Water Column Profiler™

Operators Manual

for

Model WCP

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Chapter

1

Overview

1.1 Overview

Thank you for purchasing a "Water Column Profiler" from ASL Environmental Sciences. This instrument has been thoroughly tested at the factory prior to shipment. The sensors have been individually calibrated (see Calibration Sheets in Appendix E and the calibration coefficients provided on the supplied “Coefficients File Disk”).
The purpose of this manual is to provide the user with the technical information required to successfully operate the ASL Water Column Profiler, Model WCP. To help you get started on using the ASL WCP, the manual provides a concise step-by-step approach to each required task.

This manual is designed for use in conjunction with the WcpRealTime Users Guide. For further details on a given topic please consult the WcpRealTime manual or the “Help” section of the WcpRealTime program.

Warranty

ASL Environmental Sciences Inc. (ASL) warrants all new products of its manufacture to be free from defects in material and workmanship under normal usage for a period of one year. This warranty is solely for the benefit of the original buyer. ASL will replace or repair free of charge, F.O.B. at its factory in Sidney, BC, Canada, any part or parts returned within one year of original delivery, which ASL’s examination shall show to have failed under normal use and service. This warranty does not apply to any defects or improper functioning caused by negligence, misuse, tampering, accidents, improper installation, or work performed by unauthorized personnel.

This warranty is the only warranty given for the sale of ASL products. No warranties implied in law, including but not limited to the implied warranties of merchantability and fitness for a particular purpose, shall apply. In no event will ASL be liable for any direct, indirect, consequential or incidental damages resulting from the purchase or use of ASL products, or resulting from any delays or failure of performance of ASL under agreement, or resulting from any services furnished by ASL. Equipment not manufactured by ASL is supported only to the extent of the original manufacturer’s warranty.

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

1.2 Principles of Operation

Functional Description

The Water Column Profiler Model 1 (or WCP) is a cable tethered instrument designed to measure and record the Water Column moving through its field of view from the seabed during long unattended deployments. The Water Column Profiling Sonar can be deployed as much as 150 m beneath the surface, looking upward[1] or from the surface looking downward. It transmits an acoustic pulse of programmable duration, and then listens for the echo from targets in the water column. It returns a value of the acoustic intensity for every 8th of a meter

The Water Column Profiler also contains sensors for measuring:

- Beam tilt from vertical on two axes
- Real time clock

The tilt data allows the calculation of zenith distance from echo range, if the drag forces, exerted by local ocean currents, affects the WCP orientation.

The WCP starts immediately as soon as power is applied. Data is transmitted from the WCP through a RS422 link and can be viewed using the WcpRealtime software supplied with the unit.

Instrument Operation

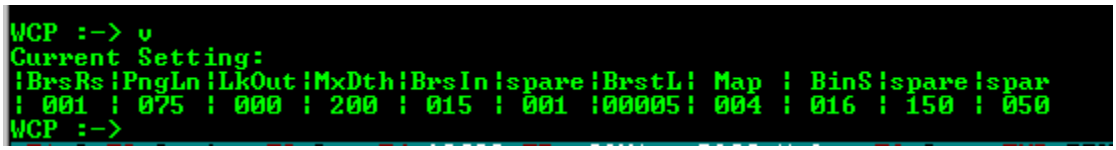
At one-second intervals, the internal echo sounder is turned on, a travel-time counter is started, and a sound pulse is transmitted for the length of time chosen via the *PING LENGTH* parameter. When the pulse transmission is complete, the WCP digitizes the returned acoustic signal strength at a sample frequency of 23.33kHz. The samples are stored in a ping buffer as data collection continues until the *MAXIMUM RANGE* is reached. Note that although *MAXIMUM RANGE* is entered in meters, WCP converts this to delay time using a sound speed of 1460 m s-1 (see ASL's application note IPS-AN2 for more details). On completion of data acquisition for a ping the WCP moves through the ping buffer and averages the number of samples required to give one echo intensity for every 1/8th meter. The WCP then waits for the next ping interval, checking the serial port for commands. In the data record, each Burst record is preceded by a header that includes the current date/time, and battery voltages and a record of readings from the auxiliary sensors (i.e. tilt), if present.

Definition of Terms

The following Image shows the standard settings for this particular Water Column Profiler. There are only three user definable fields that can be changed: **Ping Length, Max Range**

[1] Extended range operation of the WCP, to 200 m or more, can be achieved. Consult ASL Environmental Sciences Inc. for more information.

and **Gain**. Both of these parameters can be accessed using a terminal program. See section ??? for instructions on the terminal screen.



BURST RESOLUTION: (BrsRs - 001) Time interval for the BURST INTERVAL in seconds. For example the time between bursts is BURST RESOLUTION multiplied by BURST INTERVAL.

PING LENGTH: ((PngLn) User selectable) Length of the transmitted acoustic pulse in microseconds.

LOCKOUT: (LkOut - 0) Blanking distance after the pulse is transmitted to when the sounder starts to listen for returns. In this case always "0".

MAXIMUM RANGE: ((MxDth) User selectable from 2 to 200 metres) Distance to which the sounder listens for returns. This is a rough estimate and will be rounded down to the nearest bin based on the bin size. i.e. bin size is equivalent to 1/8th m, maximum range value of 30 would actually terminate at 29 7/8 m.

BURST INTERVAL: . (BrsIn -015) This is multiplied by the BURST RESOLUTION to give the time between bursts. In this case 15 sec????

SPARE (Gain): Gain setting user selectable from 1 to 4.

BURST LENGTH: (BrstL - 00005)) The number of individual pings to be averaged for each burst.???

MAP: ???

BIN SIZE: (BinS – 016) The number of samples per bin based.

SPARE: (Spare – 150) Start amplitude???

Spar – 050 Stop amplitude??

1.3 Applications

Planning a Measurement Program

The planning of a successful WCP deployment requires careful consideration of expected environmental conditions. The length of deployment, expected mooring motion, the surface-wave climate and the design of the mooring must all be taken into account. After

consideration of these factors, a decision concerning the depth of deployment and the necessary gain can be made.

Chapter
2

Installation

2.1 Equipment Inspection

Unpacking

When unpacking, use care to prevent physical damage to the transducer face and connectors. When handling any electronics modules, it is a good practice to follow proper electrostatic discharge (ESD) prevention measures.

Inventory

The WCP should come with the following items:

1) WCP complete with: Pressure case and Cable and Dummy Plugs

-

2) WcpRealTime software envelope containing;
   - Software CD
   - Installation Instructions
   - Instruments Calibration Coefficient File

3) Interface Cable. (Cable is not terminated)

4) Warranty Card.

5) Spares Kit Containing:
   - 2 O-rings # 2-260
   - 1 10mm Wrench
   - Desiccant Pack
   - Tilt coefficient disk

6) WCP Operators Manual, WcpRealTime Software Manual,

7) External Acoustic Transducer and Cable

Visual Inspection

To operate the ASL Water Column Profiler, the user needs to locate the following components on the exterior of the pressure case housing:

1) Acoustic transducer and Cable

2) Electrical bulkhead connectors and dummy plugs

Operation of the WCP also requires:

3) Surface communication cable

4) WcpRealTime software package Installed on a Windows PC Computer

Note: An Rs-422 converter is also required. This is not supplied with the instrument.

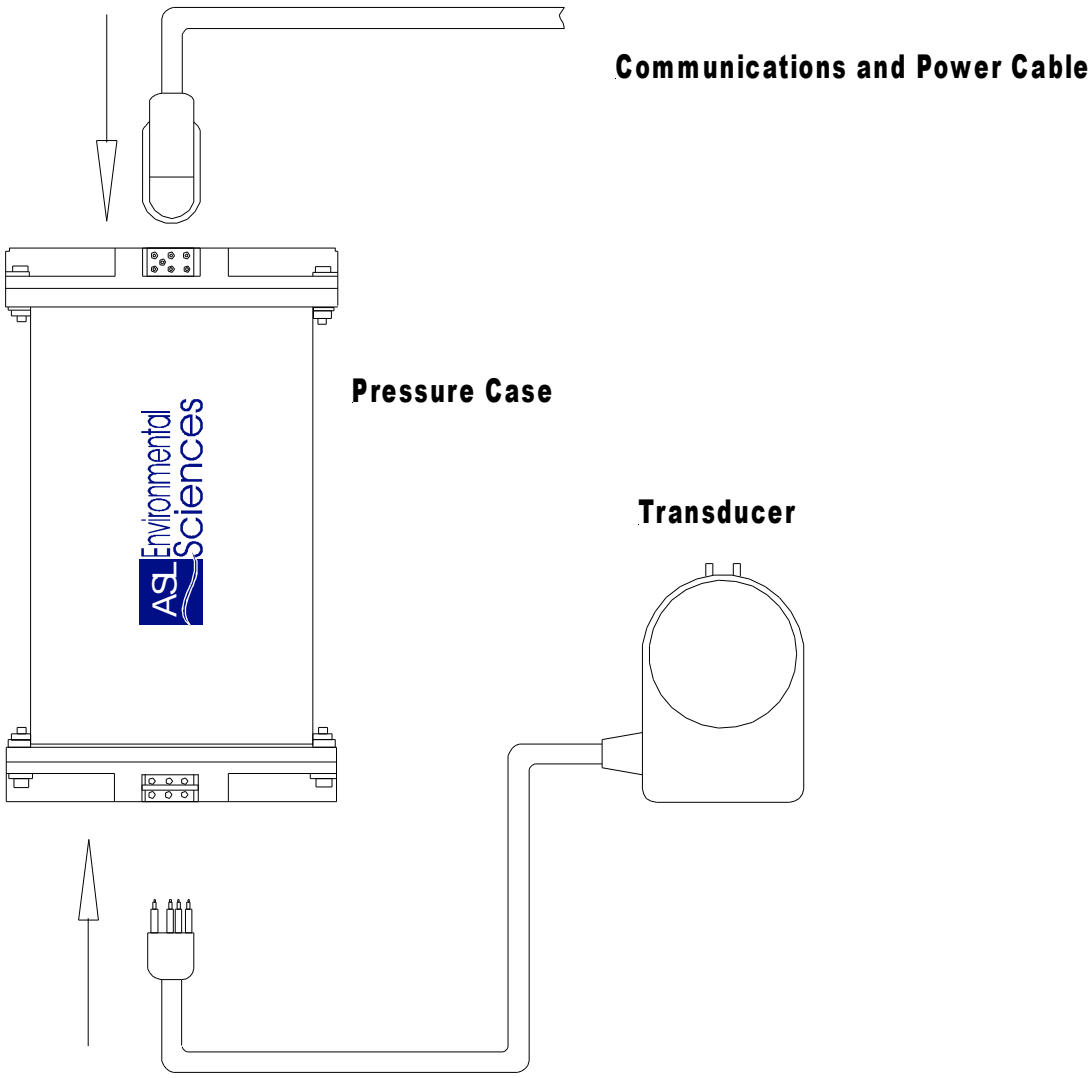


Figure 2.

2.2 Opening the Pressure Case

Cables

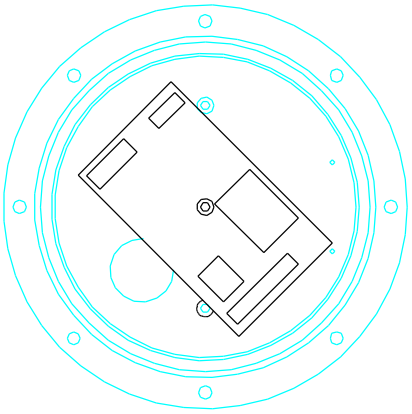
With the WCP pressure case standing vertical on a level surface, unplug both the transducer and communications cables from the pressure case in the following manner:

- Release the retaining strap by pulling it above the connector
- Grasp the cable close to the end cap. Your thumb should rest against the edge of the end cap. *Do not try to fit your hand under the cable as it passes over the end cap. Upward force such as this could damage the bulkhead connector*
- Pull the cable straight out away from the end cap with a gentle rocking motion. Again do not apply upward force.
- Place a dummy plug on to the exposed bulkhead connector.

End cap

Start first with the end cap, which contains the Power and Communication Bulkhead connector (Male Bulkhead Connector). The following instructions describe the end cap removal process:

- Loosen off the 4 bolts which hold the end cap to the pressure case
- Carefully pull the end cap away from the pressure case to gain access to the headers on the power module in the top of the pressure case.
- Remove the connectors from the appropriate headers on the board. See drawing below



Screws

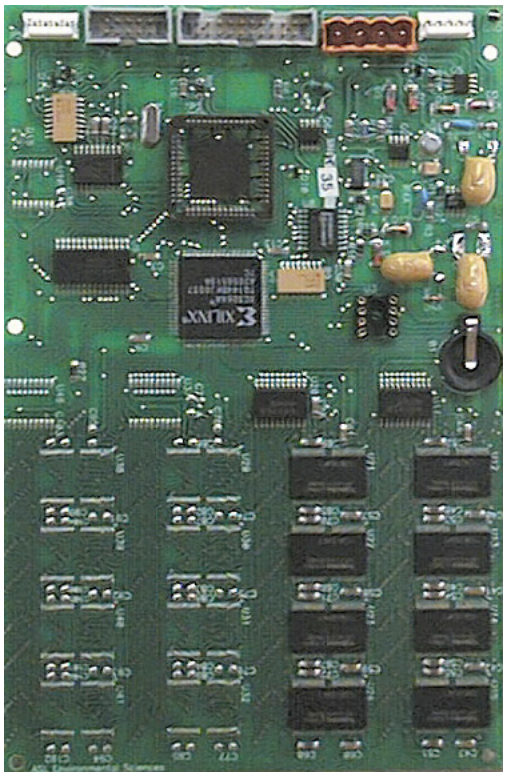
To gain access to the electronics the WCP top plate must be removed. This is accomplished by removing the three parallel screws located on top of the plate (see Diagram). To remove the plate, place a finger in the large hole of the plate and move the plate to a slight angle, then slowly slide the plate from the pressure case. **(Note: Do not apply too much of an angle as the tilt sensor is located directly under the plate)** There is a spring plunger attached to one side of the plate, which stops mooring and shipping vibration. This is the reason it is easier to remove the plate at an angle. Note: there are a number of wires, which enter the chassis through this large hole. Make sure these wires are not disturbed during this process.

To gain more access to the electronics remove the bottom end cap. This is accomplished in the same manner as described above. Remove the screws and the pressure case can now be slid up over the WCP Chassis.

2.3 Clock Battery Installation

Clock Battery

The WCP also has a small button style battery (3 volt type CR1220) located in a clip on the middle right-hand side of the Digital Board. (See Figure 5)



Button Style Battery Clip

Figure 5. (Digital Board)

This provides battery back up for the real time clock only when the main battery pack is disconnected. The battery should be checked periodically and replaced when its voltage has dropped below 2.2 volts.

2.4 Closing the Pressure Case

Caution: Do not over tighten the bolts that hold the end cap to the pressure case. If tightened to far, you can crack or damage the plastic housing. On the other hand if the bolts are not tightened enough the pressure case could flood. Tighten the pressure case bolts to the recommended torque value shown below:

Note: the recommended torque value for the end cap 6-mm bolts is 5.6 Newton-meter (50 pound-inches)

The following describes the correct procedure for replacing the end caps for deployment:

- Stand the pressure case on one end
- Inspect, clean and lubricate the O-ring housing (See O-ring Inspection and replacement) Apply a thin coat of silicone lube to the O-ring. (Use Dow corning #111 Lube). Do not use too much O-ring sealant. Using too much sealant could cause the case to leak.
- Lower the end cap onto the housing, aligning the mating holes on the end cap with that of the pressure housing. Try to apply equal pressure to all parts of the o-ring. **Make sure the face o-ring remains in the retaining grove and that no wires are pinched between the transducer housing and the end cap. Pinched wires could cause possible flooding.**
- Examine the end cap assembly nuts for corrosion and replaced if needed. Install all four sets of hardware until they are finger tight.
- Tighten the bolts in a "cross" (Star) pattern until the split washer flattens out. Then tighten each bolt ¼ turn in the same star pattern to compress the O-ring evenly. **Caution: apply equal pressure to the O-rings. If one is tightened more than the others the O-ring may become pinched and a damaged O-ring may flood the case.**
- Finally using a torque wrench tighten the bolts to the required 5.6 Newton-meters (50 pound – Inches)

O-ring Replacement and Inspection

A successfully sealed pressure case and deployment will depend on the quality of the O-rings and following the correct installation procedure.

Note: It is recommended with each new deployment to use a new set of O-rings

O-ring inspection instructions follow:

- Perform a visual inspection on all O-rings. Each ring should be free of foreign matter, scratches nicks and abrasions. Run your fingers around the entire circumference of the o-ring. If any defects are visible replace the o-ring immediately
- Clean and inspect the o-ring groves on the pressure case. The groves should also be free of foreign matter, scratches, indentations and pitting. Run your fingernail across the surface of the grove. If you cannot feel a defect the damage may be minor. Otherwise damage will need to be repaired.
- A scratch on the plastic housing may be repaired using 600 grit-wet sandpaper. Use care not to sand too much material and cause further damage.
- Lubricate the O-ring with Dow corning DC-111 lubricant. Apply the lubricant using latex gloves. Do not let any loose fiber or lint stick to the O-ring.

A chassis assembly drawing follows: (Figure 7)

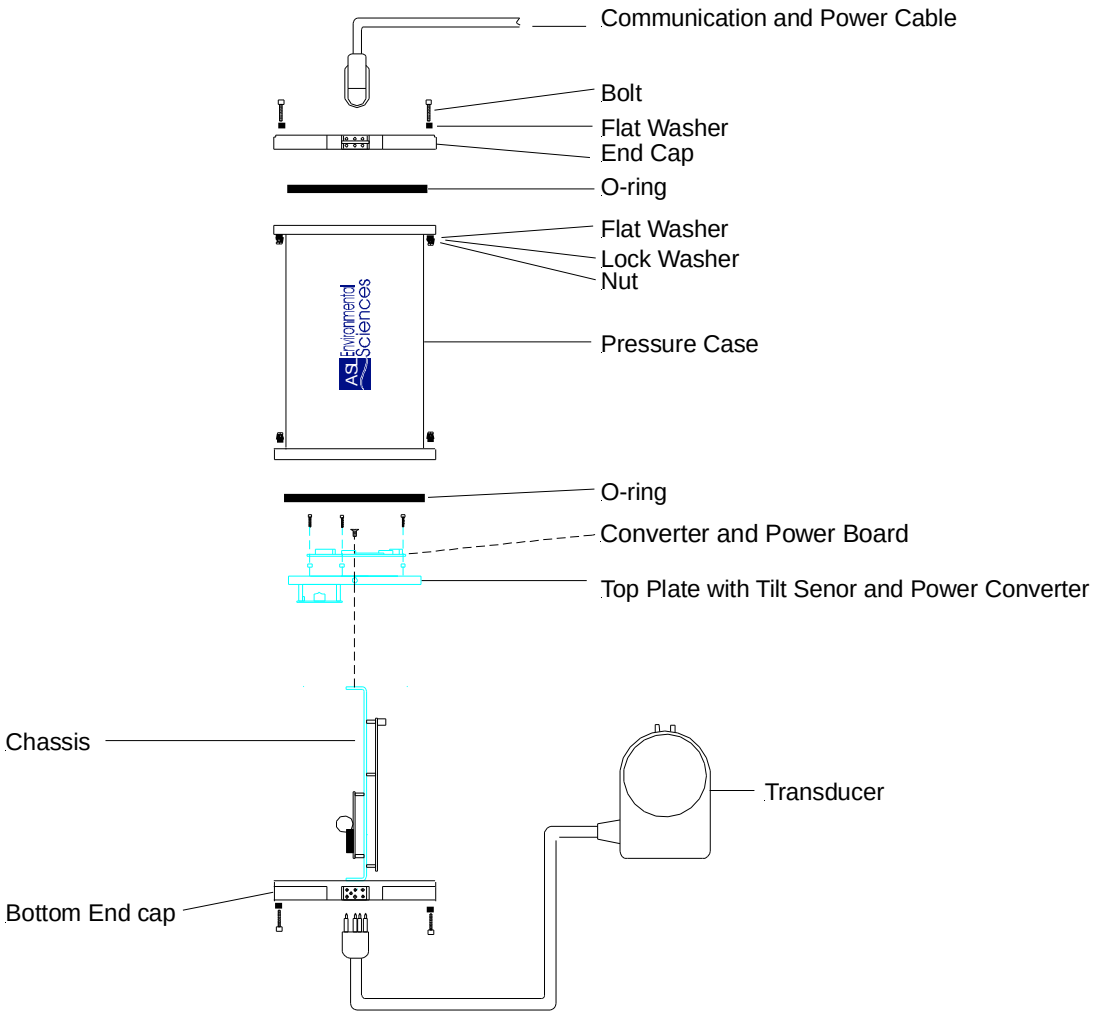


Figure 7

Chapter

3

Operation

3.1 Starting the WCP

Preparing the WCP

With power connected and a suitable computer running the WcpRealTime software, the WCP is now ready to be tested. The unit can be run directly from a power source with a range of voltage from 36VDC to 72 VDC. The unit can be remotely powered through the test cable provided using a laboratory power supply.

- Connect the interface-power cable to the electrical bulkhead connector on the top of the WCP end cap. There is only one way that the cable connector can attach to the bulkhead connector. Make sure the pins match up before pressing the cable into the connector.

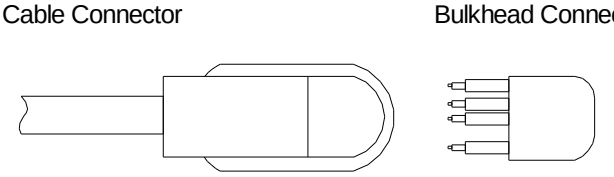
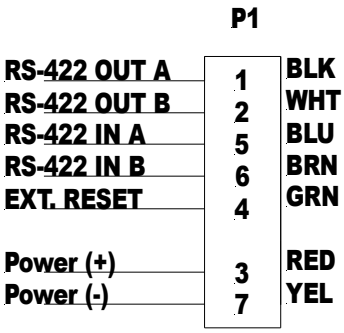


Figure 8

- Apply power to the communication cable as per the drawing shown below: (Un-terminated cable



- Attach a Rs-422 converter to the un-terminated wires)(See drawing in appendix E for communication connections)
-
- .

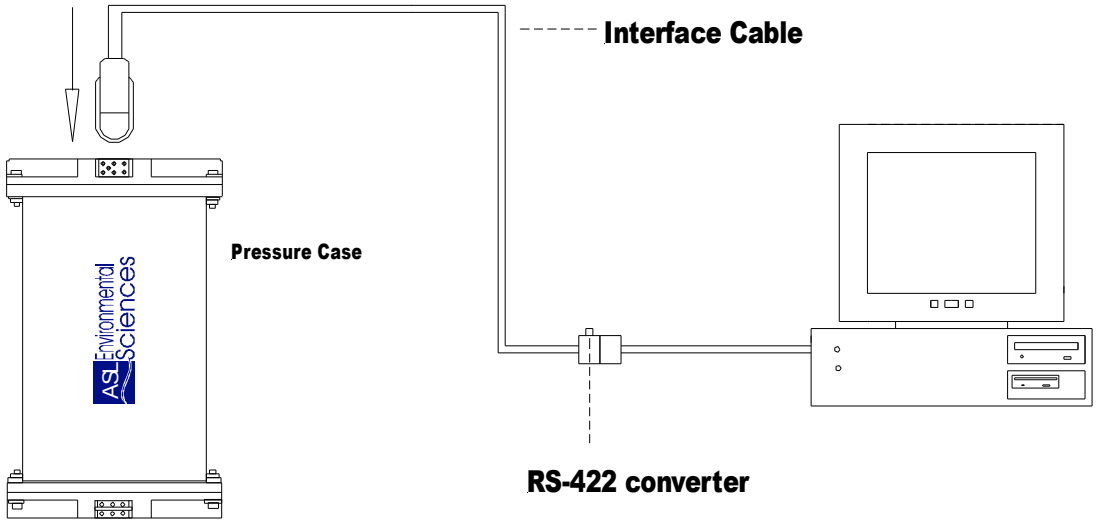
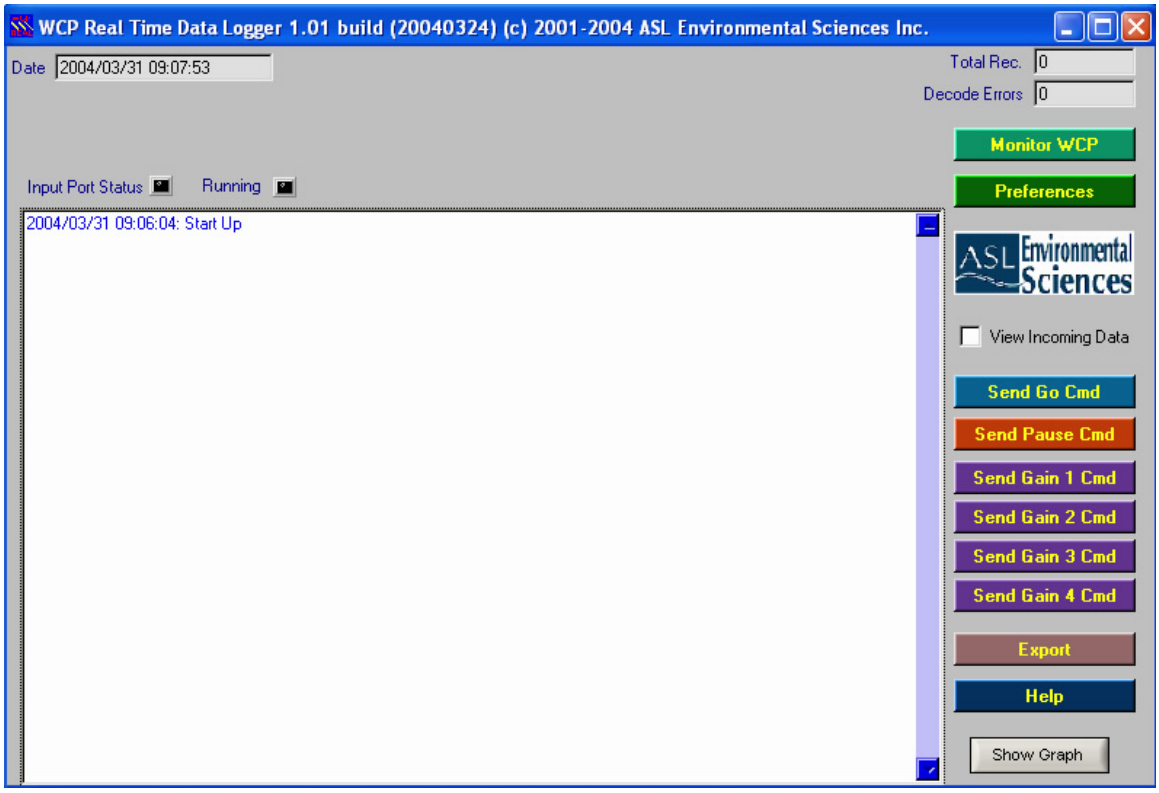
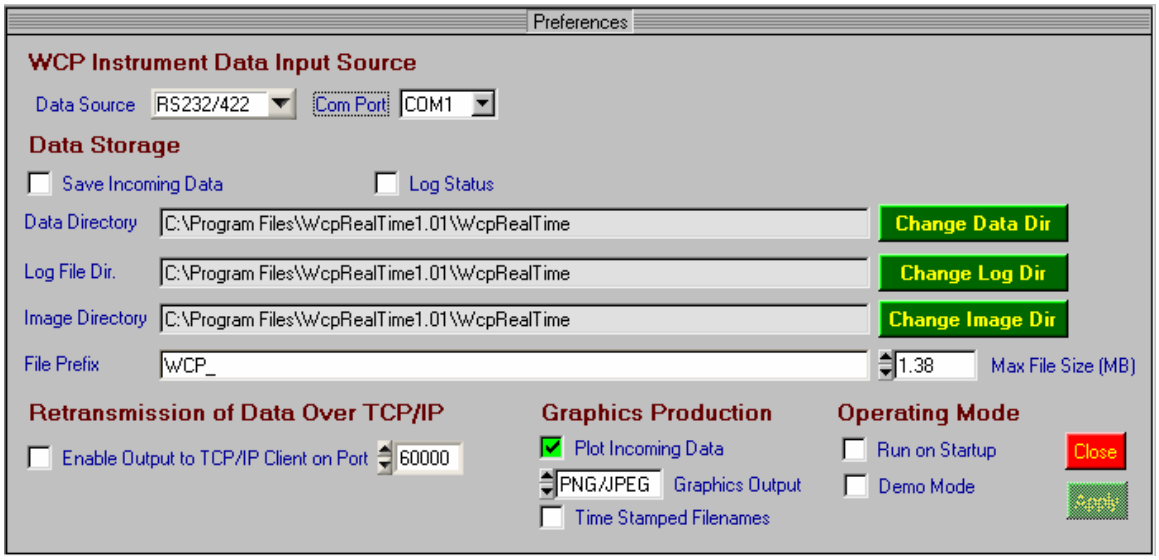


Figure 9

Start the WcpRealTime software. The following dialog box appears.

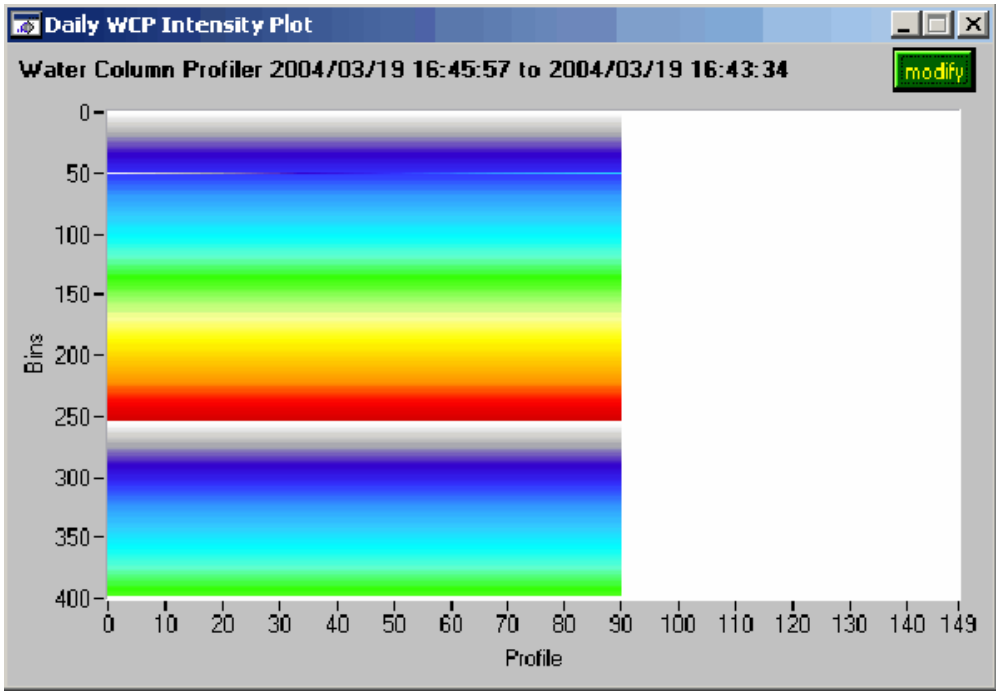


- Preferences can now be set by clicking the "**preferences"** button. This will allow the user to set parameters such as where the data is to be stored on the computer, where the log file is placed and where any images are to be stored. See example below: (Please consult the WcpRealTime manual for full explanations on each parameter shown below)



- Power can now be applied. The WCP will start immediately.

- Pressing the graph button will produce an intensity graph of incoming profile data. The graph is updated every 15 profiles. See example below.



With the use of the software data can be logged to ASCII files on the local hard disk. The plots can be saved as .jpg and .png images on the local hard disk for possible use on a web page etc. The software can also be configured as a TCP/IP server for transmission of data to a remote PC. For information on setting up these operations please consult the WcpRealTime manual.

Preparing the Instrument for Deployment in the Ocean

Unplug the Interface cable from the WCP and place a dummy plug on the exposed bulkhead connector (See Figure 7) and attach the locking strap. A light amount silicon spray on the bulkhead connector and Transducer connector will make it easier to connect and remove the plug. The lubricant is also very important to provide a watertight seal during deployment. Consult Appendix E for more information on connector installation and maintenance. **Improper connector maintenance may seriously endanger a successful deployment.** Consult section 2.4 for further details.

The WCP is now ready for deployment. Considerations for deployment of the instrument include:

- The pressure case needs to be properly secured (see section 2.5 – Closing the Pressure Case). A sacrificial anode may need to be fastened to the instrument and, as required to the mooring system, to ensure adequate corrosion protection.

- A suitable mounting arrangement or underwater mooring system is used to support the instrument.

- Just prior to deployment of the WCP in water, it is recommended that the unit be tested to ensure that it is sending out acoustic pings. This test can be carried out by using a portable AM radio tuned to frequencies between 600 and 900 KHz. The acoustic ping will be detected by the radio circuitry and emit a distinct sound from the radio. These sounds should be detected repetitively at the Ping Interval.

3.2 Mooring The WCP

When mooring the WCP in shallow water, it should be positioned sufficiently far beneath the water surface in order to minimize hazards. Depths greater than 180 m are to be avoided (unless factory modifications are made) because of the large sound transmission loss associated with round-trip travel to the surface.

Chapter

4

Demobilizing the WCP

4.1 Cleaning

It is recommended that the WCP be rinsed thoroughly with fresh water after a deployment. It may also be an opportune time to remove any biological growth that may have accumulated. The WCP can then be removed from the mooring frame and stored in the supplied shipping case

5.1 WCP Deployment Using A Terminal

The procedure for individual operating parameters is shown below. Text from the WCP is shown in *italics*

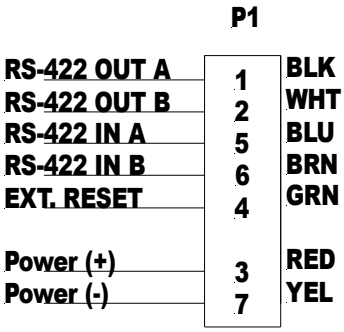
Connecting Communications

Connect the WCP RS422 Communication Interface cable to the WCP

Start a terminal emulation program on the computer and set the communication parameters to 116900 N81.

Powering Up

- Apply power to the communication cable as per the drawing shown below: (Un-terminated cable. **Note: changing operating parameters must be done quickly as the WCP is designed to start as soon as power is applied.**



The following menu should appear:

WCP Main Menu

Water Column Profiler

RT Version 1.3.1

ASL Environmental Sciences, Sidney, B.C.

TIME : 02/09/04 16:02:33

MAIN MENU

D = Deployment parameters
U = Utilities
V = View Setup

WCP :->

Setting the Clock

Choose “U” from the main menu, which will take you to the Utilities Menu:

WCP :-> u

UTILITIES:

TI = Tilts
BA = Batteries
RA= Ram check
FL = Flash format
SY = System check
GX = x is Gain Setting 1 to 4
CL = Set clock
[esc] = return to main menu

Type “CL” to set the clock.
The WCP will show the current date and time and show the format for entering the desired date and time (usually GMT).
After setting the clock, you can perform tests on the WCP systems using the other commands in the utilities menu or press [esc] to return to the main menu.

Tilts

Type “TI“ in the utilities menu. The unit will then supply the raw tilt data counts.

Batteries

Type “BA“ in the utilities menu. The unit will then supply the raw Battery voltages.

Ram Check

Type “RA“ in the utilities menu. The units Static Ram will now be tested. Note if any errors occur the unit will have to be returned to the ASL for chip replacement.

Flash Check

Type “FL“ in the utilities menu. The WCP will begin to check the on board FLASH memory. then it is best to let the WCP continue to the end and erase all the chips (approx 1-2 min).

Erasing Data Memory...

Number of Blocks/Chip that do not erase:

00:000 01:000 02:000 03:000 04:000 05:000 06:000 07:000
08:000 09:000 10:000 11:000 12:000 13:000 14:000 15:000
16:000 17:000 18:000 19:000 20:000 21:000 22:000 23:000
24:000 25:000 26:000 27:000 28:000 29:000 30:000 31:000

Note: there may be only 16 chips on the board.

Gain Setting

Type “GX’ in the utilities menu. The gain setting can now be changed by typing in a number from 1 to 4 depending on the desired gain setting. See section Appendix “D” 2 for further information on gain settings.

Deployment Parameters

Choose “D” from the main menu, which will start the deployment process:

WCP :-> d

The first user programmable parameter appears (Ping Length).

Ping Length [00300 uS] :-> 300

Set the Ping Length to the desired setting and press Enter. The Max Range parameter will now appear.

Max Range (200 m):-> 200

Type in the desired Range and press enter. The WCP promt will now appear. The settings have now been changed.

WCP :->

View Setup

Type in “V” at the WCP prompt

WCP :-> V

The current settings can now be viewed. See example below:

Appendix

A

Appendix A. Trouble Shooting

1. Software will not communicate properly with WCP.

    - Check Interface cable.
    - Check Com port setting in the software as well as the computer being used.
    - If communication still does not exist, check all internal wire harnesses and connectors on the WCP. (Consult the factory)

2. Communication cable will not fit on to the bulkhead connector.

    - Make sure pins are not bent on the bulkhead connector.
    - Make sure the pins on the interface cable are not blocked in any way.
    - Be sure the cable is oriented properly.

3. Instrument will not fit into the pressure case properly.

    - Make sure there are no wires protruding from the WCP Chassis.
    - Check for any nicks or blockages on the O-rings.
    - Ensure O-rings are properly coated with O-ring sealant.

4. Clock is reset to 2002

    This occurs when:

    - The clock battery power has been interrupted, or
    - The Micro Controller is removed, or
    - The clock battery drops below 2.2 volts.

    Note: If the clock power is interrupted for any reason, the WCP will revert to the default setting of January 1st, 2002. If this occurs check for the above problems, then reset the clock.

Appendix

B

Appendix B. Deployment Parameters

Table 1: Control parameters that define an operating phase of a WCP deployment

PARAMETER	Unit	Minimum	Maximum	Description
Ping Length (or Width)	µs	0	1020	Duration of ping
Maximum Range	meter	1	255	Furthest distance to look for echoes
Gain		1	4	Gain selection value

Appendix

C

Appendix C. Calibrations

Calibration Coefficients for use in further analysis of the saved data.

1. Speed of Sound (m/s)

Integrated speed of sound of the water column from the WCP to the water target, as estimated by the user.

2. Tilt Coefficients

Tilt coefficients are measured by ASL by operating the WCP at 20 different tilt angles, ranging from –20 degrees to + 20 degrees, as independently measured using a high pressure digital tilt meter. The calibration coefficients are computed using a least squares fitting method to a third order polynomial equation.

E.1 Tilt X Coefficients

Calibration Coefficients:
X_a (degrees); X_b (degrees); X_c (degrees); and X_d (degrees)

$Tilt\_x\ (degrees) = X\_a + X\_b\ (N_X) + X\_c\ (N_X)^2 + X\_d\ (N_X)^3$

Where N_X is the measured output count (0 – 255) from the WCP A/D output.

E.2 Tilt Y Coefficients

Calibration Coefficients:
Y_a (degrees); Y_b (degrees); Y_c (degrees); and Y_d (degrees)

$Tilt\_Y\ (degrees) = Y\_a + Y\_b\ (N_Y) + Y\_c\ (N_Y)^2 + Y\_d\ (N_Y)^3$

Where N_Y is the measured output count (0 – 255) from the WCP A/D output.

Appendix

D

Appendix D. Technical Information Notes

1. Sound Speed values for Max Range

The WCP interface has been designed to allow the user to enter the Maximum Range value in metres. In order to implement this, a value had to be chosen for the speed of sound to use in the instrument. This value used in the WCP is only for calculating the Maximum Range. The speed of sound used to convert the data collected by the instrument is specified by the end user in the calibration file during the post processing procedure.

Due to limitations of the micro-controller with respect to integer numbers and timing loops the actual speed of sound value used in calculating the ranges is different depending on the value entered for each parameter such that:

Maximum Range:	Speed of Sound
Ranges <= 26m:	1458 m/s
Ranges > 26m:	1461 m/s

2. Gain Selection

To make the WCP more versatile with respect to target strength a feature was added to allow the user to select one or more possible gain responses. Each gain response corresponds to a different operating mode. The desired gain response is selected by clicking the desired button on the main panel of the WcpRealTime. The gain selections are numbered from 1 to 4. Four resistors on the gain board set the appropriate gain curve for the settings given in the software. All gain selections are listed below:

Gain 1 (R=215k)
Gain 2 (R=169k)
Gain 3 (R=147k)
Gain 4 (R=121k)

The gain control circuitry is contained on a small board that is attached to the upper right hand side of the sounder board. The board is simply slid over the small headers already attached to the sounder board.

4. Installation Instructions for Connectors

1. When mating the connectors, there may be some difficulty due to trapped air. A slight wiggle of the connector back and forth while squeezing the air pocket with your index finger and thumb will help to "burp" out the trapped air. This is a good sign, since the trapped air indicates that the sealing faces of the connector are performing properly.
2. Be cautious that the back and forth motion is not too severe. This can lead to broken or intermittent contact between the conductors and the contacts.
3. Use of a dummy connector is always recommended. This will aid in keeping sealing surfaces clear of contamination and damage.

5. Maintenance Instructions for Connectors

A.. Visual Examination of Connectors before Mating

1. Check for any debris that may be on any connector mating surfaces. This can hinder mating and cause damage to the sealing surfaces. Debris must be removed.
2. Check the connector sealing surfaces for any signs of scratches, nicks, cuts, or tears which may lead to water intrusion. If any of these occur the connector should be replaced before continuing.
3. Verify that the correct contact configuration is being mated together. Mating a 4 contact male connector into a 3 contact female connector with extreme force could cause contact damage as well as punctures and tears along bond surfaces, which may not be apparent to the eye.

B. Lubrication of Connectors before Mating

1. Lubricate the connectors with a Silicone Spray before mating. This will allow the sealing surfaces to be matted without high friction forces, which may lead to damage to the sealing surface.
2. Spraying will also possibly remove any excess contaminants that may be left on the surfaces, which were not fully cleaned off.
3. Lubrication should be performed every time the connector is mated and unmated.
4. **Do not use WD-40 as a lubricant since it is made up of mineral spirits, which destroy chemical bonds.**

C. Sealing Mechanism of Neoprene Connectors

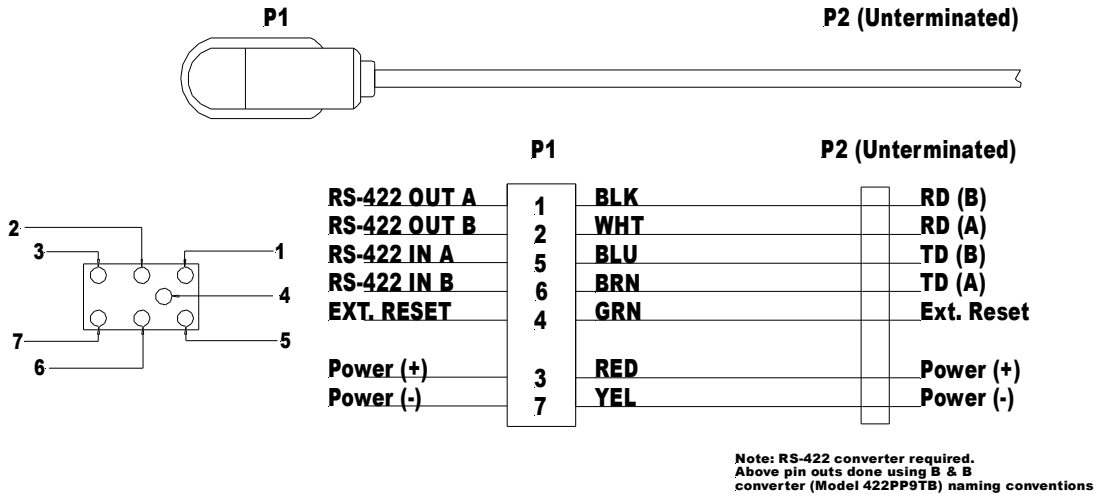
1. The sealing mechanism of these connectors is the inner diameter of the female connector and the outer diameter of the male connector.
2. The ring and grove seen on the connectors does not provide the sealing, instead the ring portion is a mechanical ring (m-ring) that helps to keep the connector mated. If the locking sleeve is left off the assembly or had come unthreaded. The m-ring would mechanically keep the connectors mated.
3. The m-ring also provides a visual indication as to whether the connector set is fully mated or not. If the m-ring is not in the corresponding grove a lump will be visible on the female connector surface. This makes it very easy to see that the connector is not mated.

Appendix

E

Appendix E. INTERFACE AND POWER WIRING DIAGRAMS

The following diagram shows the wiring schematics for the Interface cable as well as the power pin outs for the bulkhead connector:



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