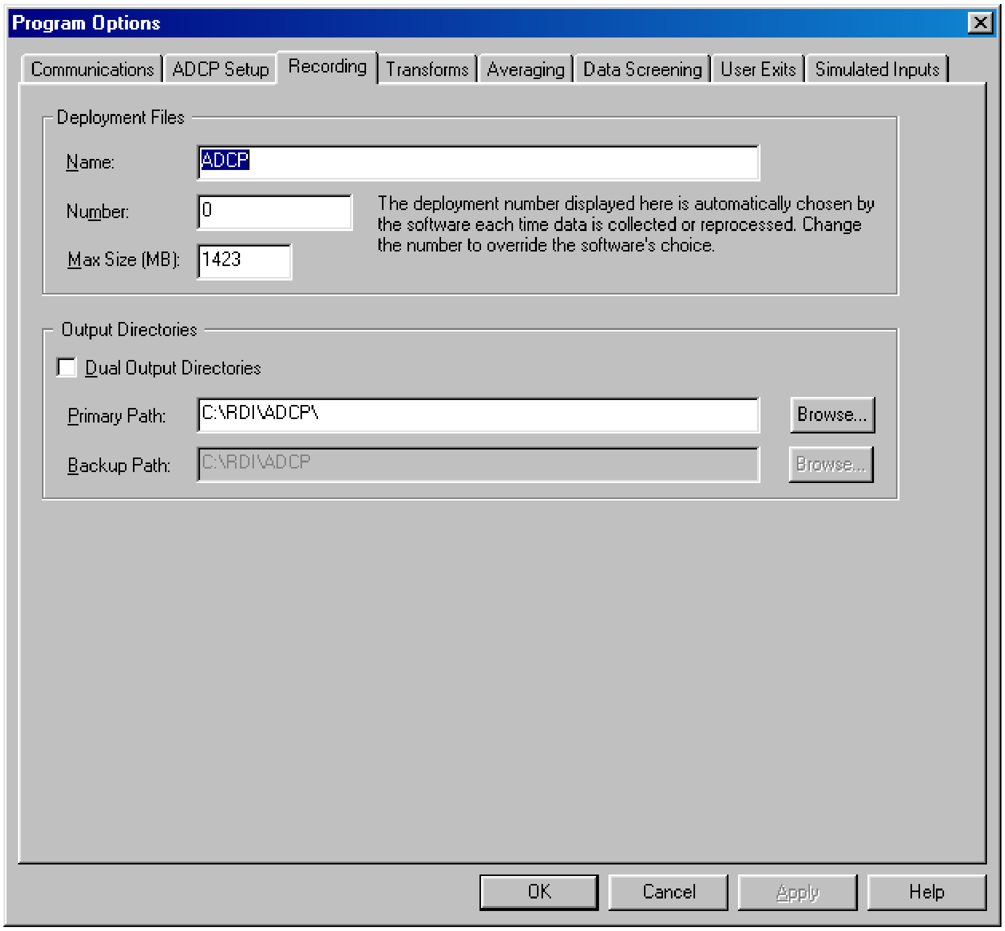


Figure 8. Recording Tab

Enter a name that identifies your deployment. This name will be used as part of the filename for each file that is part of this deployment (see "File Naming Conventions," page 73).

Normally, you do not need to enter a **Starting Number** as the software handles it automatically. This deployment number is used to identify the specific data collection run, and becomes part of the filename of each data file recorded for the deployment. If you do not enter a deployment number, the software will automatically assign one for each deployment.

Enter the desired **Maximum File Size**. Each file type in your deployment will be limited to the specified size. Each file has a sequence number as part of the filename, and as each recorded file reaches the specified size limit, the sequence number will be incremented and a new file started.

Enter the **Primary Path** where the raw, intermediate, and processed data files are to be stored. Clicking the **Browse** button to the right of the **Primary Path** edit box will allow you to browse your computer to select a folder to record to. You will be presented with a **Choose Directory** dialog box (see Figure 9), which will have the default path of C:\RDI\ADCP selected. Select the primary path (note the directory must already exist) and click **OK**.

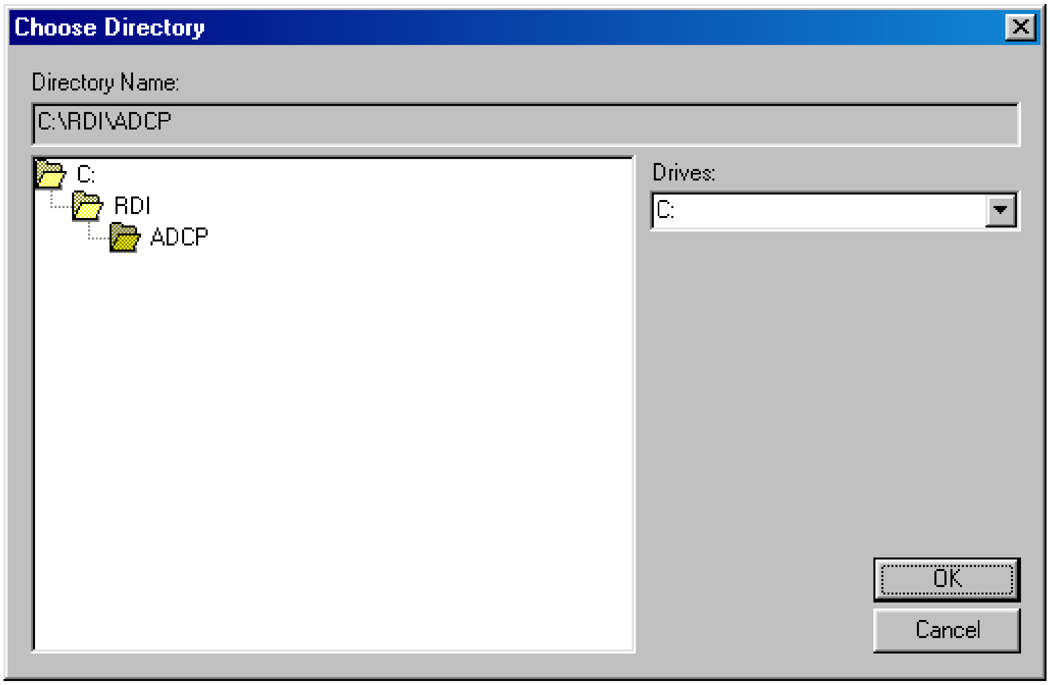


Figure 9. Choosing the Path

Check the **Duel Output Directories** box to create two copies of the raw data files and to allow a backup path to be entered. If this box is not checked, only the **Primary Path** is enabled.

Enter the **Backup Path** where optional backup copies of raw data and option files are stored. These files are not used for data processing. They are made available in case the primary files are lost. If the backup copies are needed, copy them to the primary directory and reprocess them to create intermediate and processed data files.

Suggested Setting.

Enter a file name that identifies your deployment.

Select the primary path (note the directory must exist already; *VMDAS* does not create it, except for the default path already entered).

4.2.5 Transforms Tab

Use this screen to select the **Transform Type**, **Sensor Configuration**, **Orientation**, **Heading Source**, **Tilt Source**, **Beam Angle**, **Heading Correction**, and **Velocity Scaling**.

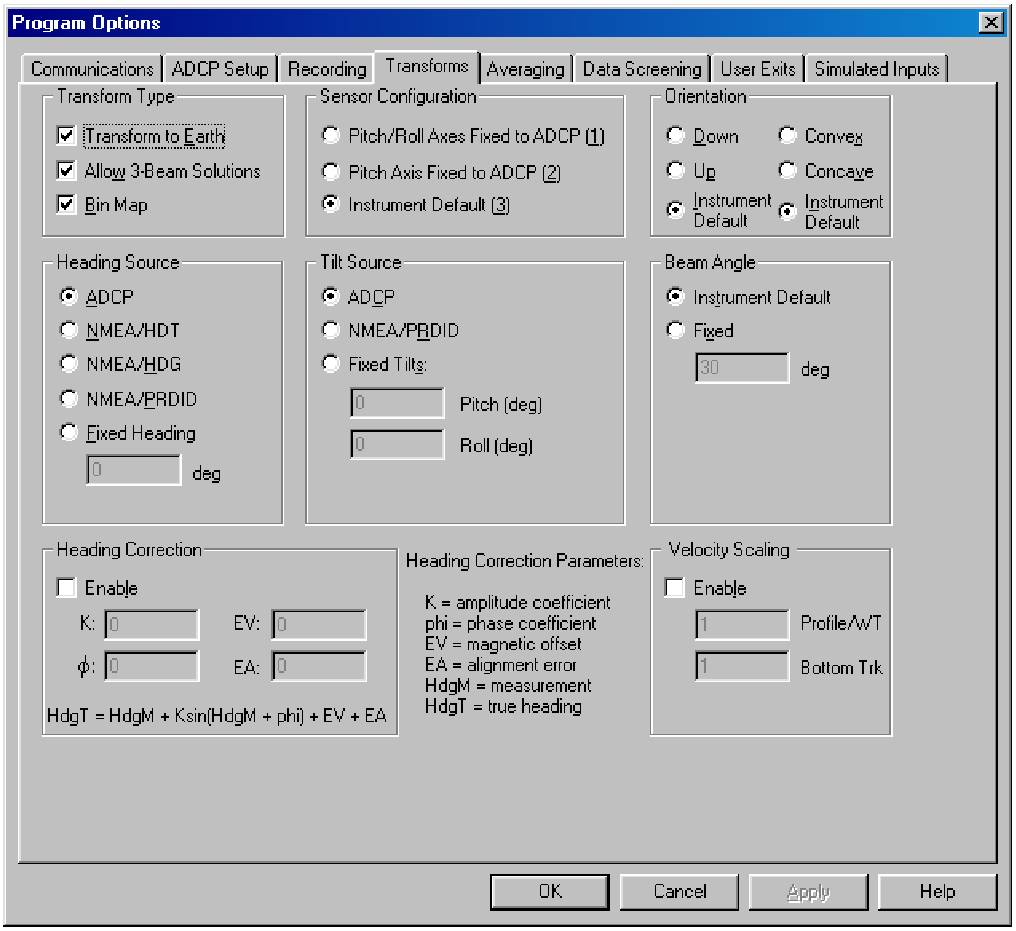


Figure 10. Transforms Tab

Click the **Transform Type** checkboxes to enable or disable beam-to-Earth transformation, three-beam solutions, or bin mapping. At present, *VmDas* averages ADCP data in the Earth frame. Therefore, if the Earth transformation is disabled, no averaged data will be produced. Raw data will still be recorded.

Select the appropriate **Sensor Configuration** radio button to indicate your sensor configuration. Select **Instrument Default** to have the software get the configuration from the ADCP leader data.

In the **Orientation** box, select **Instrument Default** to have the software get the orientation from the ADCP leader data. Otherwise, by selecting the other radio buttons you may force a particular orientation for processing.

In the **Heading Source** box, select the **ADCP** radio button to have the software get heading data from the ADCP leader (internal compass or external synchro/stepper analog gyro). Otherwise, select the radio button for the NMEA message type that you wish to decode heading data from, or select the **Fixed Heading** radio button and enter a fixed heading value to use for the processing. Heading data from the selected source will be written into the ADCP variable leader in the ENX, STA, and LTA data files.

In the **Tilt Source** box, select **ADCP** to have the software get tilt data from the ADCP leader data. Select **NMEA** to have the software get tilt data from the $PRDID string on the NMEA port, or select **Fixed Tilts** to enter fixed values for pitch and roll to use for processing.

In the **Beam Angle** box, select **Instrument Default** to have the software get the ADCP nominal transducer beam angle from the ADCP leader data. Select **Fixed** to enter a fixed beam angle to use for processing.

In the **Heading Correction** box, click the **Enable** checkbox if heading correction is desired. Enter magnetic offsets such as magnetic variation in the **EV** edit box. Enter transducer alignment offsets in the **EA** edit box. Enter coefficients for the sin correction function in the **K** and **phi** edit boxes.

Use the **Velocity Scaling** box if you need to correct velocity data that was collected using the incorrect speed of sound, salinity, or temperature.

For example, the user collects data using the factory default salinity for his ADCP. Later, the user notices that this salinity value is wrong, causing an error in the velocities. Calculate a scale factor (in this case, the same for profile and Bottom Track data), and open *VmDas* in the Reprocess mode (see "Reprocessing Data with VmDas," page 49). Enter the scale factor, and click **OK** to save the options. Click **Control**, **Go** to reprocess the data.

VmDas opens a reprocessing document with the selected data, opens the options dialog, validates and saves the new options, and reprocesses the data to new files, multiplying the velocities and error velocity thresholds in all new files by the scale factor.

Suggested Setting.

Enable all selections in the **Transform Type**.

Set the **Sensor Configuration**, **Orientation,** and **Beam Angle** to **Instrument Default**.

The **Heading Source** and **Tilt Source** should be set to **ADCP.**

Set the **Heading Correction** to your input.

The **Velocity Scaling** should be disabled.

4.2.6 Averaging Tab

The Averaging property page allows you to set the Ensemble Averaging interval and Reference Layer Averaging properties.

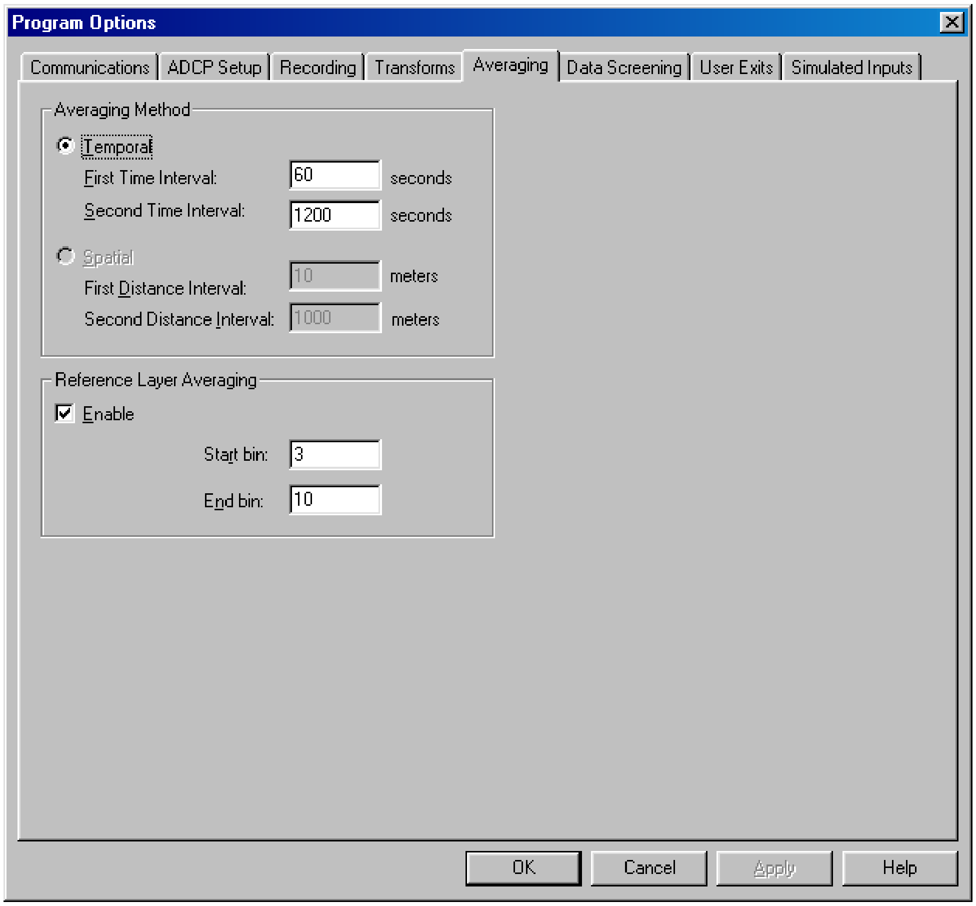


Figure 11. Averaging Tab

Enter the **Temporal Averaging** short-term averaging in the **First Time Interval** box. Use the short-term average to get more frequent updates for a data quality check. The **First Time Interval** is what we refer to as the Short Term Average (which will become file name with a *.STA extension).

Enter the long-term averaging period in the **Second Time Interval** box. Use the long-term average to get your intended results. The **Second Time Interval** is what we refer to as the Long Term Average (which will become file name with a *.LTA extension).

Enable the **Reference Layer Averaging** checkbox to turn on or off the reference layer averaging feature. Using a Reference Layer helps removes biases caused from accelerations on platforms or ships. To set up a Reference Layer, you must set the **Start Bin** and the **End Bin** to be used as the “meaning” reference layer.

Noise, introduced by platform accelerations, can overwhelm the velocity measurements. We have found keeping track of velocities relative to a stable reference layer can improve the data in such Cases. As an example, suppose we have a four-ping ensemble. Because signal amplitude falls off with distance, the deeper bins will have more of the data flagged as bad. Bad data are not included in averages. As a result, the average profile might be erratic when the percent good is low. In the data below, a constant profile is assumed for bins 20 to 22, yet the average of good data shows it to be sheared.

		Ping #			
	1	2	3	4	
Bin		**Velocities**			**AVG #1**
1	5	6	18	19	12
2	3	4	16	17	10
↓	↓	↓	↓	↓	↓
20	bad	bad	bad	16	16
21	2	bad	bad	bad	2
22	bad	bad	15	bad	15

Bins 1 and 2 have all good data; and in this example, are used as the reference layer. Averaging these bins for each ping gives a reference velocity of:

```
       Ping #:              1    2    3    4
Layer Average:              4    5   17   18
Mean Layer Average = 11 : (4 + 5 + 17 + 18) / 4
```

When the layer average is subtracted from the velocities within each ping the data become:

Bin	**Velocities**				**Average #1**	**Average #2**
1	1	1	1	1	1	12
2	-1	-1	-1	-1	-1	10
↓	↓	↓	↓	↓	↓	↓
20	bad	bad	bad	-2	-2	9
21	-2	bad	bad	bad	-2	9
22	bad	bad	-2	bad	-2	9

The last column, Average #2, gives a better picture of the velocities at the deeper bins than the algorithm for obtaining Average #1.

NOTE. When using a reference layer, use bins in the upper part of the profile and bins that have a high percent good (more than 85%). If you select a bad bin range, the averages will be wrong and data will be bad.

Suggested Setting.

You will be collecting three different files and will be able to view all three during real time data collection. The first file is the raw data input, which is *single ping* data. The selections for the other two files are based on your time input values here. The **First Time Interval** is what we refer to as the Short Term Average (which will become file name with a *.STA extension). The **Second Time Interval** is what we refer to as the Long Term Average (which will become file name with a *.LTA extension). You can set these to any times you like and they may even be the same value.

4.2.7 Data Screening Tab

Click the checkboxes for the data screening options you wish to enable. When a box is checked, its associated edit box becomes enabled, and you may enter a threshold value for screening the data.

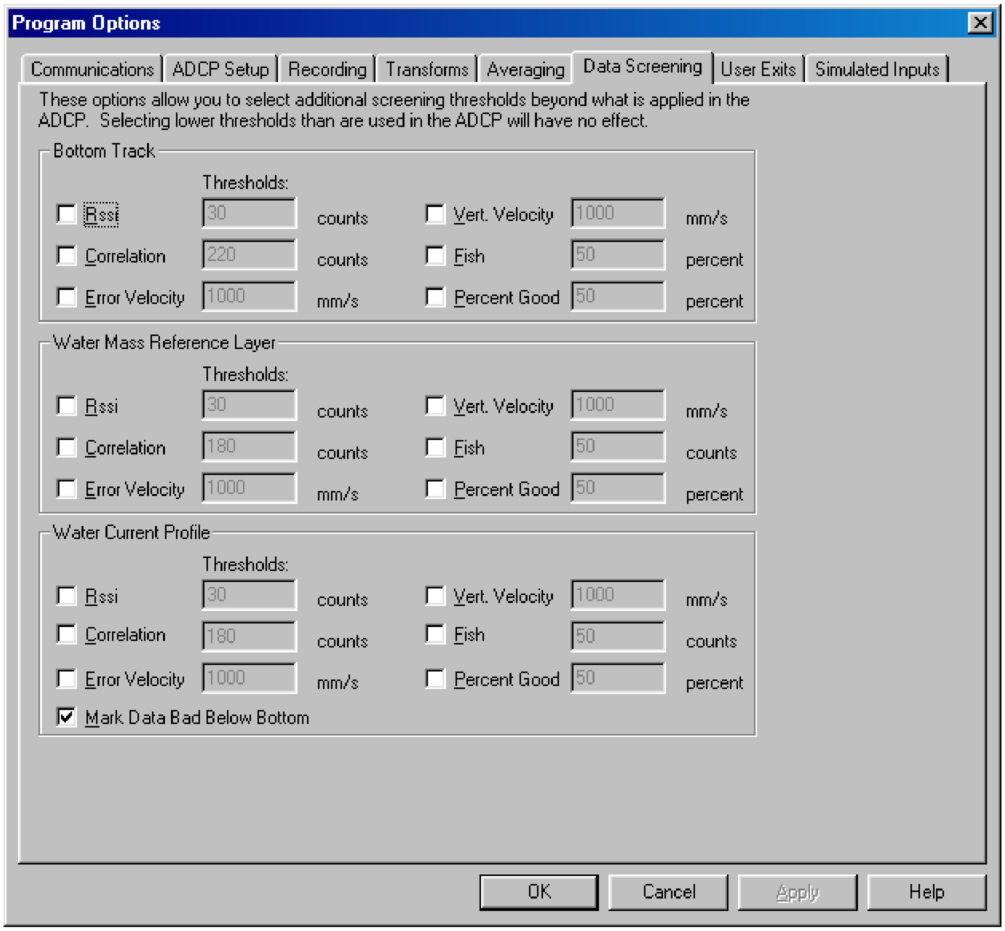


Figure 12. Data Screening Tab

For **RSSI** (amplitude), **Correlation**, and **Percent Good** screening, the threshold value represents a minimum allowed value. For example, if you set the RSSI threshold to 35 counts, then any beam with an RSSI value below 35 counts will be discarded and not used in the processed data. RSSI and correlation screening for each beam are performed on the raw data. Percent good screening is performed on the averaged data.

For **Error Velocity** and **Vertical Velocity** screening, the threshold value represents a maximum allowed value. For example, if you set the **Error Velocity** threshold to 1500 mm/s, then any transformed ensemble that has an error velocity greater than 1500 mm/s will be discarded and not used in the processed data. **Error Velocity** and **Vertical Velocity** screening are performed data. **Error Velocity** and **Vertical Velocity** screening are performed on the transformed data, before averaging.

For **Fish** screening (also known as false-target detection), the threshold used for bottom track has a different meaning than that used for the water track ping or the profile ping. In screening water data, the amplitudes of all the beams are compared, and if the amplitude of the weakest beam differs from the amplitude of the strongest beam by more than the specified number of counts (i.e. the threshold value), then the weaker beam is discarded. The process is repeated with the remaining beams until either the test passes with three or more good beams, or two beams have been marked bad, in which case the profile bin is discarded.

In fish screening bottom track data, the depths of all four beams are compared. If the depth of the shallowest beam is less than the average depth of the remaining beams by more than the specified percentage (i.e. the threshold value), then the shallowest beam is discarded. This process is repeated until either the test passes with three or more good beams, or more than two beams have been marked bad, in which case the measurement is discarded.

Check the box labeled **Mark Data Bad Below Bottom** to have the software mark bad all profile bins that fall below the sea bottom. The formula is Last-GoodBin = (ShallowestBeam) * (COS (BeamAngle)) + (BinLength).

NOTE. The ADCP has its own internal thresholds. Setting thresholds on this page that is lower than those used by the ADCP will have no effect.

While it is possible for advanced users to modify the ADCP command file to disable some of the internal thresholds, this practice is not recommended. *VmDas* is designed to do those checks. It allows you to change them when you reprocess the data. This gives you the maximum flexibility.

Suggested Setting.

You are able to screen data based on the items in this menu and the thresholds you decide during real-time or when reprocessing. This screening will affect what is displayed on the screen and what data is recorded to the *.STA and *.LTA files. *The original raw data will be unaffected by what is setup here.* For real-time data collection, we recommend you only enable **Mark Bad Below Bottom**. You can reprocess data later and change the settings in this screen to see what the effect is.

4.2.8 Users Exits Tab

User exits are hooks at various points in the processing where the user can modify the data with an external program. The external user application needs to be written so that it will keep trying to look for the appropriate file names, which will not exist until *VmDas* creates them some time after starting the program. It then needs to monitor the file size to determine when new data is available, and it has to observe the same file size limits specified for *VmDas* and automatically advance to the next file in the sequence when the size limit is reached.

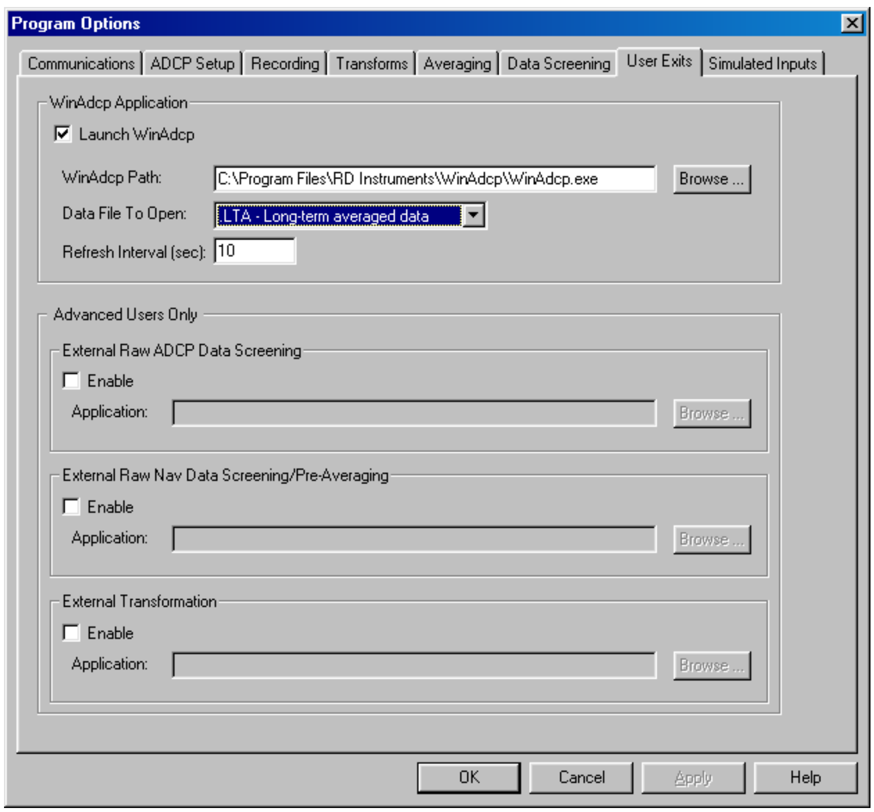


Figure 13. Users Exits Tab

Click the **Launch WinADCP** checkbox to have *VmDas* automatically start the *WinADCP* application in monitor mode when data collection is started. When in monitor mode, *WinADCP* will periodically refresh its displays from the data recorded by *VmDas*, and will allow you to view time series and contour graphs of the data. From the *WinADCP* application menu, you can exit the monitor mode to change the *WinADCP* setup, and then reenter the monitor mode to continue the data updates. The *WinADCP* application must be installed on the computer for this option to work.

Enter the *WinADCP* program file name in the **WinADCP Path** box, including the entire path for the directory in which it resides. *VmDas* uses this information to find the *WinADCP* application. Alternatively, you may click the **Browse** button to navigate using the **File Open** dialog.

Select which type of data to view with *WinADCP* using the **Data File to Open** box. Choose from single-ping beam data, single-ping Earth data, short-term averaged data, or long-term averaged data. Once data collection has started, you can use the *WinADCP* application menu to open a different file type if desired. Just remember to exit the monitor mode in order to make the change, then reenter monitor mode to continue the automatic data refreshing.

Enter the number of seconds that *WinADCP* should wait between screen refreshes in the **Refresh Interval (sec)** box.

> **NOTE.** When you press **Stop**, *VmDas* leaves WinADCP open so that your data screen does not disappear. A consequence of that is if you have WinADCP enabled as a User Exit, and click **Go**, **Stop**, **Go** in *VmDas*, it will cause a second instance of WinADCP to run.

Click the **External Raw ADCP Data Screening** checkbox (see "VmDas User Exits," page 67 and Figure 16, page 72) to give an external user-supplied program access to the raw ADCP data before the initial screening. The user-supplied program is expected to read raw ADCP ensemble data from the .ENR file and write the modified ensembles to an .ENJ file. This occurs before *VmDas* performs its data screening (does not bypass it), and if additional screening by *VmDas* is desired, it may be enabled.

Click the **External Raw Nav Data Screening** checkbox (see "VmDas User Exits," page 67 and Figure 16, page 72) to give an external user-supplied program access to the raw NMEA data. Normally the *VmDas* NMEA data screening logic reads data from the .N1R/N2R raw NMEA data file, screens the data and averages the data between ADCP time stamps, then writes the averaged data out in binary format to a .NMS file. When this user exit option is enabled, the user-supplied program is expected to read data from the .N1R/N2R files, and write the modified data to a .N1J or N2J text file with the same NMEA format. The *VmDas* NMEA data screening and averaging functions will then read the NMEA data from the .N1J (or N2J) file instead of the .N1R (or N2R) file.

> **Suggested Setting.**
>
> If you want to view the data using *WinADCP*, select the **Launch WinADCP** box. Enter the path to the *WinADCP* program using the **Browse** button. *VmDas* will automatically enter the default path.
>
> Select what file you want to view in the **Data File to Open** drop-down list.
>
> Select a **Refresh Rate**. The *WinADCP* program will check *VmDas* for new data based on the **Refresh Rate.**

4.2.9 Simulated Inputs Tab

Use the simulated data files to help learn how to use *VmDas* or to test the User Exits.

NOTE. Enabling the simulated data will automatically disable the serial port communications setting for the corresponding items on the communication setup tab.

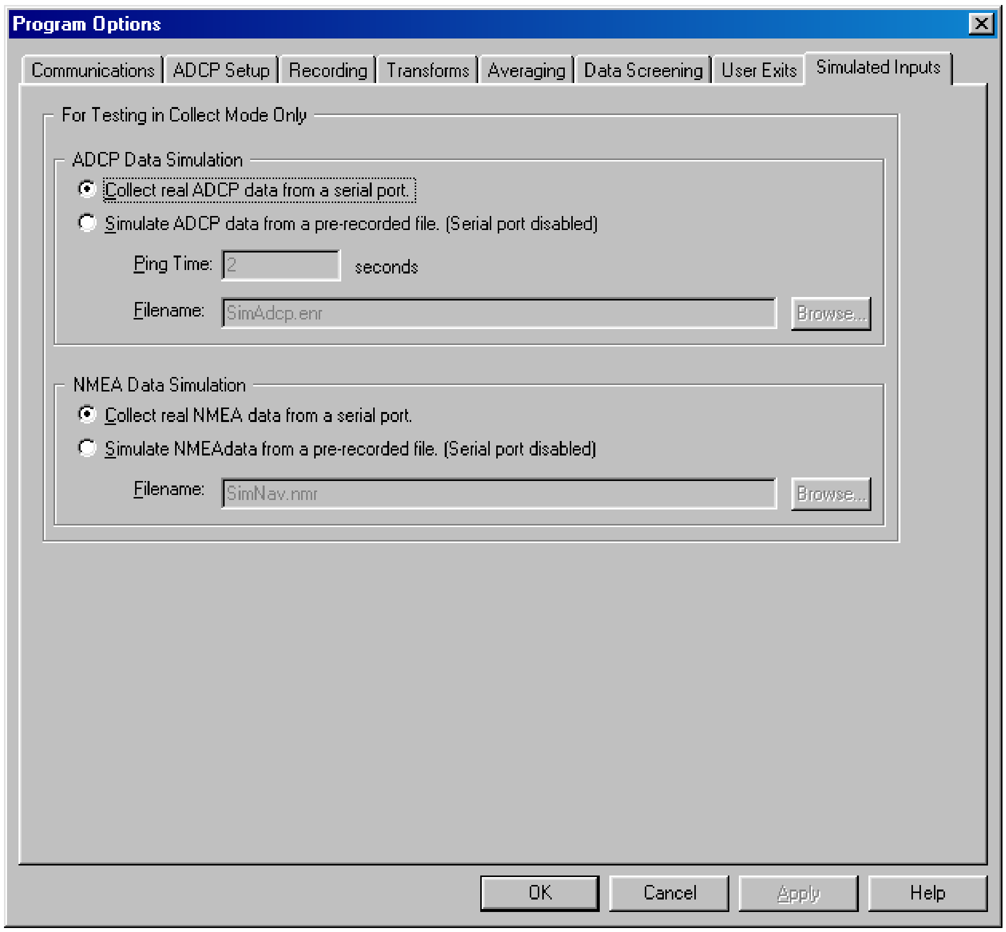


Figure 14. Simulated Inputs Tab

4.3 Command Files

This page shows the direct ADCP commands that correspond to the fields set in the **ADCP Setup Options**, on the **ADCP Setup** tab. You can refer to the ADCP Technical Manual for more information on these direct ADCP commands. See "VmDas ADCP Initialization," page 42 for details on how the ADCP commands are generated and sent to the ADCP.

To create your own command file, do the following.

a. Open one of the default command files (see Table 2, page 8) in NotePad or a similar type of text editor.

b. On the **File** menu, click **Save AS**. Give the command file a unique name.

c. Edit the commands as needed. Refer to the ADCP Technical Manual for detailed information on each command. You may want to *add* commands, but ***do not delete*** any command. The commands shown in the default command file are all ***required***.

NOTE. Use the **ADCP Setup** tab to set the ADCP commands. Select either **Use Options** to set the ADCP commands on this tab or select **Use File** to use a command file (see "Load a Command File," page 8).

Ensemble Time must always be set on this tab.

NOTE. The default command files have comments that explain the function of each command. It is a good idea to keep the comments and edit them when you make command changes.

CAUTION. In order for *VmDas* to perform correctly, your command file must use **single ping** (WP1, NP1, BP1) **beam** data (EX00000). See "*VmDas* ADCP Initialization," page 42 for details on how commands are sent to the ADCP.

The following shows the printout of the default command file OS38BBDEF.txt.

```
;----------------------------------------------------------------------------\
; ADCP Command File for use with VmDas software.
;
; ADCP type:      38 Khz Ocean Surveyor
; Setup name:     default
; Setup type:     High resolution, short range profile(broadband)
;
; NOTE:  Any line beginning with a semicolon in the first
;        column is treated as a comment and is ignored by
;        the VmDas software.
;
; NOTE:  This file is best viewed with a fixed-point font (eg. courier).
;----------------------------------------------------------------------------/

; Restore factory default settings in the ADCP
cr1
```

```
; set the data collection baud rate to 115200 bps,
; no parity, one stop bit, 8 data bits
; NOTE:  VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb811

; Set for broadband profile mode, single-ping ensembles,
; forty 24 meter bins, 16 meter blanking distance, 390 mm/s ambiguity vel
NP0
WP00001
WS2400
WF1600
WN040
WV390

; Enable single-ping bottom track,
; Set maximum bottom search depth to 2000 meters
BP001
BX20000

; Output velocity, correlation, echo intensity, percent good
WD111100000

; Two seconds between bottom and water pings
TP000200

; Four seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas ADCP Setup tab
TE00000400

; Set to calculate speed-of-sound, no depth sensor,
; External synchro heading sensor, use internal
; transducer temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000

; Set transducer depth to zero
ED00000

; save this setup to non-volatile memory in the ADCP
CK
```

NOTE. These files have been setup for shipboard use. They can also be used for stationary systems (such as Oil Rig platforms) but you must first open the file (right click on file and select open) and modify the EZ command from EZ1020001 to EZ1111111. This new setting will enable the use of the internal heading, pitch, and roll sensors.

4.3.1 *VmDas* ADCP Initialization

The following section explains how *VmDas* sends the commands to the ADCP.

4.3.2 Choosing Setup Parameters

When *VmDas* **Collect** mode starts, one part of the process is to initialize the ADCP. Sending commands to the ADCP is a major part of the process.

Some commands are generated by *VmDas* from setup data taken from various tabs of the **Edit User Options** dialog box. Others are read from a command file. This can lead to conflicts and confusion.

Exactly which commands must be sent depends on the type of ADCP being initialized. *VmDas* currently recognizes the following types of ADCPs: Broadband (**BB**), Workhorse (**WH**), and Ocean Surveyor (**OS**). If *VmDas* does not recognize the ADCP type but the data format is correct, it will display Unknown (**UN**).

NOTE. For *VmDas* purposes, a Navigator is a BroadBand ADCP.

4.3.3 Using the ADCP Setup Options

VmDas presents an easy interface for making some setup choices in the **ADCP Setup Options** dialog. Most of them are on the **ADCP Setup** tab. The serial port settings are on the **Communications** tab.

The **ADCP Setup** tab options are used only to initialize the ADCP. They do not have anything to do with how *VmDas* processes or displays data. They only control what data the ADCP collects and makes available.

NOTE. The options dialog does not completely control initialization.

4.3.4 Using a ADCP File Option

Advanced users can define a command file in the **ADCP Setup** tab for more flexibility in initializing the ADCP.

NOTE. The command file does not completely control initialization.

4.3.5 Interactions

VmDas generates some required commands without input from the **Edit User Options** dialog or a command file.

Use the **ADCP Setup** tab to setup the ADCP. Select either **Use Options** to set the ADCP commands on this tab or select **Use File** to use a command file (see "Load a Command File," page 8). **Ensemble Time** must always be set on this tab.

> **NOTE.** If a command is not sent to the ADCP through either the **Use Options** or **Use File**, the setting the ADCP had on wakeup are used.

4.3.6 Automatically Generated Commands

Some commands must be sent to the ADCP for proper functioning of *VmDas*. *VmDas* always generates these commands.

Manual pinging

VmDas generates a CF 0111x command, where x indicates that the last bit is unchanged from its current setting. This bit controls the recorder.

This setup places the ADCP in a Manual Ensemble mode. A Manual Ensemble mode means that *VmDas* will control the timing of ADCP ensembles and therefore the ADCP TE command is ignored. *VmDas* sets up the ADCP for single ping Water Profile and single ping Bottom Track (if Bottom Track is required). Because of this setting, the ADCP ensemble can be thought of as a ping and thus manual pinging.

Beam coordinates

VmDas generates an EX00000 command. This places the ADCP in Beam Coordinates. With the ADCP in Beam Coordinates, *VmDas* is able to perform the transformations to Earth Coordinates. The advantage of this is *VmDas* can interface with external Heading, Pitch, and Roll sensors and therefore it can be setup to use either the internal or external input for this information.

Magnetic corrections

VmDas generates an EA0 and EB0 command (for an Ocean Surveyor, an EV0 command will be generated instead of the EB0 command).

To set the Magnetic Offset or transducer Alignment Error offsets you must use the **Transforms** tab.

4.3.7 Commands and How They are Generated

The **ADCP Setup Options** can generate some commands, but only generates the command if the proper check boxes are checked. If the boxes are checked then the commands created will be sent.

If the **ADCP File Option** generates the commands, it is important to put them in the command file correctly. Several default command files are provided with *VmDas*. If you change or add commands refer, to your ADCP Technical Manual for proper command syntax. Some of the problems that can arise are not obvious. For example, since data is in beam coordinates, it is important not to average data in the ADCP unless the ADCP is in a fixed orientation. This means that the WP command must be WP1 or in the case of the Ocean Surveyor, a NP1 command may be used. The BP command must be BP0 to disable bottom tracking, or BP1 to enable it.

If a command generates an error in the ADCP, the rest of the command file will not be processed. *VmDas* will warn the user and continue initialization.

The commands that can be generated by each check box in the **ADCP Setup Options** are listed below.

Set Profile Parameters

> **NOTE.** These commands are only generated if the **Set Profile Parameters** box is checked (see "ADCP Setup Tab," page 27).

The WN (Number of Bins), WS (Bin size), WF (Blank Distance), and ED (Transducer Depth) commands are generated from data in the **Set Profile Parameters** controls. For an Ocean Surveyor in Narrow Bandwidth Profiling mode, this would be the NN, NS, NF, and ED commands instead.

Set Processing Mode

> **NOTE.** These commands are only generated if the **Set Processing Mode** box is checked (see "ADCP Setup Tab," page 27).

If Hi-resolution (short range) option is selected,

- For Workhorse ADCPs, WP1, WM1, WB0, and WV480 are generated.
- For BroadBand ADCPs, WP1, WM1, WB0, and WV650 are generated.
- For Ocean Surveyor ADCPs, NP0 and WP1 are generated. This sets the Ocean Surveyor to Broad Bandwidth Profiling mode.
- For all others, no commands are generated

If Low-resolution (long range) option is selected,

- For Workhorse and BroadBand ADCPs, WP1, WM1, WB1, and WV330 are generated.
- For Ocean Surveyor ADCPs, NP1 and WP0 are generated. This sets the Ocean Surveyor to narrow Bandwidth Profiling mode.
- For all others, no commands are generated

Set BT On/Off

> **NOTE.** These commands are only generated if the **Set BT On/Off** box is checked (see “ADCP Setup Tab,” page 27).

If **Off** is selected, a BP0 command is generated. If **On** is selected, a BP1 command is generated and a BX command is generated from data in the control box.

Some Workhorse ADCPs do not support bottom tracking. The BP command will fail on those Workhorses. This is OK if the **ADCP Setup Options** generates the BP command, but a failed command in the command file aborts processing of the command file. The BP command should be removed from the command file in this case.

Heading/Tilt Sensor

> **NOTE.** These commands are only generated if the **Set Sensor Type** box is checked (see “ADCP Setup Tab,” page 27).

If either check box is checked, an EZ command is generated. The current EZ setting is read and used to generate the new command. Only the heading and tilt source are changed.

4.3.8 Serial Port Setup

The port settings on the **Communications** tab control only the PC serial port, not the ADCP serial port. The PC serial port parameters must be set to match the settings the ADCP will use when it wakes up.

It is possible to change the ADCP serial port settings in a command file with a CB command. *VmDas* will detect this command and hold it until all other command file commands are executed. Then *VmDas* sends the CB command and makes the same change in the PC serial port.

This is done because the command file might include a CK command to store the ADCP current settings in non-volatile memory. This makes sure that the CB command is done after the CK command. The next time the ADCP wakes up, it will have the same serial port settings as before, and the current *VmDas* serial port options will still work.

> **NOTE.** Typically the ADCP internal serial port settings is set to 9600 Baud, no parity, 8 data bits, and 1 stop bit.

4.3.9 Detailed ADCP Initialization Procedure

a. Open the serial port using the settings from the **Communications** tab.

b. Send a break.

c. Interpret the ADCP's response to the break to determine what kind of ADCP is present.

d. For **OS**, Initialize the ADCP time to the PC time with a TS command.

e. If a command file is selected, copy it to the ADCP one line at a time with the following caveats.

- Letters are converted to upper case.
- Comments (lines starting with ;) are removed.
- CS (Start Pinging) and CZ (Power Down) commands are not sent.
- Baud rate commands (CB) are held until all other commands in the file have been sent
- After each line, a check is done for an error message from the ADCP. If one is found, no further commands from the file are sent. Initialization will start over.
- Immediately after sending a CB command, change the PC serial port parameters to match the new ADCP parameters.

f. For **BB** and **WH**, read the beam-to-instrument transformation matrix. Write it to a log on the hard disk.

g. Send commands from the **ADCP Setup** tab and a few that must be sent in any case. Each check box on the **ADCP Setup** tab enables choices to configure a particular set of commands. If the check box is unchecked, the **ADCP Setup** tab will not generate the commands, and the current ADCP settings will be used.

Bottom track

- If the **Set BT On/Off** check box is unchecked, nothing is sent.
- If **Off** is selected, BP0 is sent.
- If **On** is selected, BP1 and a BX command created from the **ADCP Setup** tab maximum range is sent.

Processing Mode

- If the **Set Processing Mode** check box is unchecked, nothing is sent.
- Different commands are sent to different types of ADCP, as shown in the tables below.
- If Hi-resolution (short range) option is selected, the following commands are sent.

Command	Command Description	ADCP Type
NP0	NB mode Pings per Ensemble	OS
WP1	Pings per Ensemble	OS,BB,WH
WM1	WT Profiling Mode	BB,WH
WB0	Mode 1 WT Bandwidth	BB,WH
WV650	WT Mode 1 Ambiguity Velocity	BB
WV480	WT Mode 1 Ambiguity Velocity	WH
<none>		All others

- If Low-resolution (long range) option is selected, the following commands are sent.

Command	Command Description	ADCP type
WP0	Pings per Ensemble	OS
NP1	NB mode Pings per Ensemble	OS
WP1	Pings per Ensemble	BB,WH
WM1	WT Profiling Mode	BB,WH
WB1	Mode 1 WT Bandwidth	BB,WH
WV330	WT Mode 1 Ambiguity Velocity	BB, WH
<none>		All others

Profile Parameters

- If the **Set Profile Parameters** check box is unchecked, nothing is sent.
- For Ocean Surveyor only, no commands are sent unless it is in either NP1 or WP1 mode.
- For Ocean Surveyor in NP1 mode, the following commands are constructed and sent.

Command	ADCP setup tab data source
NN	Number of Bins
NS	Bin Size
NF	Blank Distance
ED	Transducer Depth

- For Ocean Surveyor in WP1 mode or any other type of ADCP, the following commands are constructed and sent.

Command	ADCP setup tab data source
WN	Number of Bins
WS	Bin Size
WF	Blank Distance
ED	Transducer Depth

CF command

- This command is always sent.
- The current CF setting is read. A new command is generated using the last bit (the recorder bit) of the current setting.
- CF 0111x is sent.

Remaining commands

- Heading and Tilt Sensor Source
    - If either the Heading or Tilt **ADCP Setup** tab check box is checked, the current EZ command is read. A new EZ command is generated and sent with the heading and tilt characters set from the **ADCP Setup** tab settings.
    - Otherwise, nothing is sent.
- Heading alignment. EA0 is always sent.
- Heading bias.
    - This is always sent.
    - For all non-Ocean Surveyor type ADCPs, EB0 is sent.
    - For Ocean Surveyor ADCPs, early versions use the EB command others use the EV command. EV0 is sent. If that generates an error, EB0 is sent.
- Beam coordinates. EX00000 is always sent.

4.4 Reprocessing Data with *VmDas*

a. Start *VmDas*. Click **File**, **Reprocess Data**.

b. Browse and locate the *.vmo file for the data you wish to reprocess. Click **Open** (see "File Naming Conventions," page 73).

c. Click **Options**, **Edit Data Options**.

d. Click the **Recording** tab (see "Recording Tab," page 29).

- Enter the Name of the data set you wish to reprocess.
- Enter the Number of the data set you wish to reprocess.

e. Click the **Transforms** tab (see "Transforms Tab," page 31).

- Leave the settings for the **Transform Type**, **Sensor Configuration**, **Orientation**, and **Beam Angle** as selected.
- The **Heading Source** needs to be selected for the input you intend to use. If you will use the gyro heading being fed into the ADCP real time then leave it selected to ADCP.
- The **Tilt Source** needs to be selected for the input you intend to use.

f. Click the **Averaging** tab (see "Averaging Tab," page 33).

- Enter a time value for the **First Time Interval.** This is the Short Term Average (which will become file name with a *.sta extension). Enter a time value for the **Second Time Interval.** This is the Long Term Average (which will become file name with a *.lta extension). You can set these to any times you like and they may even be the same.

g. Click the **Data Screening** tab.

- You are able to screen data based on the items in this menu and the thresholds you decide. This screening will affect what is displayed on the screen and what data is recorded to the *.sta and *.lta files. The original raw data will be unaffected by what is setup here.

h. Save the User Option file by clicking **Options**, **Save As**.

- Enter a file name for the *.ini file that you have just created.

i. To start data reprocessing, on the **Control** menu, click **Go**.

4.5 Playback a Data File

a. Start *VmDas*. Click **File**, **Playback Data**.

b. Browse and locate the data file for the data you wish to view. Click **Open**.

> **NOTE.** *VmDas* will automatically search for *.enr, *.enx, *.sta, and *.lta files.
>
> In order to view files that use other naming conventions, the user can either type the file name directly into the **File name** field of the **Open File** dialog box, or click in the **Files of type** box to select the **All files (*.*)** filter from the drop-down list.

c. On the Playback Tool Bar, click **Play**.

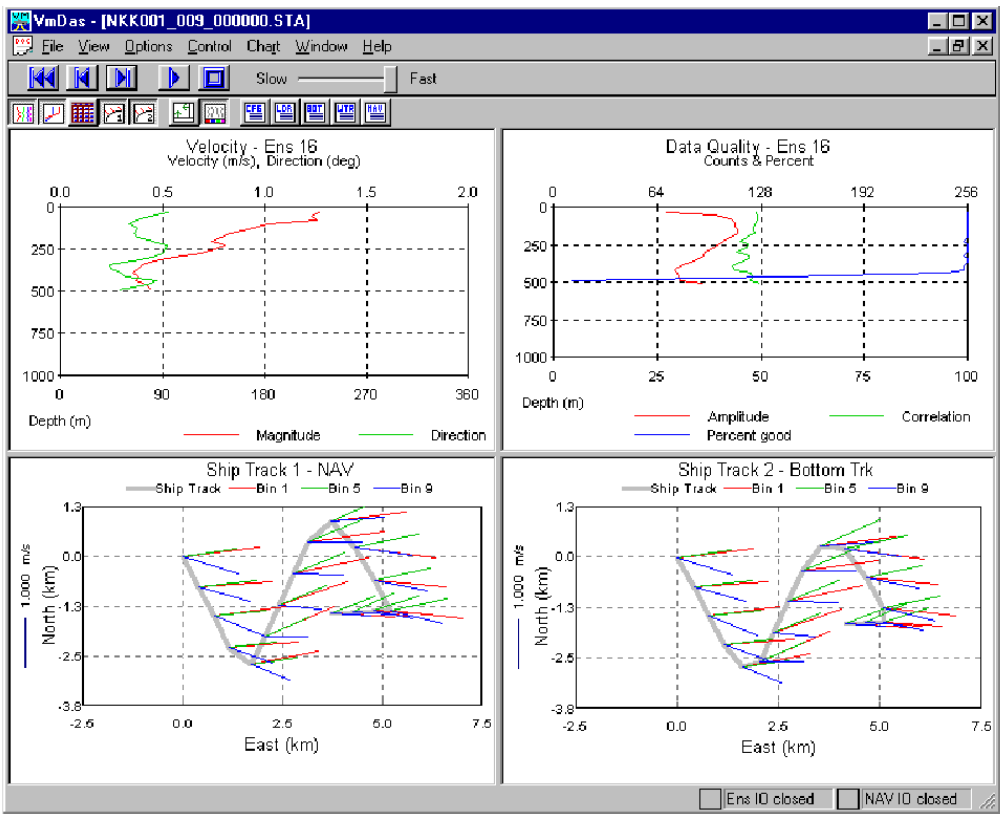


Figure 15. Playing Back a Data File

5 *VmDas* and NMEA Data

VmDas can read in, decode, and record ensembles from an ADCP and NMEA data from some specific (i.e. GPS and attitude sensors) external devices. *VmDas* stores this data in both raw data files (leaving all original data input in its original format) and in a combined, averaged data file. *VmDas* uses all of this data to create different displays for the user.

As well as being able to input NMEA strings to *VmDas*, it can produce NMEA output strings of speed log information. The speed log contains VDVBW (ground/water speed), VDDBT (depth), VDHDT (Heading True), and VDZDA (UTC Time and Date).

5.1 General NMEA Data Format

Much of the following information was abstracted from the NMEA 0183 standard. Discussion is limited to NMEA strings that *VmDas* understands. All NMEA messages are ASCII strings with the general format as shown in Table 3.

Table 3: NMEA Data Format

String	Description
$	HEX 24 – start of sentence
<Address field>	Approved address fields consist of five characters defined by the NMEA 0183 standard. The first two characters are the TALKER identifier. The next three characters identify the message. The proprietary address field consists of the proprietary character “P” followed by a three-character Manufacturer’s Mnemonic Code, used to identify the TALKER issuing a proprietary sentence, and any additional characters as required. (*VmDas* accepts any two valid characters as the TALKER identifier in approved address fields.) (RD Instruments uses the RDI Mnemonic Code for proprietary address fields, even though it is assigned to Radar Devices. *VmDas* also uses the unassigned ADC Mnemonic Code for its own data files).
[“,”<data field>] . . . [“,”<data field>]	Zero or more data fields, each preceded by a “,” (comma, HEX 2C) delimiter. The number of data fields and their content are determined by the address field. Data fields may be null (contain no characters). The comma delimiter is required even when a data field is null.
[“*”checksum field]	Checksum The checksum is the 8-bit exclusive OR (no start or stop bits) of all characters in the sentence, including “,” delimiters, between but not including the “$” and the “*” delimiters. The hexadecimal value of the most significant and least significant 4 its of the result are converted to two ASCII characters (0-9, A-F) for transmission, The most significant character is transmitted first.
<CR><LF>	HEX 0D 0A – End of sentence

Data Fields

Detailed descriptions of each message *VmDas* uses are provided below. These descriptions use format specifiers for data fields. The meanings of some of the format specifiers are listed in Table 4.

Table 4: Data Fields

Field	Description
hhmmss.ss	A mixed fixed/variable length time field. 2 fixed digits of hours, 2 fixed digits of minutes, 2 fixed digits of seconds, and a variable number of digits for decimal-fraction of seconds. Leading zeros are always included for hours, minutes, and seconds to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
x.x	A variable length integer or floating numeric field with optional leading and trailing zeros. The decimal point and associated decimal-fraction are optional if full resolution is not required. (example: 73.10 = 73.1 = 073.1 = 73). A negative sign "-" (HEX 2D) is the first character if the value is negative. The sign is omitted if value is positive.
hh	A fixed length HEX number. The most significant digit is on the left.
a aa aaa etc.	A fixed length alpha field. This type of field contains a fixed number of upper-case or lower-case alpha characters. In all strings recognized by *VmDas*, all these fields have a length of one character.
x xx xxx etc.	A fixed length numeric field. This type of field contains a fixed number of numeric characters (0 - 9). Some fields allow negative values. If needed, a negative sign "-" (HEX 2D) is the first character, increasing the length of the field by one. The sign is omitted if value is positive.
A	A single character status field. A = Yes, Data Valid, or Warning Flag Clear. V = No, Data Invalid, or Warning Flag Set.
Other single letter	A single character field with fixed content. The letter is the content of the data field. When used below, the HEX value of the letter is also given.

NOTES. Spaces should not be used anywhere in these NMEA strings. Spaces may only be used in variable text fields. No NMEA string recognized by *VmDas* uses a variable text field.

If data is not available or unreliable, a null field is used. A null field is a field with no characters in it. When a null field is present, two delimiters (comma, *, or <CR>) are found side by side. A null field does NOT contain the zero character (HEX 30), the ASCII NUL character (HEX 00), a space (HEX 20), or other character.

VmDas ignores some fields when it decodes messages. The fields it reads are explained in "NMEA Input," page 53.

5.2 NMEA Input

The messages *VmDas* reads are standard GGA, HDG, HDT, VTG messages, and a proprietary PRDID message.

VmDas data files may contain the proprietary PADCP message. *VmDas* generates this message and uses it internally. It is expected to be of no use externally, and is not transmitted to other devices. It is stored in the *.N1R and *.N2R data files.

5.2.1 GGA – Global Positioning System Fix Data

Time, position, and fix related data for a GPS receiver.

$__GGA,hhmmss.ss,llll.ll,a,yyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF>

Table 5: GGA NMEA Format

Field		Description
1*	hhmmss.ss	UTC of position - 2 fixed digits of hours, 2 fixed digits of minutes, 2 fixed digits of seconds, and a variable number of digits for decimal-fraction of seconds. Leading zeros are always included for hours, minutes, and seconds to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
2*	llll.ll	Latitude - Two fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal-fraction of minutes. Leading zeros are always included for degrees and minutes to maintain fixed length of the first 4 chars. The decimal point and associated decimal-fraction are optional if full resolution is not required.
3*	a	Latitude hemisphere. N or S.
4*	yyyy.yy	Longitude - 3 fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal-fraction of minutes. Leading zeros are always included for degrees and minutes to maintain fixed length of the first 5 chars. The decimal point and associated decimal-fraction are optional if full resolution is not required.
5*	a	Longitude hemisphere. E or W.
6*	x	GPS Quality indicator: 0 = fix not available or invalid 1 = GPS fix 2 = Differential GPS fix 3 = GPS PPS Mode, fix valid 4 = Real Time Kinematic. System used in RTK mode with fixed integers 5 = Float RTK. Satellite system used in RTK mode, floating integers 6 = Estimated (dead reckoning) mode 7 = Manual Input Mode 8 = Simulator mode This shall not be a null field.
7	xx	Number of satellites in use, 00 – 12, may be different from the number in view
8	x.x	Horizontal dilution of precision
9	x.x	Antenna altitude above/below mean-sea-level (geoid)
10	M	HEX 4D. Units of antenna altitude, meters
11	x.x	Geoidal separation. The difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid), "-" = mean-sea-level below ellipsoid.
12	M	HEX 4D. Units of geoidal separation, meters
13	x.x	Age of Differential GPS data. Time in seconds since last SC104 Type 1 or 9 update, null field when DGPS is not used.
14	xxxx	Differential reference station ID, 0000-1023

* This field is used by *VmDas*.

5.2.2 HDG – Heading, Deviation, and Variation

Heading (magnetic sensor reading), which if corrected for deviation, will produce Magnetic heading, which if offset by variation will provide True heading.

$__HDG,x.x,x.x,a,x.x,a*hh<CR><LF>

Table 6: HDG NMEA Format

Field		Description
1*	x.x	Magnetic sensor heading, degrees
2*	x.x	Magnetic deviation, degrees
		This field and the following direction field are null if deviation is unknown.
3*	a	Direction of magnetic deviation. E or W.
4*	x.x	Magnetic variation, degrees
		This field and the following direction field are null if variation is unknown.
5*	a	Direction of magnetic variation. E or W.

* This field is used by *VmDas*.

To obtain Magnetic Heading:

a. Add Easterly deviation (E) to Magnetic Sensor Reading.

b. Subtract Westerly deviation (W) from Magnetic Sensor Reading.

To obtain True Heading:

a. Add Easterly variation (E) to Magnetic Heading.

b. Subtract Westerly variation (W) from Magnetic Heading.

5.2.3 HDT – Heading – True

Actual vessel heading in degrees True produced by any device or system producing true heading.

$__HDT,x.x,T *hh<CR><LF>

Table 7: HDT NMEA Format

Field		Description
1*	x.x	Heading, degrees True
2	T	HEX 54

* This field is used by *VmDas*.

5.2.4 VTG – Track Made Good and Ground Speed

The actual track made good and speed relative to the ground.

$__VTG,x.x,T,x.x,M,x.x,N,x.x,K,a*hh<CR><LF>

Table 8: VTG NMEA Format

Field		Description
1*	x.x	Track, degrees true
2	T	HEX 54
3*	x.x	Track, degrees magnetic
4	M	HEX 4D
5	x.x	Speed, knots
6	N	HEX 4E
7*	x.x	Speed, km/hr
8	K	HEX 4B
9	a	Mode indicator A=Autonomous mode D=Differential mode E=Estimated (dead reckoning) mode M=Manual input mode S=Simulator mode N=Data not valid This shall not be a null field.

* This field is used by *VmDas*.

5.2.5 $PRDID

RDI defines a proprietary NMEA message that contains ship heading, pitch, and roll data.

$PRDID,x.x,x.x,x.x,*hh<CR><LF>

Table 9: PRDID NMEA Format

Field		Description
1*	x.x	Vessel Pitch, degrees. + = bow up.
2*	x.x	Vessel Roll, degrees. + = port up.
3*	x.x	Vessel Heading, degrees True

* This field is used by *VmDas*.

5.2.6 Reading NMEA Data

NMEA input is not required. *VmDas* can just collect ensembles from an ADCP. If NMEA data is to be used, options must be set in the communications tab to configure the serial ports to read the data (up to two serial ports are available).

Each enabled port logs all data that arrives. The Navigation port logs to a file with an N1R extension. The RPH port uses an N2R extension. The ports are not interchangeable. *VmDas* expects certain data at each one. Any unexpected NMEA messages will be logged, but not processed further.

If only one port is enabled, it must be the Navigation port. When used alone, this port will process any GGA, HDG, HDT, VTG, and PRDID messages it receives.

If two ports are enabled, *VmDas* expects GPS data (GGA, VTG) at the Navigation port, and attitude data (HDG, HDT, PRDID) at the RPH port.

VmDas internally generates PADCP messages and adds them to both log files. These messages are expected to have meaning only to *VmDas*.

5.3 NMEA Output

5.3.1 $VDDBT – Depth Below Transducer

Water depth referenced to the transducer

$VDDBT,x.x,f,x.x,M,x.x,F*hh<CR><LF>

Table 10: VDDBT NMEA Format

Field		Description
1	x.x	Water depth, feet
2	f	HEX 66
3	x.x	Water depth, Meters
4	M	HEX 4D
5	x.x	Water depth, Fathoms
6	F	HEX 46

5.3.2 $VDHDT – Heading – True

Actual vessel heading in degrees True.

$VDHDT,x.x,T*hh<CR><LF>

Table 11: VDHDT NMEA Format

Field		Description
1	x.x	Heading, degrees True.
2	T	HEX 54

5.3.3 $VDVBW – Dual Ground/Water Speed

Water referenced and ground referenced speed data.

$VDVBW,x.x,x.x,A,x.x,x.x,A*hh<CR><LF>

Table 12: VDVBW NMEA Format

Field		Description
1	x.x	Longitudinal water speed, knots. "-" = astern.
2	x.x	Transverse water speed, knots. "-" = port.
3	A	Status: water speed, A = Data valid, V = Data invalid.
4	x.x	Longitudinal ground speed, knots. "-" = astern.
5	x.x	Transverse ground speed, knots. "-" = port.
6	A	Status: ground speed, A = Data valid, V = Data invalid.

5.3.4 $VDZDA – Time and Date

UTC, day, month, year, and local time zone.

$VDZDA,hhmmss.ss,xx,xx,xxxx,xx,xx*hh<CR><LF>

Table 13: VDZDA NMEA Format

Field		Description
1	hhmmss.ss	UTC
2	xx	Day, 01 – 31.
3	xx	Month, 01 – 12.
4	xxxx	Year
5	xx	Local time zone description. –13 to 13 hours. The number of whole hours added to local time to obtain GMT. Zone description is negative for East longitudes.
6	xx	Local time zone minutes description. –59 to 59 minutes. The number of whole minutes added to local time to obtain GMT. This permits a finer resolution time zone description than is possible using hours alone. The sign is the same as the hour time zone description. *VmDas* produces a null field here.

5.3.5 Writing NMEA Data

VmDas writes strings formatted as described in the NMEA 0183 standard to a serial port, a TCP/IP port, or both.

NOTE. This is not in keeping with NMEA standards. The NMEA 0183 standard specifies that strings are to be transmitted through a serial port. The NMEA 2000 standard is being developed for transmitting similar data over a network. *VmDas* does not support the NMEA 2000 standard.

5.4 Internal NMEA Messages

RDI defines a proprietary NMEA message for *VmDas* internal use only that contains *VmDas* internal timing information.

5.4.1 $PADCP

This message is stored in *VmDas* N1R and N2R extension data files as a time stamp. It is not transmitted over any I/O port.

$PADCP, ens,yyyy,xx,xx,xx,xx,ss.ss,x.x*hh<CR><LF>

Table 14: PADCP NMEA Format

Field		Description
1	ens	Ensemble number. A variable length integer numeric field without leading zeros.
2	yyyy	Year, 4 digits, PC local time.
3	xx	Month, 01 – 12, PC local time.
4	xx	Day, 01 – 31, PC local time.
5	xx	Hours, 00 – 23, PC local time.
6	xx	Minutes, 00 – 59, PC local time.
7	ss.ss	Seconds and hundredths, 00.00 – 59.99, PC local time.
8	x.x	PC clock offset from UTC in seconds. –86399.99 to 86399.99.
		VmDas keeps track of the date/time of GGA messages by recording the date/time according to the PC clock when the message is read, and calculating the offset between the times in the PC clock and the GGA message. If the clock offset is added to a GGA message time, the result is a local PC time, The offset corrects for the difference in time zone between local PC time and GGA time (UTC) and any errors because the two clocks are not perfectly synchronized.
		If no GGA messages have been read, this field is null.

NOTES. This message is used to synchronize ensemble data and NMEA data.

The year, month, day, hour, minute, and second fields describe the time that a ping command was sent to the ADCP.

The ens field contains the number of the ensemble generated by the ping command.

5.5 Further Information About NMEA Strings

Users who need full details about NMEA data strings can find more information in the NMEA 0183 standard, available from the National Marine Electronics Association at.

P O Box 3435	252-638-2626 (voice)	nmea@coastalnet.com (e-mail)
New Bern, NC	252-638-4885 (fax)	http://www.nmea.org/ (web site)
28564-3435		

6 *VmDas* Outputs

VmDas can output Ensemble, Speed Log, and ASCII data out the serial port or through an Ethernet port.

6.1 Output Ensemble Data

Long term averaged ensemble data is output in the RDI standard binary ensemble (PD0) output format.

a. On the **File** menu, click **Collect Data**.

b. On the **Options** menu, click **Edit Data Options**. If you have created a User Option File, click **Load**.

c. On the **Communications** tab, select the **Long Term Avg Data Output** button.

d. To output the data to a serial port, click the **Enable Serial** box, and configure the serial port parameters, then click the **Set** button to apply the new configuration. Verify that the new settings appear in the **Current Settings** section.

e. To output the data to a network port, click the **Enable Network** box, and set the **Local IP Port** number. *VmDas* will be the server, and the local machine's IP address will be used automatically. After data collection has started, a remote client can request a TCP/IP connection using the specified port number and the IP address of the computer running *VmDas* to receive the data.

6.2 Output Speed Log Data

Speed log data output consists of the NMEA VBW and DBT messages, and is calculated from the short-term averaged data. Use the following procedure to enable speed log data output.

NOTE. Speed log data is not stored to a disk file. It is only sent to a serial port and/or an Ethernet port.

a. On the **File** menu, click **Collect Data**.

b. If you have created a User Option File, on the **Options** menu, click **Load**. Choose your file and click **OK**.

c. On the **Options** menu, click **Edit Data Options**.

d. On the **Communications** tab, select the **Speed Log Output** button. In the **Select Item to Set** box, choose **Speed Log Output**.

e. To output the data to a serial port, click the **Enable Serial** box, and configure the serial port parameters, then click the **Set** button to apply the new configuration. Verify that the new settings appear in the **Current Settings** section. Make sure the **On** box is checked.

f. To output the data to a network port, first choose an IP port number. *VmDas* uses 5434 by default, which should be fine for most users. Remote clients will need to know the IP port number and the IP address of the computer running *VmDas* to receive data.

Click the **Enable Network** box, and set the **Local IP Port** number. *VmDas* will use the local machine's IP address automatically. Click the **Set** button to apply the new configuration. Verify that the new settings appear in the **Current Settings** section. Make sure the **On** box is checked.

After data collection has started, a remote client can request a TCP/IP connection using the specified port number and the IP address of the computer running *VmDas* to receive the data.

Tips for Advanced Users

Advanced users can get more control over the Speed Log data by using the following tips.

Speed Log data will only be output if the serial and/or Ethernet port(s) are configured for that purpose.

- If a port is configured for speed log output, speed log output will be produced. If there is no data or the data is invalid, the NMEA messages will indicate that they contain invalid data.

The data will only be received if something is listening to the port(s). This requires a cable and usually a second computer.

- One device may listen to a serial port. When sending speed log data out an Ethernet port, *VmDas* is a TCP/IP server and supports up to 100 clients.

Speed log data is calculated from ensembles in the short-term averaged data. There will be one VBW and one DBT message for each short-term average ensemble.

- To control the time between messages, on the **Options** menu, click **Edit Data Options**, choose the **Averaging** tab, and change the **First Time Interval**.

The speed log will contain valid data only if the ADCP is configured to produce the data. The data comes from the bottom track field in the short-term average data.

- The VBW message will contain water speed data only if the ADCP has been configured to produce water reference layer data. The BK and BL commands are useful here.

- The VBW message will contain bottom speed data only if the ADCP has been configured to produce bottom velocity data. The BP command is useful here.
- The DBT message will contain depth data only if the ADCP has been configured to produce bottom track range data. This data is present whenever bottom track data is being produced, and the bottom is in range. The BP and BX commands are useful here.
- The Options on the ADCP Setup tab can override the BP and BX commands in a command file. To use the ADCP defaults for these commands or to set them from a command file, the Set BT On/Off box must be unchecked.

6.3 Output ASCII Ensemble Data

ASCII-out files contain a fixed format of text. You can then use these files in other programs (spreadsheets, databases, and word processors).

a. On the **File** menu, click **Collect Data**.

b. On the **Options** menu, click **Edit Data Options**. If you have created a User Option File, click **Load**.

c. On the **Communications** tab, select the **Ensemble Output (ASCII)** button.

d. To output the data to a serial port, click the **Enable Serial** box, and configure the serial port parameters, then click the **Set** button to apply the new configuration. Verify that the new settings appear in the **Current Settings** section.

e. To output the data to a network port, click the **Enable Network** box, and set the **Local IP Port** number. *VmDas* will be the server, and the local machine's IP address will be used automatically. After data collection has started, a remote client can request a TCP/IP connection using the specified port number and the IP address of the computer running *VmDas* to receive the data.

f. In the **Set Ensemble Output Configuration Here** section, check the box for each type of data within the ensemble that you want output. In the **Data Select** box, select the desired data source. In the **Velocity Ref** box, select the desired reference velocity to be applied to the profile data. In the **Output** column, select the desired depth cell range to output by setting the **Start Bin** and **End Bin**. If **Mean** is selected as the velocity reference, then in the **Mean** column, select the desired depth cell range to use as the reference velocity by setting the **Start Bin** and **End Bin**.

6.3.1 ASCII Ensemble Output Format

This section explains the format of the data sent from the ADCP to the ensemble-out serial device after each ADCP ensemble. Sending ensemble-out data is an option in the **Options**, **Program Options**, **Communications Setup** menu. You set the communications protocol and select the data to send to the ensemble-out device through the **Communication** options. Ensemble-out data are in ASCII with fixed field lengths.

The transmission of ensemble-out data occurs after *VmDas* finishes recording ADCP data after each ADCP ensemble. The next section shows a sample ensemble-out data transmission. The first byte in the ensemble-out data stream is a START OF TEXT (^B) byte. This byte is also known as STX, ASCII character 2, or Control-B (^B). *VmDas* always sends the STX byte when data transmission begins. After the STX byte, *VmDas* sends a 2-byte flag that represents the data type that will be sent next. See "Ensemble-Out Data Format Description," page 63 for an explanation of all the flags and associated fields used in the ensemble-out data stream.

6.3.2 Sample Ensemble-Out Data Transmission

```
^B 0      96 91 10  2  9 54 30<CR/LF>
 1   4   4   1   4     0     0     0     0<CR/LF>
       6   -1375     -38      33<CR/LF>
     -23   -1453      -2      -3<CR/LF>
      85   -1465     -44     -52<CR/LF>
      49   -1464     -76      30<CR/LF>
 2   4 4   1   4<CR/LF>
     128     119     133     142<CR/LF>
     129     103     120     110<CR/LF>
     117     133     141     142<CR/LF>

     134     141     134     127<CR/LF>
 3   4 4   1   4<CR/LF>
     167     155     159     168<CR/LF>
     162     151     149     161<CR/LF>
     154     145     137     154<CR/LF>
     146     138     130     152<CR/LF>
 4   4 4   1   4<CR/LF>
     100     100     100     100<CR/LF>
     100     100     100     100<CR/LF>
     100     100     100     100<CR/LF>
     100     100     100     100<CR/LF>

 5   4 4   1   4<CR/LF>
 -32678 -32678 -32678 -32678<CR/LF>
 -32678 -32678 -32678 -32678<CR/LF>
 -32678 -32678 -32678 -32678<CR/LF>
 -32678 -32678 -32678 -32678<CR/LF>
 6  0  0  0  10  100  25  25  2  0  0  0  0  5000  25  0  0  0  2500  0  0  0  35  1480<CR/LF>
 7  2  4<CR/LF>
     -33   -1414     -62  -32768<CR/LF>
     833     878       0     783<CR/LF>
 8  13856000 -324937000    634   4786    425    470<CR/LF>

^C^B 0      97 91 10  2  9 55 00<CR/LF>
 1   4   4   1   4     0     0     0     0<CR/LF>
       7   -1373     -40      29<CR/LF>
     -19   -1456      -1      -4<CR/LF>
      89   -1462     -46     -51<CR/LF>
      48   -1466     -73      34<CR/LF>
 2   4 4   1   4<CR/LF>
     121     123     130     139<CR/LF>
     127     100     122     114<CR/LF>
     130     135     140     141<CR/LF>

     130     140     138     129<CR/LF>
 3   4 4   1   4<CR/LF>
     167     156     153     166<CR/LF>
     163     155     147     162<CR/LF>
     156     143     138     153<CR/LF>
     147     140     132     151<CR/LF>
```

```
 4   4 4   1   4<CR/LF>
     100     100     100     100<CR/LF>
     100     100     100     100<CR/LF>
     100     100     100     100<CR/LF>
     100     100     100     100<CR/LF>

 5   4 4   1   4<CR/LF>
 -32678 -32678 -32678 -32678<CR/LF>
 -32678 -32678 -32678 -32678<CR/LF>
 -32678 -32678 -32678 -32678<CR/LF>
 -32678 -32678 -32678 -32678<CR/LF>
 6  0  0  0  10  100  25  25  2  0  0  0  0  5000  25  0  0  0  2500  0  0  0  35  1480<CR/LF>
 7  2  4<CR/LF>
     -31   -1420     -58    -768<CR/LF>
     840     862     845     850<CR/LF>
 8  13857000 -324938000    634   4787    426    471<CR/LF>

^C
```

6.3.3 Ensemble-Out Data Format Description

Each ASCII ensemble-out data stream begins with a **Start Of Text** code <^B> and ends with an **End Of Text** code <^C>. *VmDas* identifies each data type with an integer flag. At least one space separates the fields within each data type. Each line of data ends with a carriage return <CR> and line feed <LF> sequence.

Table 15: Ensemble-Out Data Format

Flag	Field	Description
0	1	Flag 0 identifies the ensemble number just processed by the ADCP and the date/time that data collection for the ensemble began. The fields identified by this flag contain:
	2	The ensemble number just processed by the ADCP.
	3	The year data collection began for this ensemble.
	4	The month data collection began for this ensemble.
	5	The day data collection began for this ensemble.
	6	The hour data collection began for this ensemble.
	7	The minute data collection began for this ensemble.
	8	The second data collection began for this ensemble.
1	1	Flag 1 marks the start of velocity data. *VmDas* scales the water current velocity data in millimeters per second (mm/s). A value of -32768 indicates bad or missing data. *VmDas* lists water profile velocity data in columns beginning with the next output line. The fields identified by this flag contain:
	2	The number of bins selected for transmission.
	3	The number of beams used by the ADCP to collect the data. This value corresponds to the number of COLUMNS of data beginning with the next output line.
	4	The first bin selected for transmission in the Communication options.
	5	The last bin selected for transmission in the Communication options.
	6	The east(+)/west(-) water-current velocity of the reference layer if VELOCITY REF is set to BOTTOM or MEAN (Communication options).
	7	The north(+)/south(-) water-current velocity of the reference layer if VELOCITY REF is set to BOTTOM or MEAN (Communication options).

Continued Next Page

Table 15: Ensemble-Out Data Format (continued)

Flag	Field	Description
	8	The up(+)/down(-) water-current velocity of the reference layer if VELOCITY REF is set to BOTTOM or MEAN (Communication options).
	9	The error velocity of the reference layer if VELOCITY REF is set to BOTTOM or MEAN (Communication options).
	10	Column data for the east(+)/west(-) water-current velocities for the bin range selected in the Communication options.
	11	Column data for the north(+)/south(-) water-current velocities for the bin range selected in the Communication options.
	12	Column data for the up(+)/down(-) water-current velocities for the bin range selected in the Communication options.
	13	Column data for the error velocities for the bin range selected in the Communication options.
2	1	Flag 2 marks the start of correlation magnitude data. A value of -32768 indicates missing data. *VmDas* lists correlation data in columns beginning with the next output line. The fields identified by this flag contain:
	2	The number of bins selected for transmission.
	3	The number of beams used by the ADCP to collect the data. This value corresponds to the number of COLUMNS of data beginning with the next output line.
	4	The first bin selected for transmission in the Communication options.
	5	The last bin selected for transmission in the Communication options.
	6	Column data for the Beam #1 correlation data for the bin range selected in the Communication options.
	7	Column data for the Beam #2 correlation data for the bin range selected in the Communication options.
	8	Column data for the Beam #3 correlation data for the bin range selected in the Communication options.
	9	Column data for the Beam #4 correlation data for the bin range selected in the Communication options.
3	1	Flag 3 marks the start of echo intensity data. *VmDas* scales echo intensity data in ADCP counts. A value of -32768 indicates missing data. *VmDas* lists echo intensity data in columns beginning with the next output line. The fields identified by this flag contain:
	2	The number of bins selected for transmission.
	3	The number of beams used by the ADCP to collect the data. This value corresponds to the number of COLUMNS of data beginning with the next output line.
	4	The first bin selected for transmission in the Communication options.
	5	The last bin selected for transmission in the Communication options.
	6	Column data for the Beam #1 echo intensity data for the bin range selected in the Communication options.
	7	Column data for the Beam #2 echo intensity data for the bin range selected in the Communication options.
	8	Column data for the Beam #3 echo intensity data for the bin range selected in the Communication options.
	9	Column data for the Beam #4 echo intensity data for the bin range selected in the Communication options.

Table 15: Ensemble-Out Data Format (continued)

Flag	Field	Description
4	1	Flag 4 marks the start of percent-good data. *VmDas* scales percent-good data in percentage points (0-99). A value of -32768 indicates bad or missing data. *VmDas* lists percent-good data in columns beginning with the next output line. The fields identified by this flag contain:
	2	The number of bins selected for transmission.
	3	The number of beams used by the ADCP to collect the data. This value corresponds to the number of COLUMNS of data beginning with the next output line.
	4	The first bin selected for transmission in the Communication options.
	5	The last bin selected for transmission in the Communication options.
	6	Column data for the Beam #1 percent-good data for the bin range selected in the Communication options.
	7	Column data for the Beam #2 percent-good data for the bin range selected in the Communication options.
	8	Column data for the Beam #3 percent-good data for the bin range selected in the Communication options.
	9	Column data for the Beam #4 percent-good data for the bin range selected in the Communication options.
5	1	Flag 5 marks the start of status data. See *VmDas* STA and LTA Output Data Format for information on how status data are scaled. A value of -32768 indicates bad or missing data. *VmDas* lists status data in columns beginning with the next output line. The fields identified by this flag contain:
	2	The number of bins selected for transmission.
	3	The number of beams used by the ADCP to collect the data. This value corresponds to the number of COLUMNS of data beginning with the next output line.
	4	The first bin selected for transmission in the Communication options.
	5	The last bin selected for transmission in the Communication options.
	6	Column data for the Beam #1 status data for the bin range selected in the Communication options.
	7	Column data for the Beam #2 status data for the bin range selected in the Communication options.
	8	Column data for the Beam #3 status data for the bin range selected in the Communication options.
	9	Column data for the Beam #4 status data for the bin range selected in the Communication options.
6	1	Flag 6 marks the start of leader data. The fields identified by this flag contain:
	2	The minutes portion of the time between pings as set by the TP-command.
	3	The seconds portion of the time between pings as set by the TP-command.
	4	The hundredths of seconds portion of the time between pings as set by the TP-command.
	5	The number of pings per ensemble as set by the WP-command.
	6	The number of depth cells (bins) as set by the WN-command.
	7	The depth cell (bin) length in centimeters as set by the WS-command.
	8	The blank after transmit in centimeters as set by the WF-command.

Table 15: Ensemble-Out Data Format (continued)

Flag	Field	Description
	9	The ADCP profiling mode as set by the WM-command.
	10	The Built-In Test result code from the last ADCP ensemble.
	11	The sensor source as set by the EZ-command.
	12	The available sensors as read by the PS1-command.
	13	The low correlation threshold as set by the WC-command.
	14	The error velocity threshold in mm/s as set by the WE-command.
	15	The percent-good minimum as set by the WG-command.
	16	The average ADCP pitch (tilt 1, x-axis) angle in hundredths of degrees (e.g., -70 = -0.7°) during the ADCP data ensemble. This value comes from the internal pendulums or external gyrocompass.
	17	The average ADCP roll (tilt 2, y-axis) angle in hundredths of degrees (e.g., 430 = 4.3°) during the ADCP data ensemble. This value comes from the internal pendulums or external gyrocompass.
	18	The average ADCP heading angle in hundredths of degrees (e.g., 7707 = 77.07°) during the ADCP data ensemble. This value comes from the internal flux-gate compass or external gyrocompass.
	19	The average water temperature in hundredths of degrees C (e.g., 1711 = 17.11°C) at the transducer head during the ADCP data ensemble.
	20	The standard deviation (accuracy) of heading data in degrees during the ADCP data ensemble from the compass.
	21	The standard deviation (accuracy) of pitch (tilt 1, x-axis) data in tenths of degrees (e.g., 15 = 1.5°) during the ADCP data ensemble from the pendulum/gyrocompass.
	22	The standard deviation (accuracy) of roll (tilt 2, y-axis) data in tenths of degrees (e.g., 5 = 0.5°) during the ADCP data ensemble from the pendulum/gyrocompass.
	23	The salinity value in parts per thousand from the ADCP (ES or EZ-command).
	24	The speed of sound value in m/s from the ADCP (EC or EZ-command).
7	1	Flag 7 marks the start of bottom-track data. A value of -32768 indicates bad or missing velocity data. A zero indicates bad or missing beam range data. The fields identified by this flag contain:
	2	The number of lines of bottom-track data sent. This value corresponds to the number of ROWS of data beginning with the next output line.
	3	The number of beams used by the ADCP to collect the bottom-track data. This value corresponds to the number of COLUMNS of data beginning with the next output line.
	4	The east(+)/west(-) bottom-track velocity in mm/s.
	5	The north(+)/south(-) bottom-track velocity in mm/s.
	6	The up(+)/down(-) bottom-track velocity in mm/s.
	7	The bottom-track error velocity in mm/s.
	8	The Beam #1 range in meters to the bottom/surface, excluding ADCP depth.
	9	The Beam #2 range in meters to the bottom/surface, excluding ADCP depth.
	10	The Beam #3 range in meters to the bottom/surface, excluding ADCP depth.
	11	The Beam #4 range in meters to the bottom/surface, excluding ADCP depth.

Table 15: Ensemble-Out Data Format (continued)

Flag	Field	Description
8	1	Flag 8 marks the start of external navigation data collected by *VmDas*. A value of 2147483647 indicates bad or missing latitude/longitude data. A value of -32768 indicates bad or missing data for all other fields. The fields identified by this flag contain:
	2	Navigation device latitude in thousandths of seconds.
	3	Navigation device longitude in thousandths of seconds (-324937000 = W90°15'37").
	4	Navigation device speed in mm/s.
	5	Navigation device course in hundredths of degrees (4786 = 47.86°).
	6	The east(+)/west(-) navigation device velocity in mm/s.
	7	The north(+)/south(-) navigation device velocity in mm/s.

7 *VmDas* User Exits

The User Exit options in *VmDas* are hooks at various points in the processing where the user can modify the data with an external program.

- The first User Exit option selects a *VmDas* data file to be displayed using WinADCP.
- The second User Exit option allows a program to adjust RAW ADCP data that *VmDas* put in the *.ENR file.
- The third User Exit option allows a program to adjust RAW NMEA data that *VmDas* put in the *.N1R and *.N2R file.
- The fourth User Exit option allows a program to perform coordinate transformations.

For example, a User Exit could be used to translate all or part of a non-supported NMEA string (e.g. Ashtech's $GPPAT position and attitude NMEA string) into a supported string (e.g. RD Instruments $PRDID NMEA string).

NOTE. The last three user exits are enabled by clicking on their associated checkboxes in the **User Exits** tab. However, *VmDas* does not currently support automatic launching of these user exits. They must be launched independently before selecting **Go** on the **Control** menu in *VmDas*.

7.1 Tips and Tricks to Creating User Exit Programs

There are many non-supported NMEA string formats for position, heading, and pitch/roll devices. In order to use a non-supported NMEA string with *VmDas*, the user needs to create a User Exit program. The User Exit program needs to do the following:

- Opens the .N1R (or .N2R) file for input (the file may not exist right away, so it must clear the error condition and keep trying).
- Creates the .N1J (or .N2J) file for output.
- Read characters from the file until an end of line is found. It has to handle the fact that it will often see an End-Of-File condition, because the data may not be there yet, but it must clear the error condition and keep trying. The best way to do this might be to check the file status in a loop to get the current file size and detect when it changes.
- Each time it has read a complete line, decode and convert the non-supported NMEA string into a $xxHDT string (the first two letters could be anything, as *VmDas* doesn't care about the device ID).
- Write the new $xxHDT string out to the .N1J (or .N2J) file
- Repeat

This program can be written in any of several ways:

- DOS-type program written using Borland C, or Turbo Pascal, or other programs.
- Windows console program
- Visual Basic program
- Visual C++ program

In other words, you can use any development tool that can create a program that will read and write disk files on a PC running the Microsoft Windows® operating system.

7.2 Example 1 - Modifying Raw ADCP Data

VmDas writes the ADCP raw data into a file with the naming convention *.ENR. The format of this data is the ADCP raw binary data. The data file *.ENR is normally read in by the *VmDas* screening and filtering stage of the software. The output of this screening and filtering is then written into a file with the naming convention of *.ENS. A customer can set an option (via the **User Exit** tab) that will instruct the *VmDas* program to read in a file with the naming convention of *.ENJ instead of the *.ENR file.

This allows the customer to write their own program which can modify the data inside the *.ENR file in anyway as long as they write the data back out into a file with the same original data format as the *.ENR file except they rename the file *.ENJ. The *VmDas* program will read in the *.ENJ file and screen and process it as it would have the *.ENR file.

An example of why a customer may want to do this is that the customer wishes to screen the heading data that is read directly by the ADCP gyro interface board and output to the *.ENR data file. The customer could write a program that would read the heading data from the *.ENR file and compare that heading data to the heading in the NMEA data file *.N1R (or *.N2R). The customer can then decide based on an algorithm they write which heading is more accurate to use. The customer would then take the heading they chose to use and write this new heading value into the raw ADCP ensemble file *.ENJ, being sure to modify the ADCP checksum for that ensemble as required. The *VmDas* would read in the *.ENJ file because the user had selected the User Exit Option for RAW ADCP Data Screening.

7.3 Example 2 - Modifying Raw NMEA Data

VmDas writes the NMEA raw data into a file with the naming convention *.N1R or *.N2R (depending on which NMEA device we are working with). The format of this data is ASCII and is in the same format as what is transmitted by the customers NMEA device (with one exception). That exception being we add an ADCP mark (or time tag) string $PADCP. The *.N1R (or *.N2R) data file is normally then just converted to binary and stored in a file with the naming convention *.NMS. A customer can set an option (via the **User Exit** menu) that will instruct the *VmDas* program to read in a file with the naming convention of *.N1J (or *.N2J) instead of the *.N1R (or *.N2R) naming convention.

This allows the customer to write their own program which can modify the data inside the *.N1R (or *.N2R) in anyway as long as they write the data back out into a file with the same original data format as the *.N1R (and if collected *.N2R) file except they rename the file *.N1J (and if N2R is collected the file *.N2J). When the user turns on the **User Exit** option **External Raw Nav Data Screening/Pre-Averaging** the *VmDas* program will read in the *.N1J (or

*.N2J) file convert it into the binary file with the naming convention of *.NMS.

An example of why a customer may want to do this is that the customer wishes to decode pitch and roll data from a NMEA string that the *VmDas* does not currently decode. The customer can write a program that would read in the data from the *.N1R file (or *.N2R) and create a string that is read by the *VmDas* program from the data available in the NMEA strings.

An example of this is seen when using an Ashtech device that outputs pitch and roll data in the string $GPPAT and $GPASHR. *VmDas* does not currently decode this proprietary NMEA string. The user could write a program that would take the data from either of these Ashtech NMEA strings and write them into the RDI propriety NMEA string $PRDID. This RDI NMEA string contains heading, pitch, and roll data and is decoded by the *VmDas* program. The format for this string is as follows:

```
$PRDID,ppp.pp,rrr.rr,hhh.hh@   or
$PRDID,-ppp.pp,-rrr.rr,hhh.hh@
```

Where:

@ = carriage return
h = heading
p = pitch
r = roll

7.4 Example 3 - Transformation

The *VmDas* program normally reads in the contents of the binary file *.ENS and performs a beam to earth coordinate transformation. This beam to earth coordinate transformation is performed using the users selections for where to obtain attitude information such as heading, pitch, and roll (the choices being either the raw ADCP leader data or the raw NMEA data). Using this attitude information *VmDas* will transform the data from beam to earth using RDI's standard matrix table conversion and then writes this data to the file *.ENX.

The *VmDas* program does allow however the user to perform their own coordinate transformation routine. The user would select the **User Exit** option of **External Transformation**. This choice would disable the *VmDas* coordinate transformation routine and the user would have to create their own being sure to write the data out in correct format to a data file with the *.ENX naming convention. This is important as the next routines of the *VmDas* program will be reading in the *.ENX data for averaging, displaying, and recording in the *.STA and *.LTA files.

An example of why a customer may want to do this is that the customer may have purchased a special RDI ADCP that does not have the standard 4-beam Janus configuration. Many times these systems do not come with a coordinate transformation algorithm built into them. The user is responsible for this conversion.

Special Notes. Included in the **Transformation** routine are the following functions. If the customer chooses to perform their own Transformation they must ensure that these functions are also covered. A description of how RDI performs this transformation is included in the Coordinate Transformation Booklet.

- Selection of the attitude sensor (based on the user input during Edit Data Options)
- Apply Heading Corrections
- Apply Beam Angle Corrected Matrix table (read from the ADCP)
- Bin Mapping
- Three Beam Solutions
- Mark Data Bad Below Bottom
- Error Velocity Screening
- Vertical Velocity Screening
- Percent Good Calculations and Screening

7.5 User Displays

The *VmDas* program has its own display modules built in. The *VmDas* program reads in the raw ADCP files (*.ENR), short-term average files (*.STA), and long term average files (*.LTA) and displays this data in either a Tabular, Profile, or Ship Track plot.

The files *.ENR, *.STA, and *.LTA are available to be read by other programs such as *WinADCP* during real time data collection. This allows a user to create their own software package to display, or output the data in any way they would like. The only restriction is that when reading in the data file they must leave the data file open (or in a shared condition) so that *VmDas* may continue to access the file and update it with the new ensembles.

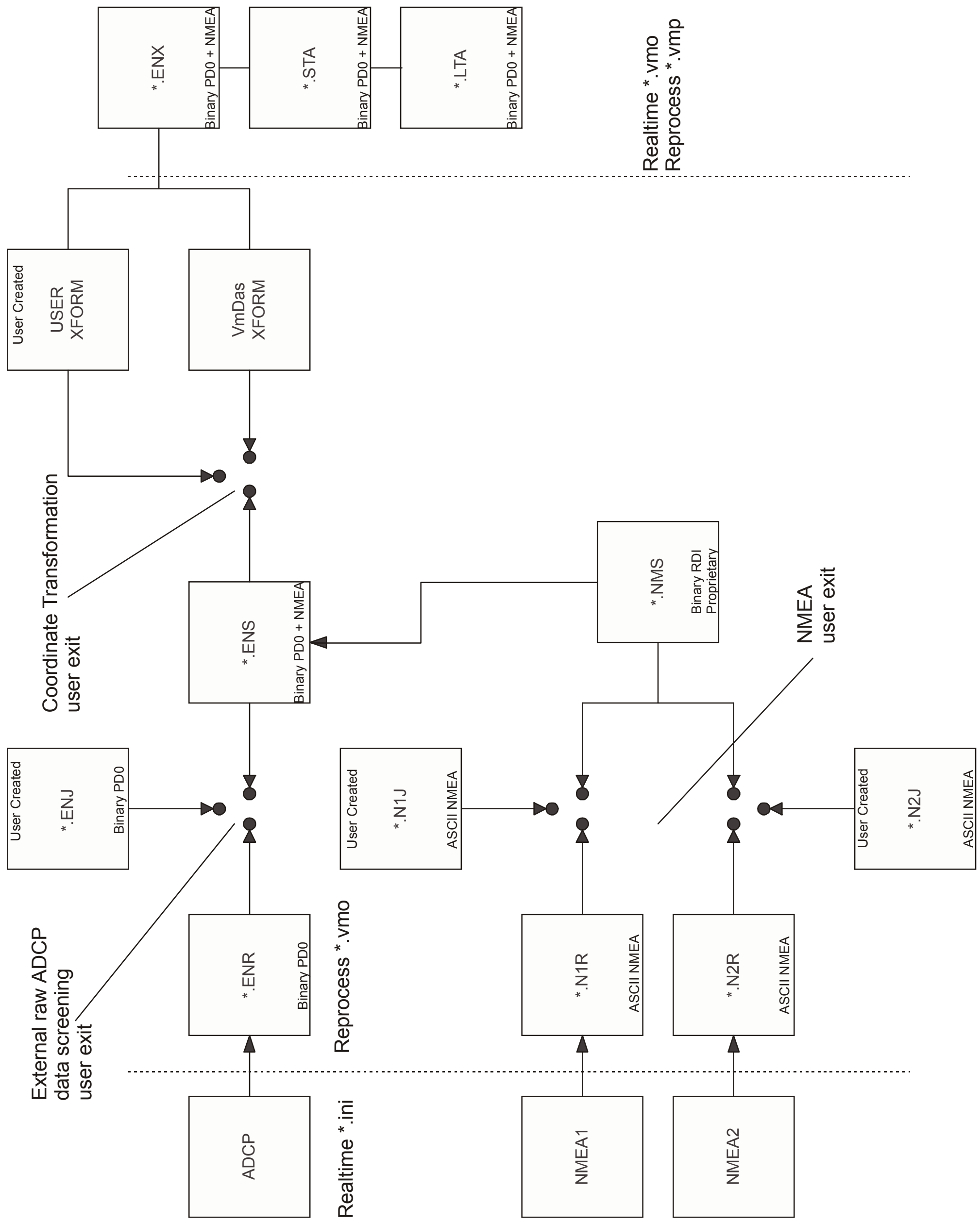


Figure 16. User Exits

8 File Naming Conventions

Data files produced by *VmDas* during **data collect** mode have the following filename format: DeployName000_000000.Ext,

Where:

DeployName is a user-entered name for the deployment (up to 128 characters),

000 is the deployment number (changes with each stop/restart),

000000 is the file sequence number, which is incremented when the specified maximum file size is reached, and

Ext is the file extension, and reflects the type of data in the file

Reprocessed files have a similar format: DeployName000_000_000000.Ext,

Where:

000 Represents the reprocessing number, and gets incremented each time the same raw data is reprocessed. The other fields are the same as for the data collect mode format, and identify the raw data source that was reprocessed.

The file extensions have the following meaning:

.ENR Raw ADCP data file (see your ADCP Technical Manual for the output data format).

.LTA ADCP (plus Navigation Data (see “Binary Navigation Data Format,” page 75)) data that has been averaged using the long time period specified in the **Options**, **Edit Data Options**, **Averaging** tab.

.STA ADCP (plus Navigation Data (see “Binary Navigation Data Format,” page 75)) data that has been averaged using the short time period specified in the **Options**, **Edit Data Options**, **Averaging** tab.

.ENS ADCP data after having been screened for RSSI and correlation by *VmDas*, or adjusted by the customer via a User Exit. Also has Navigation Data (see “Binary Navigation Data Format,” page 75) records merged into the ensembles from the .NMS file.

.ENX ADCP single-ping data (plus Navigation Data (see “Binary Navigation Data Format,” page 75) after having been bin-mapped, transformed to Earth coordinates, and screened for error velocity, vertical velocity, and false targets. This data is ready for averaging.

.N1R, .N2R Raw NMEA data files - text files; includes ADCP time stamps with the following format: $PADCP,eeeee,yyyymmdd,hhmmss,-nnnnn.nn<CR><LF>

Where:
eeeee = ADCP ensemble number
yyyymmdd = Year, Month, Day (date of ADCP ping)
hhmmss.ss = Hour, minute, seconds.hundredths (Time of ADCP ping)
-nnnnn.nn = (signed) PC clock offset from UTC in seconds; includes time zone difference).

The .N1R extension is used for single-port NMEA data collection, or for GPS position data (Nav) in dual-port collection mode. The .N2R extension is used for Roll/Pitch/Heading (RPH) data collection when using two serial ports for NMEA data collection.

.NMS Binary format NAV data file after having been screened and pre-averaged.

.VMO The option settings used for collecting the data (text file).

.VMP The option settings used for reprocessing the data (text file).

.ENJ ADCP raw data after adjustment by a user-exit application.

.N1J, .N2J Raw NMEA data after being adjusted by a user-exit application.

.LOG ASCII file containing any errors found in NEA, ASCII Ensemble Output, or ADCP communications.

9 ADCP Output Data Format and *VMDAS*

This section shows the format of the *VmDas* Navigation data when using an ADCP. This output can only be binary.

The ADCP binary output data buffer contains header data, leader data, velocity, correlation magnitude, echo intensity, percent good, and a checksum. The ADCP collects all data in the output buffer during an ensemble. The *VmDas* program writes this ADCP output into the *.ENR files. The *.ENR file format is described in the ADCP Technical Manual.

The Navigation data is inserted before the checksum (and reserved bytes) when *VmDas* saves the STA and LTA files. Figure 17 show the sequence in which the *VmDas* program creates the STA and LTA files that make up the binary output buffer. Figure 18, page 75 shows the format of the binary Navigation Data. Table 16, page 78 lists the format, bytes, fields, scaling factors, and a detailed description of every item in the binary navigation output buffer.

Always Output	**HEADER**
	FIXED LEADER DATA
	VARIABLE LEADER DATA
WD-command WP-command	**VELOCITY**
	CORRELATION MAGNITUDE
	ECHO INTENSITY
	PERCENT GOOD
BP-command	**BOTTOM TRACK DATA**
See "Binary Navigation Data Format," page 75	**NAVIGATION DATA** (78 BYTES)
Always Output	**RESERVED**
	CHECKSUM

Figure 17. ENS, ENX, STA and LTA Binary Output Data Format

> **NOTE.** For a full description of the STA and LTA Binary Output Data Format (i.e. Header, Fixed Leader Data, etc.), see the *VmDas* help file and your ADCP Technical Manual.

9.1 Binary Navigation Data Format

Figure 18. Binary Navigation Data Format

BIT POSITIONS

BYTE	7	6	5	4	3	2	1	0	
1	NAVIGATION ID								LSB 00h
2									MSB 20h
3	UTC DAY								
4	UTC MONTH								
5	UTC YEAR								LSB
6									MSB
7	UTC TIME OF FIRST FIX								LSB
8									
9									
10									MSB
11	PC CLOCK OFFSET FROM UTC								LSB
12									
13									
14									MSB
15	FIRST LATITUDE								LSB
16									
17									
18									MSB
19	FIRST LONGITUDE								LSB
20									
21									
22									MSB
23	UTC TIME OF LAST FIX								LSB
24									
25									
26									MSB
27	LAST LATITUDE								LSB
28									MSB
29									LSB
30									MSB

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Continued from Previous Page

Byte	Field	
31	LAST LONGITUDE	LSB
32		MSB
33		LSB
34		MSB
35	AVG SPEED	LSB
36		MSB
37	AVG TRACK TRUE	LSB
38		MSB
39	AVG TRACK MAGNETIC	LSB
40		MSB
41	SPEED MADE GOOD	LSB
42		MSB
43	DIRECTION MADE GOOD	LSB
44		MSB
45	RESERVED	
46		
47	FLAGS	
48		
49	RESERVED	
50		
51	ADCP ENSEMBLE NUMBER	LSB
52		
53		
54		MSB
55	ADCP ENSEMBLE YEAR	LSB
56		MSB
57	ADCP ENSEMBLE DAY	
58	ADCP ENSEMBLE MONTH	
59	ADCP ENSEMBLE TIME	
60		
61		
62		
63	PITCH	LSB
64		MSB

Continued Next Page

Continued from Previous Page

Byte	Field	
65	ROLL	LSB
66		MSB
67	HEADING	LSB
68		MSB
69	NUMBER OF SPEED AVG	LSB
70		MSB
71	NUMBER OF TRUE TRACK AVG	LSB
72		MSB
73	NUMBER OF MAG TRACK AVG	LSB
74		MSB
75	NUMBER OF HEADING AVG	LSB
76		MSB
77	NUMBER OF PITCH/ROLL AVG	LSB
78		MSB

See Table 11 for description of fields

NOTE. This data is output in this format only by the *VmDas* program in the STA and LTA data files.

9.2 Navigation Data Format – Detailed Explanation

These fields contain the Navigation Data. This data is only recorded in the STA and LTA files created by the RDI Windows software program *VmDas*. The LSB is always sent first. The ADCP Technical Manual has descriptions of commands used to set these values.

Table 16: Binary Navigation Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the sum of velocities identification word (20 00h).
5-6	3	UTC Day	This field contains the UTC Day.
7-8	4	UTC Month	This field contains the UTC Month.
9-12	5,6	UTC Year	This field contains the UTC Year, i.e. i.e. 07CF = 1999
13-20	7-10	UTC Time of first fix	UTC time since midnight; LSB = 0.01 seconds
21-28	11-14	PC Clock offset from UTC	PC Time – UTC (signed); LSB = milliseconds

29-36	15-18	First Latitude	This is the first latitude position received after the previous ADCP ping.
			
			LSB = approx. 8E-8 deg (32-bit BAM)
			
			In the BAM (Binary Angular Measure) format, the most significant bit of the word has a weight of 180 degrees, and you keep dividing by 2 as you proceed to the right. The lease significant bit for a 32-bit BAM is about 8E-8 arc degrees ($180/2^{31}$), or just under 1 cm of longitudinal distance at the equator, where 1 arc minute = 1 Nautical mile. If you interpret the BAM word as an unsigned number, the range is 0 to (360-LSB) degrees, and if you interpret the BAM as a signed number, the range is –180 to 180-LSB) degrees. The least significant bit for a 16-bit BAM is about 0.0055 degrees ($180/2^{15}$). Some 32-bit BAM examples are:
			
			UNSIGNED
			`0x40000000   90 degrees`
			`0x80000000  180 degrees`
			`0xC0000000  270 degrees`
			`0xFFFFFFFF  360 degrees minus one LSB degrees`
			SIGNED
			`0x40000000   90 degrees`
			`0x80000000  minus 180 degrees`
			`0xC0000000  minus 90 degrees`
			`0xFFFFFFFF  minus one LSB degrees`

37-44	19-22	First Longitude	This is the first longitude position received after the previous ADCP ping. LSB = approx. 8E-8 deg (32-bit BAM)
45-52	23-26	UTC Time of last fix	Time since midnight UTC; LSB = 1E-4 seconds
53-60	27-30	Last Latitude	This is the last latitude position received prior to the current ADCP ping. LSB = approx. 8E-8 deg (32-bit BAM)

Continued Next Page

Table 16: Binary Navigation Data Format (continued)

Hex Digit	Binary Byte	Field	Description
61-68	31-34	Last Longitude	This is the last longitude position received prior to the current ADCP ping. LSB = approx. 8E-8 deg (32-bit BAM)
69-72	35,36	Avg Speed	Average Navigational Speed mm/sec (signed)
73-76	37,38	Avg Track True	Average True Navigational Ship Track Direction LSB = approx. 0.0055 deg (16-bit BAM)
77-80	39,40	Avg Track Magnetic	Average Magnetic Navigational Ship Track Direction LSB = approx. 0.0055 deg (16-bit BAM)
81-84	41,42	Speed Made Good (SMG)	Speed calculated between navigation positions. LSB = one mm/sec (signed) The Speed Made Good (SMG) and Direction Made Good (DMG) quantities are calculated from the navigation fixes that enter the system between ADCP outputs, and are calculated as follows: IF: aLat(i) = the average of the latitudes of the nav fixes in interval I aLon(i) = the average of the longitudes of the nav fixes in interval I Ta(i) = the average of the time of validity of the nav fixes in interval I dLat = the difference in average latitude between averaging intervals dLon = the difference in average longitude between averaging intervals VelMGn (i) = the velocity made good in the East direction for interval I VelMGn (i) = the velocity made good in the East direction for interval I LatToDist (dLat) is a function that converts delta Latitude to a distance LonToDist (dLon) is a function that converts delta Longitude to a distance Smg (i) = speed made good in interval i Dmg (i) = direction made good in interval i THEN: dLat = (aLat (I-1) – aLat (i)) dLon = (aLon (i-1) – aLon (i)) VelMgn (i) = LatToDist (dLat) / (Ta(i-1) – Ta(i)) VelMge (i) = LonToDist (dLon) / (Ta(i-1) – Ta(i)) Smg(i) = sqrt(VelMgn(i)^2 + VelMGe(i)^2) Dmg(i) = atan(VelMge(i) / VelMGn(i))
85-88	43,44	Direction Made Good (DMG)	Direction calculated between navigation positions. LSB-= approx. 0.0055 deg (16-bit BAM)
89-92	45,46	Reserved	Reserved for RDI use.

Table 16: Binary Navigation Data Format (continued)

Hex Digit	Binary Byte	Field	Description
93-96	47,48	Flags	Describes the validity of the data. Each bit has represents a separate flag and has its own meaning 1=true, 0=false. The flag bits are defined as follows: bit 0 = Data updated bit 1 = PSN Valid bit 2 = Speed Valid bit 3 = Mag Track Valid bit 4 = True Track Valid bit 5 = Date/Time Valid bit 6 = SMG/DMG Valid bit 7 = Pitch/Roll Valid bit 8 = Heading Valid bit 9 = ADCP Time Valid bit 10 = Clock Offset Valid bit 11 = Reserved bit 12 = Reserved bit 13 = Reserved bit 14 = Reserved bit 15 = Reserved
97-100	49,50	Reserved	Reserved for RDI use.
101-108	51-54	ADCP Ensemble Number	This field contains the sequential number of the ensemble to which the data in the output buffer apply. Scaling: LSD = 1 ensemble; Range = 1 to 4,294,967,296 ensembles
109-112	55,56	ADCP Ensemble Year	This field contains the ADCP year, i.e. 07CFH = 1999
113-114	57	ADCP Ensemble Day	This field contains the ADCP day.
115-116	58	ADCP Ensemble Day	This field contains the ADCP month.
117-124	59-62	ADCP Ensemble Time	Number of seconds since midnight; LSB=1E-4 seconds
125-128	63,64	Pitch	Pitch angle. LSB- = approx. 0.0055 deg (16-bit BAM) Pitch is positive when bow is higher than stern.
129-132	65,66	Roll	Roll angle. LSB- = approx. 0.0055 deg (16-bit BAM) Roll is positive when the port side is higher than the starboard side.
133-136	67,68	Heading	Heading input. LSB- = approx. 0.0055 deg (16-bit BAM)
137-140	69,70	Number of Speed Samples Averaged	The number of speed samples averaged since the previous ADCP ping.
141-144	71,72	Number of True Track Samples Avg	The number of True Track samples averaged since the previous ADCP ping.
145-148	73,74	Number of Magnetic Track Samples Avg	The number of Magnetic Track samples averaged since the previous ADCP ping.

Table 16: Binary Navigation Data Format (continued)

Hex Digit	Binary Byte	Field	Description
140-152	75,76	Number of Heading Samples Averaged	The number of Heading samples averaged since the previous ADCP ping.
153-156	77,78	Number of Pitch/Roll Samples Averaged	The number of Pitch/Roll samples averaged since the previous ADCP ping.

NOTES

Collecting Data

a. On the **File** menu, click **Collect Data**.

b. On the **Options** menu, click **Load**.

c. Select the **default.ini** file. Click **Open**.

d. On the **Options** menu, click **Edit Data Options**. On the **ADCP Setup** tab click **Use File** and select a default ADCP Command File to load (use the **Browse** button). The following is a brief description of each file.

File Name	Description
OS38BBDEF	Default setup for an OS 38kHz ADCP in the highest precision (broad bandwidth) but reduced range profiling mode.
OS38NBDEF	Default setup for an OS 38kHz ADCP in the lowest precision (narrow bandwidth) but extended range profiling mode.
OS75BBDEF	Default setup for an OS 75kHz ADCP in the highest precision (broad bandwidth) but reduced range profiling mode.
OS75NBDEF	Default setup for an OS 75kHz ADCP in the lowest precision (narrow bandwidth) but extended range profiling mode.
OS150BBDEF	Default setup for an OS 150kHz ADCP in the highest precision (broad bandwidth) but reduced range profiling mode.
OS150NBDEF	Default setup for an OS 150kHz ADCP in the lowest precision (narrow bandwidth) but extended range profiling mode.
BB75DEF	Default setup for a BB 75kHz ADCP to provide the most range with the optimal precision.
BB150DEF	Default setup for a BB 150kHz ADCP to provide the most range with the optimal precision.
BB300DEF	Default setup for a BB 300kHz ADCP to provide the most range with the optimal precision.
BB600DEF	Default setup for a BB 600kHz ADCP to provide the most range with the optimal precision.
WH300DEF	Default setup for a Workhorse 300kHz ADCP to provide the most range with the optimal precision.
WH600DEF	Default setup for a Workhorse 600kHz ADCP to provide the most range with the optimal precision.
WH1200DEF	Default setup for a Workhorse 1200kHz ADCP to provide the most range with the optimal precision.

NOTE. These files have been setup for shipboard use. They can also be used for stationary systems (such as Oil Rig platforms) but you must first open the file (right click on file and select open) and modify the EZ command from EZ1020001 to EZ1111111. This new setting will enable the use of the internal heading, pitch, and roll sensors.

e. As a minimum, set the options for **Communications** (ADCP and NMEA Com Port), and **Transforms** (Heading Source). Press **OK**.

f. On the **Options** menu, click **Save As**. Save the VmDas setting to your own *.ini file.

g. On the **Control** menu, click **GO** to begin collecting data.

Reprocessing Data

a. On the **File** menu, click **Reprocess Data**.

b. On the Reprocessing Tool Bar, click the **View/Edit** processing settings button.

c. Select the desired options for reprocessing the data.

d. Click the **Reprocess Data** button on the tool bar to start reprocessing the data file.

Playback Data

a. On the **File** menu, click **Playback Data**.

b. Select the data file to view. VmDas will automatically search for *.enr, *.enx, *.sta, and *.lta files. You may also enter *.* to search for all files, or enter any filename as long as the file contains valid ADCP data in the proper format. See File Naming Conventions for details of what each file extension means.

c. On the Playback Tool Bar, click **Play**.

File Naming Conventions

Data files produced by VmDas during **data collect** mode has the following filename format:

DeployName000_000000.Ext,

Where:

DeployName — is a user-entered name for the deployment (up to 128 characters),

000 — is the deployment number (changes with each stop/restart),

000000 — is the file sequence number, which is incremented when the specified maximum file size is reached, and

Ext — is the file extension, and reflects the type of data in the file

Reprocessed files have a similar format: DeployName000_000_000000.Ext,

Where:

000 — represents the reprocessing number, and gets incremented each time the same raw data is reprocessed. The other fields are the same as for the data collect mode format, and identify the raw data source that was reprocessed.

The file extensions have the following meaning:

.ENR — Raw ADCP data file (see your ADCP Technical Manual for the output data format).

.LTA — ADCP (plus Navigation Data) data that has been averaged using the long time period specified in the **Options**, **Edit Data Options**, **Averaging** tab.

.STA — ADCP (plus Navigation Data) data that has been averaged using the short time period specified in the **Options**, **Edit Data Options**, **Averaging** tab.

.ENS — ADCP data after having been screened for RSSI and correlation by *VmDas*, or adjusted by the customer via a User Exit. Also has Navigation Data records merged into the ensembles from the .NMS file.

.ENX — ADCP single-ping data (plus Navigation Data) after having been bin-mapped, transformed to Earth coordinates, and screened for error velocity, vertical velocity, and false targets. This data is ready for averaging.

.N1R, .N2R — Raw NMEA data files - text files; includes ADCP time stamps with the following format:
$PADCP,eeeee,yyyymmdd,hhmmss,-nnnnn.nn<CR><LF>

Where:
eeeee = ADCP ensemble number
yyyymmdd = Year, Month, Day (date of ADCP ping)
hhmmss.ss = Hour, minute, seconds.hundredths (Time of ADCP ping)
-nnnnn.nn = (signed) PC clock offset from UTC in seconds; includes time zone difference).

The .N1R extension is used for single-port NMEA data collection, or for GPS position data (Nav) in dual-port collection mode. The .N2R extension is used for Roll/Pitch/Heading (RPH) data collection when using two serial ports for NMEA data collection.

.NMS — Binary format Navigation data file after having been screened and pre-averaged.

.VMO — The option settings used for collecting the data (text file).

.VMP — The option settings used for reprocessing the data (text file).

.ENJ — ADCP raw data after adjustment by a user-exit application.

.N1J, .N2J — Raw NMEA data after being adjusted by a user-exit application.

.LOG — ASCII file containing any errors found in NEA, ASCII Ensemble Output, or ADCP communications.

RD Instruments
Field Service Bulletin

FSB-125

Ocean Surveyor Real-Time Clock and Leap Years

Date: March 1, 2000

Abstract

The Ocean Surveyor real time clock function did not correctly handle the leap year on February 29, 2000.

Instrument/Program Affected

Ocean Surveyor

Description

On February 29, 2000 the date reported in the data is March 1, 2000. Additionally it will not be possible to enter in the date 2/29/2000 into the Ocean Surveyor Real-Time Clock. This means that data will have to be collected with the wrong date stamp for 2/29/2000. It will then be necessary to reset the clock on March 1, 2000 so that all date stamps from this time on will be correct (on 3/1/2000 the Ocean Surveyor will be reporting 3/2/2000).

If data was collected on 2/29/2000 it is possible to correct the date via two utility programs from RDI (BBCONV and BBMERGE). If interested in this setup please contact the RDI Customer service.

Solution/Action

Short-Term Solution

On March 1 reset the real-time clock to March 1 (it will be off 1 day and state it is March 2).

Long-Term Solution

RDI has corrected the Real-Time Clock algorithms in firmware version 14.14. Systems should be updated to version 14.14 (available April 1, 2000).

RD Instruments

Field Service Bulletin

FSB-126

NMEA External Heading with TRANSECT & VmDas

Date: April 7, 2000

Abstract

TRANSECT and VmDas do **not** rotate the velocities based on the NMEA heading input if Earth coordinate data (EX11xxx) is received from the ADCP.

Instrument/Program Affected

Workhorse, Rio Grande, Long Ranger, Ocean Surveyor, and BroadBand DR/SC/VM ADCPs using *TRANSECT* (2.xx, 3.xx, and 4.xx series) or VmDas.

Please note that this notice is also true when you are using a BroadBand or Workhorse ADCP with the Deck Box and you will output the RDI NMEA heading data format from the Deck Box to the computer.

Description

When using RDI's software *TRANSECT* (2.xx, 3.xx, and 4.xx series), and VMDAS in conjunction with the NMEA external heading input then you must be sure to have the ADCP set to Beam, ADCP (or Instrument), or Ship Coordinates. These software programs will **not** rotate the velocities based on the NMEA heading input if Earth coordinate data is received from the ADCP.

Additionally, we recommend that you collect single ping ensembles (i.e. one water profile ping (WP1) and one bottom track ping (BP1)). This recommendation is true for all moving applications but especially true when using an NMEA input for the heading. Averaging data in the ADCP can cause vector summation errors as the vessel turns.

Solution/Action

Short-Term Solution

Use the following settings for the EX command in any configuration or command files used by VmDas or *TRANSECT*.

EX00xxx = Beam coordinates

EX01xxx = Instruments coordinates

EX10xxx = Ship coordinates

Where xxx = 0 or 1

Long-Term Solution

No software corrections are planned at this time.

NOTE. This FSB supercedes Workhorse FAQ #30 and all other documentation that recommends using EX**11**xxx with *TRANSECT* or VmDas.

RD Instruments
Field Service Bulletin

FSB-128

EB-Command

Date: May 31, 2000

Abstract

The sign of the EB command entry is documented incorrectly.

Instrument/Program Affected

Workhorse, Rio Grande, Long Ranger, Ocean Surveyor, BroadBand DR/SC/VM, TRANSECT, VmDas, WinRiver, and BBLIST

Description

The correct way to enter the magnetic offset in the BroadBand (phase 2 and 3), Workhorse, and Ocean Surveyor ADCPs is to enter the **same** sign as the magnetic declination. This will also be true for what is entered as the corrections done in TRANSECT, VmDas, WinRiver, and BBLIST.

Example: A bottom-mounted ADCP is receiving heading from its internal compass. A magnetic declination map for the deployment area shows a declination of W3.5° (–3.5°). To counteract the effects of this magnetic field, you must enter a heading bias value of –3.5°. To convert –3.5° to an EB-command value, multiply the desired bias angle in degrees by 100: EB = –3.5 × 100 = -350 = EB–350.

NOTE. This FSB supercedes all other documentation that recommends entering the opposite sign as the magnetic declination.

NOTE. The Ocean Surveyor uses the EV command for magnetic declination correction.

Solution/Action

Short-Term Solution

Use the **same** sign for the EB and EV (Ocean Surveyor only) commands in any configuration or command files used by the ADCP.

Long-Term Solution

All documentation will be corrected when they are revised.

Corruption of Correlation and Percent Good Data

Date: June 26, 2000

Abstract

The use of an EXxxxx1 (x = 1 or 0) command and an internal or external pitch and roll reference (EZxxx11xxx or EZxxx22xxx) causes corrupted correlation and percent good data.

Instrument/Program Affected

OS I with firmware version 14.10 to 14.14 and OS II firmware version 23.03 and lower

Description

Setting the EX-command to EXxxxx1 and using an internal or external pitch and roll reference (EZxxx11xxx or EZxxx22xxx) causes corrupted correlation and percent good data.

Solution/Action

Short-Term Solution

Setting the EX-command to EXxxxx0 (no bin mapping) eliminates the problem.

Long-Term Solution

RDI plans to update the OS I firmware as soon as possible. Updating an OS II firmware to version 23.04 will eliminate this problem.

RD Instruments
Acoustic Doppler Solutions

Field Service Bulletin FSB-134

OS No Ping in Air

Date: May 8, 2001

Abstract

Pinging an Ocean Surveyor in air will damage the electronics chassis.

Instrument/Program Affected

All Ocean Surveyor models

Description

Do NOT ping the Ocean Surveyor with the transducer in air. The power amplifier board will short, causing the electronics chassis to no longer communicate. The transducer is pinged by sending a CS command or if *VmDas* is started for collecting data – either of these methods will cause damage if the transducer in air.

NOTE. It is OK to run the *DumbTerm* tests with the transducer in air – the transducer is not pinged for testing.

Solution/Action

Short-Term Solution

Do NOT ping the Ocean Surveyor with the transducer in air.

Long-Term Solution

RD Instruments is looking into a hardware solution.

RD Instruments

Acoustic Doppler Solutions

Interim Change Notice ICN-001

Ocean Surveyor Outline Installation Drawings

Date: May 23, 2001

Abstract

The Ocean Surveyor Outline Installation drawings have been changed.

Manual Affected

The following manuals with the listed revision date are affected by this change. Manuals with newer revision dates will have the change incorporated.

- Vessel Mount Installation Guide 954-6007-00 (February 2000)
- Ocean Surveyor Installation Guide – 95A-6019-00 (January 2001) (Part of Ocean Surveyor Technical Manual 95A-6012-00 (January 20001)
- Ocean Surveyor Installation Guide 95A-6003-00 (May 1998)

Description

The Ocean Surveyor Outline Installation drawings have been updated. Please use the following table to identify the new drawings. The drawings are included with this notice.

Description	Old Drawing Number	New Drawing Number
38kHz Round	SK0195	96A-6005
38kHz Oval	SK0193	96A-6006
75kHz	SK0197	96A-6007
150kHz	SK0201	96A-6008

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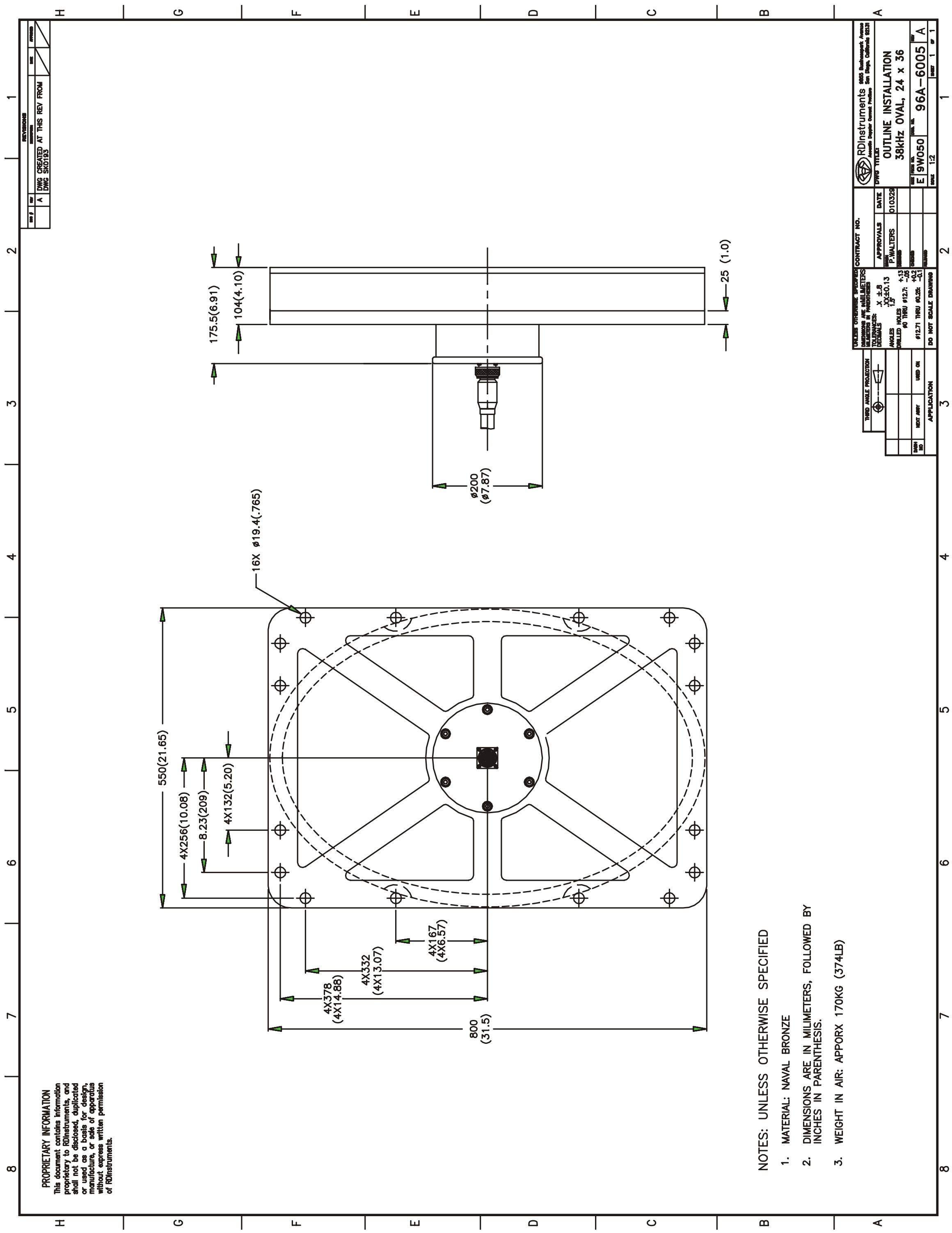
Interim Change Notice ICN-001



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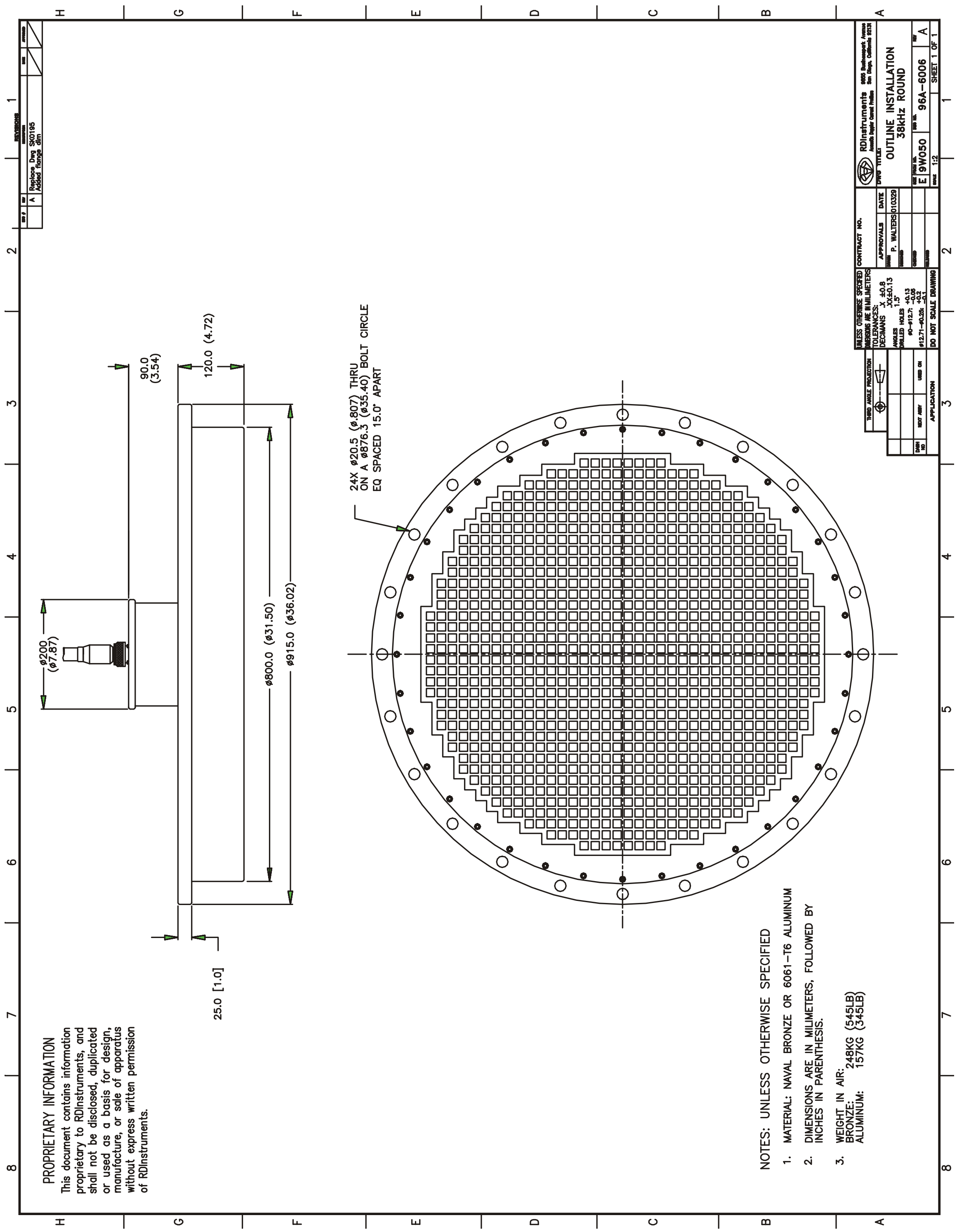
Interim Change Notice ICN-001



Interim Change Notice   ICN-001

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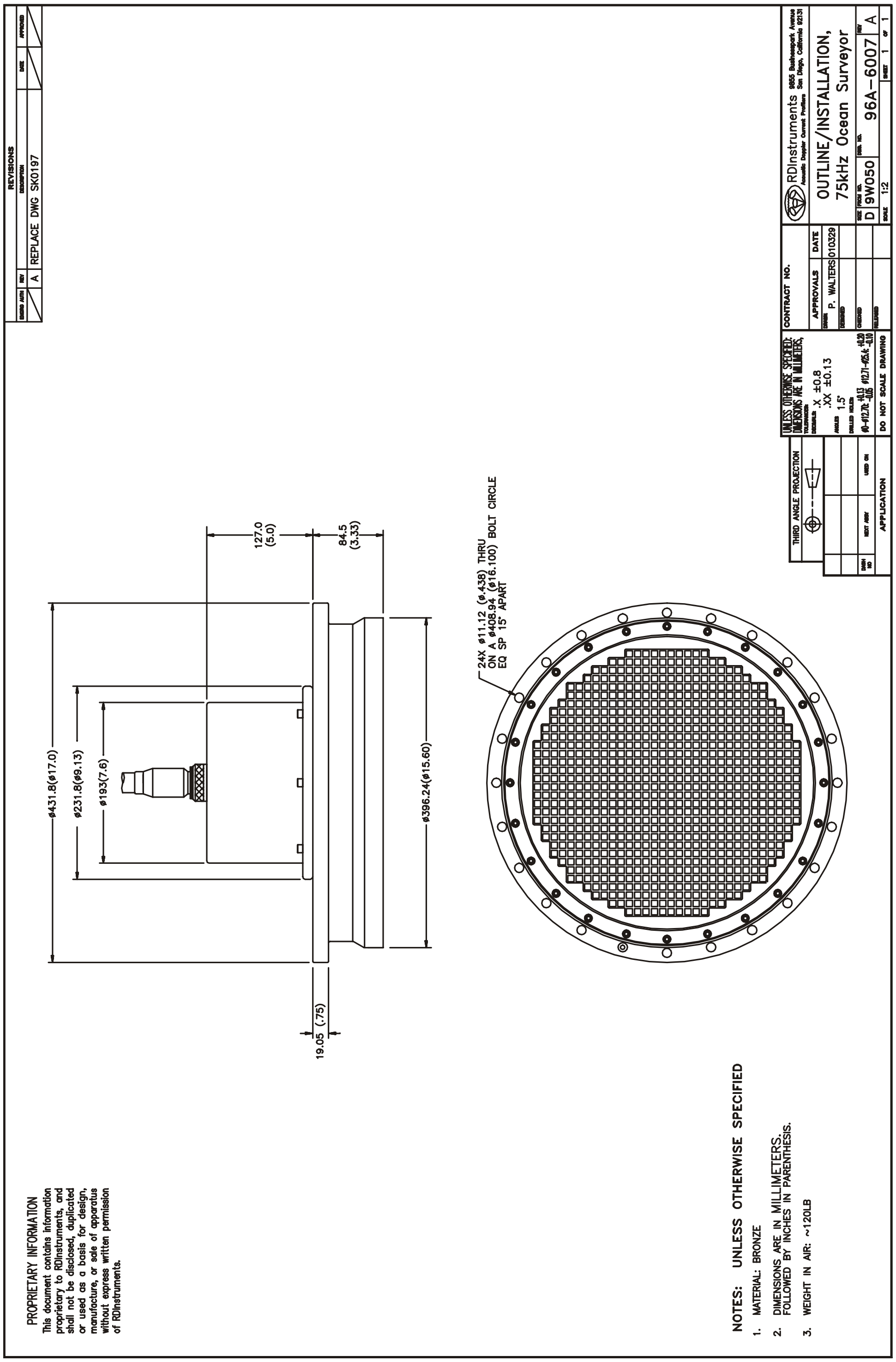

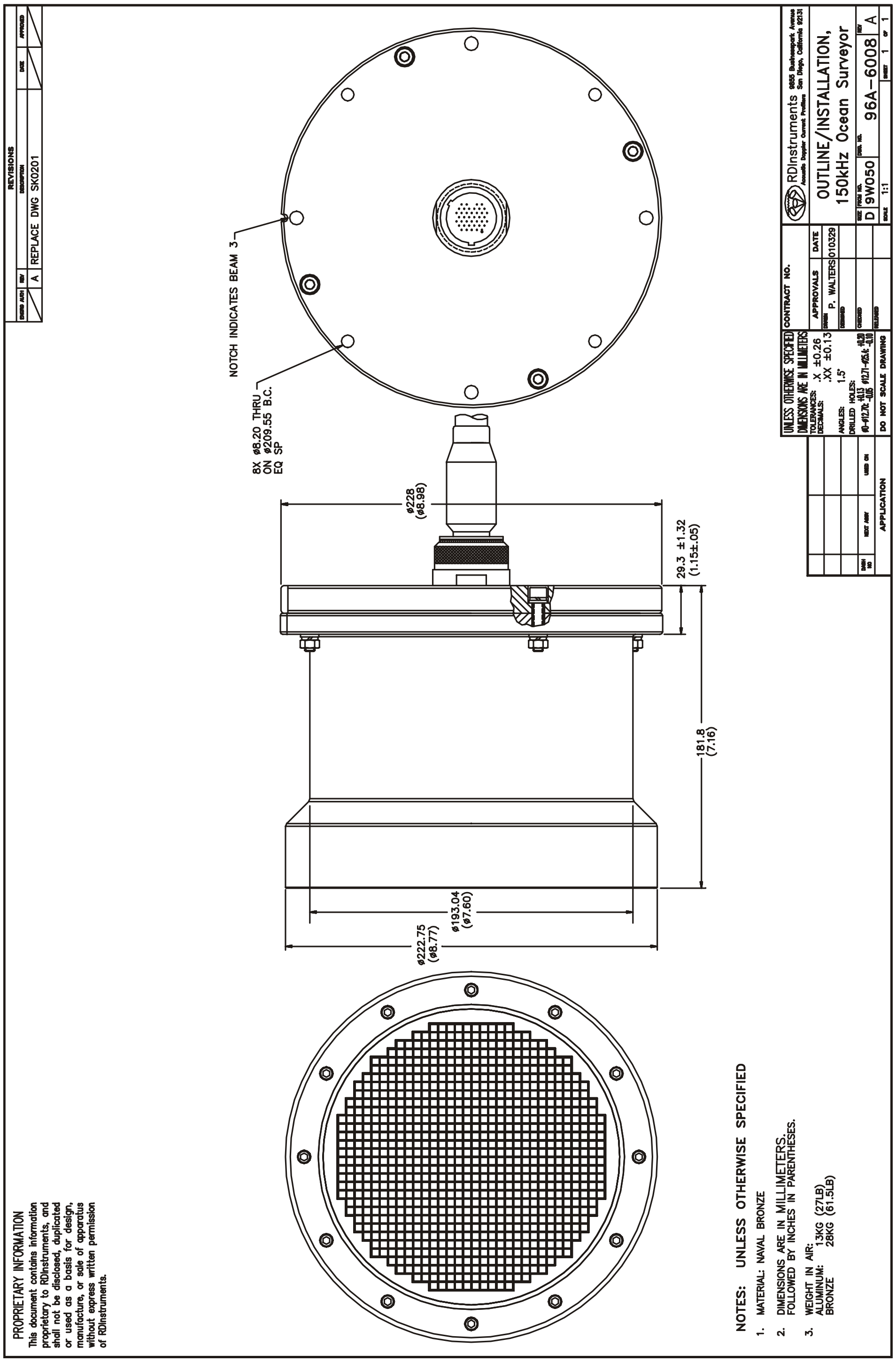
REVISIONS
A REPLACE DWG SK0201
NOTCH INDICATES BEAM 3
8X ø8.20 THRU
ON ø209.55 B.C.
EQ SP
ø228
(ø8.98)
29.3 ±1.32
(1.15±.05)
181.8
(7.16)
ø193.04
(ø7.60)
ø222.75
(ø8.77)
PROPRIETARY INFORMATION
This document contains information proprietary to RDInstruments, and shall not be disclosed, duplicated or used as a basis for design, manufacture, or sale of apparatus without express written permission of RDInstruments.
NOTES: UNLESS OTHERWISE SPECIFIED
1. MATERIAL: NAVAL BRONZE
2. DIMENSIONS ARE IN MILLIMETERS, FOLLOWED BY INCHES IN PARENTHESES.
3. WEIGHT IN AIR:
ALUMINUM: 13KG (27LB)
BRONZE 28KG (61.5LB)
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS
TOLERANCES: DECIMALS: .X ±0.26 .XX ±0.13
ANGLES: 1.5°
DO NOT SCALE DRAWING
APPLICATION
CONTRACT NO.
APPROVALS
DATE
P. WALTERS 010329
RDInstruments
OUTLINE/INSTALLATION,
150kHz Ocean Surveyor
D 9W050 96A-6008 A
1:1
SHEET 1 OF 1

RD Instruments
Acoustic Doppler Solutions

Interim Change Notice ICN-005

Ocean Surveyor Reserved Byte

Date: May 25, 2001

Abstract

The Output Data Format Reserved byte is incorrectly described as being 14 bytes – it is 2 bytes.

Manual Affected

Ocean Surveyor 95A-6022-00 (January 2001)

Description

The Reserved byte shown in Figures 6, 7, 17, and Table 23 in the Output Data Format is 2 bytes long, not 14 bytes as shown in the Technical Manual.

The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	***To***	***Multiply by***	***To change***	***To***	***Multiply by***
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C