WorkHorse Monitor / Sentinel User's Guide

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NOTES

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Monitor and Sentinel User's Guide

Introduction

Thank you for purchasing the Teledyne RD Instruments (TRDI) WorkHorse Monitor/Sentinel Acoustic Doppler Current Profiler (ADCP). This User's Guide will lead you through the steps required for a successful deployment. Please read the entire guide, and then follow the instructions in the order they are presented. Additional information can be found in the WorkHorse Technical Manual that is supplied on CD-ROM.

NOTE. To purchase a printed copy of the WorkHorse documentation (includes the WorkHorse Technical Manual and software guides), contact our Customer Service department at rdifs@teledyne.com or call (858) 842-2600 and order the WorkHorse Manual kit.

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Overview

The first step is to become familiar with the Monitor/Sentinel ADCP. Read the short descriptions of the hardware and software that comes with the WorkHorse.

This Section Covers:

- Hardware Overview
- Battery Packs and Power Overview
- Serial Communication Overview
- Deployment Overview
- Software Overview
- Installing the Software

Hardware Overview

The WorkHorse Sentinel ADCP system consists of an ADCP, cables, battery pack, flash memory card, and software. The WorkHorse Sentinel can also be used for direct-reading current profile operation. The ADCP requires the addition of a Windows® compatible computer to configure the ADCP and replay collected data.

The WorkHorse Monitor system consists of an ADCP, cables, and software. The Monitor does not include the internal battery or flash memory and therefore uses a shorter housing. The Sentinel and Monitor use the same electronics.

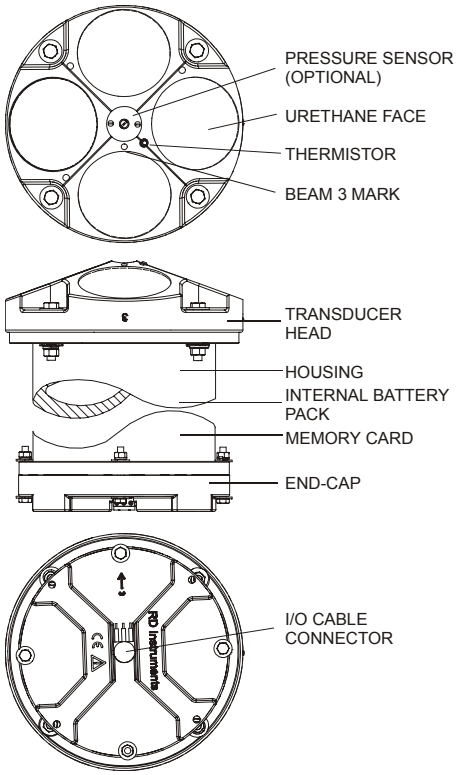


Figure 1. WorkHorse Sentinel Exploded View

The transducer assembly contains the transducer ceramics and electronics. Standard acoustic frequencies are 600 and 1200 kHz. See the outline drawings in the WorkHorse Technical Manual for dimensions and weights.

I/O Cable Connector – Input/Output (I/O) cable connects the WorkHorse ADCP to the computer.

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.

Housing – The WorkHorse housing allows deployment depths to 200 meters.

Thermistor – The Thermistor measures the water temperature.

Pressure Sensor – The optional pressure sensor measures water pressure (depth).

Transducer Head – The WorkHorse electronics and transducer ceramics are mounted to the transducer head. The numbers embossed on the edge of the transducer indicates the beam number. When assembling the unit, match the transducer beam number with the Beam 3 mark on the end-cap.

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

Internal Battery Pack – WorkHorse Sentinel ADCPs use an internal battery pack to provide power to the ADCP.

Flash Memory Card – WorkHorse Sentinel ADCPs come standard with one memory card. Two PCMCIA memory cards slots are available, with the total memory capacity not to exceed 1GB.

Battery Packs and Power Overview

WorkHorse Monitor/Sentinel ADCPs require +20 to 50 VDC to operate. The standard AC Adapter runs on any standard AC power and supplies +48 VDC to run the WorkHorse when the batteries are not connected. The WorkHorse Sentinel's internal battery supplies +42 VDC.

NOTE. The AC Adapter input voltage is sufficient to override the internal battery voltage (i.e. the ADCP will draw all power from the AC adapter even if the battery is installed and connected). Always use the AC adapter when testing the ADCP to conserve the battery power.

Keep in mind the following about Sentinel battery packs:

- TRDI specifies its battery packs to have 450 Watt-hours (Wh) of usable energy at 0°C.
- A Standard WorkHorse battery packs hold 28 'D-cell' alkaline batteries with a voltage, when new, of approximately 42 VDC.
- When the capacity of a battery pack is 50% used, the voltage (measured across the battery connector under no-load conditions) falls to approximately 32 to 35 volts. However, keep in mind that this voltage is not an accurate predictor of remaining capacity.

- Transmitted power increases or decreases depending on the input voltage (within the voltage range of 20 to 50 VDC). A fresh battery provides +42 VDC. Batteries spend most of their life at a nominal voltage of +33 VDC.

NOTE. The transmitted power is decreased one DB if the input voltage drops from 42 VDC to 33 VDC. For a 600 kHz WorkHorse ADCP, each one DB drop will result in a decrease in range of one default depth cell.

- Batteries should be replaced when the voltage falls below 30 VDC (measured across the battery connector under no-load conditions).
- Battery packs differ from one to another.
- Store batteries in a cool dry location (0 to 21 degrees C).
- Do not store batteries inside the ADCP for extended periods. The batteries may leak.
- Use batteries within one year (shelf life).

NOTE. Battery replacement induces both single and double cycle compass errors. The compass accuracy should be verified after replacing the battery pack. The compass does not have to be recalibrated if the compass verification passes specification.

These compass effects can be avoided by using an optional external battery pack. The optional external battery housing holds two batteries, and can easily be replaced on-site. If the optional external battery is placed a minimum of 30 cm away from the ADCP, no compass calibration will be required.

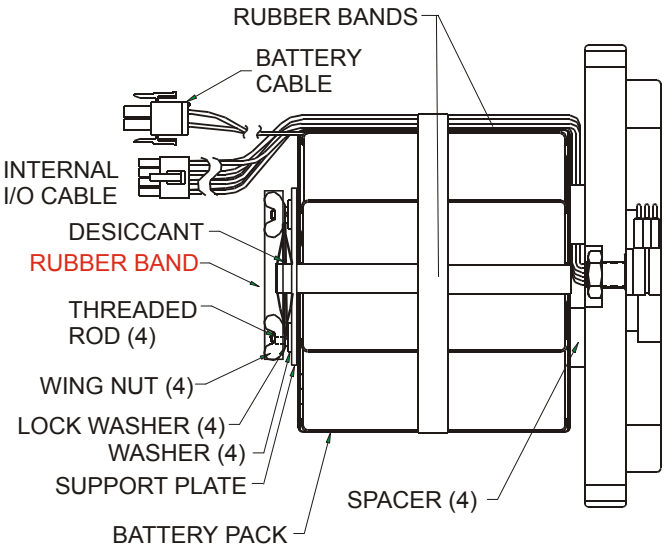


Figure 2. WorkHorse Sentinel Battery Pack

Optional External Battery Pack

The optional External Battery Pack holds two 450 Watt-hours (Wh) batteries. To avoid affecting the compass, place the external battery case at least 30-cm away from the WorkHorse ADCP.

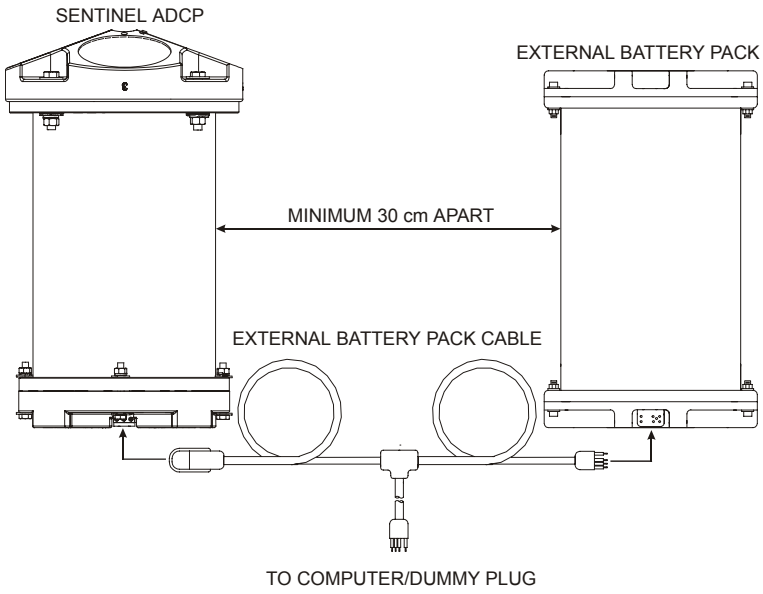


Figure 3. External Battery Pack Connection

NOTE. The optional external battery pack can be used with both the WorkHorse Monitor and Sentinel model ADCPs.

Flash Memory Card

WorkHorse Sentinel ADCPs come standard with one memory card. Two PCMCIA memory cards slots are available, with the total memory capacity not to exceed 2GB. Memory cards are not included with the Monitor ADCP. The PC Card recorder is located on the Digital Signal Processor (DSP) board inside the Workhorse's electronics. To recover data, the card can be removed and used in a personal computer (PC), or left in the Workhorse, and accessed by using *WinSC* (see the WinSC and PlanADCP User's Guide).

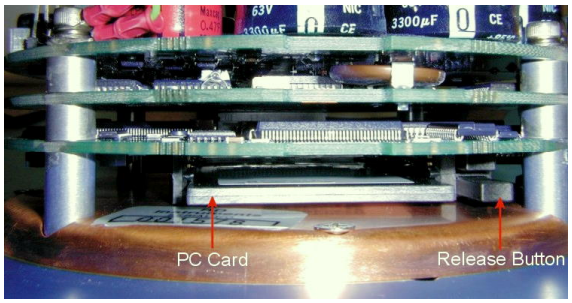


Figure 4. Memory Card Overview

Serial Communication Overview

The standard communications settings for the WorkHorse Monitor/Sentinel is RS-232, 9600-baud, no parity, 8 data bits and 1 stop bit. Self-contained applications receive no benefit from setting a faster baud rate.

You can set the WorkHorse for baud rates other than 9600 baud using the CB command (see the WorkHorse Technical Manual). If you make the new baud rates permanent with the CK command, *WinSC* and *BBTalk* will search for the correct settings if you use the **Auto Detect** function, which searches for the WorkHorse's current serial port and baud rate (see "Connecting to the WorkHorse," page 22). If you tell the programs these settings, you will save time required for searching. Both *WinSC* and *BBTalk* will use the last communication setting for future use.

Change Communication Setting. Changing a switch setting on the PIO board will change the communication setting between RS-232 and RS-422. The switch is in plain view on the top circuit board, near the cable connectors. Its settings are plainly marked on the board. If the serial protocol is set for RS-422 and your computer expects RS-232, you will need an RS-232 to RS-422 adapter between the ADCP cable and your computer. This user's guide assumes that you use RS-232. There is no reason to use RS-422 for Self-Contained operations.

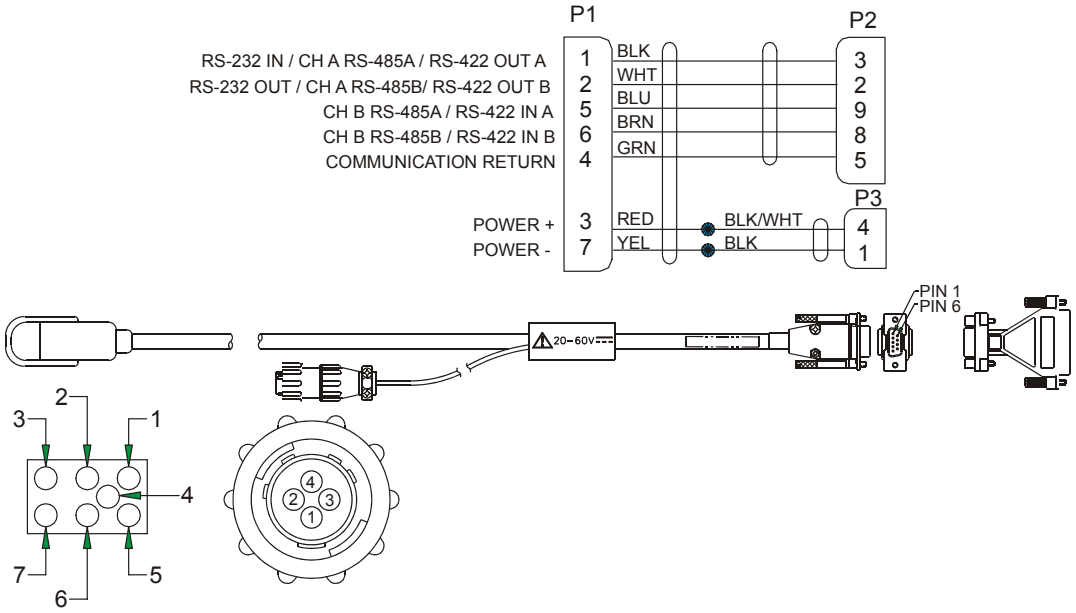


Figure 5. I/O Cable Wiring Diagram

Deployment Overview

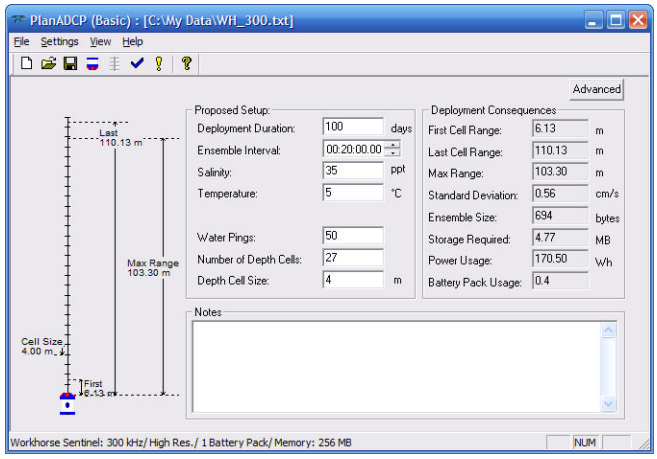
WorkHorse Sentinel deployments are most often Self-Contained but can be Real-Time. Typically, deployments are considered to be Self-Contained when the WorkHorse ADCP is remotely deployed and powered using internal batteries. In this configuration, no external connections to the WorkHorse are made during the deployment. However, the WorkHorse can be connected to external power. This power can be provide either by an external battery case or from shore. This type of deployment is still considered Self-Contained, but this guide may not consider all of the possibilities of this application.

WinSC is the software package for self-contained WorkHorse setup, data collection, and data review. *PlanADCP* (part of *WinSC*) lets you enter known or "best-guess" values for the various WorkHorse profiling parameters and shows predictions of expected results. The WorkHorse Sentinel can be used for several-month autonomous current profile deployments from temporary or permanent mountings in the ocean, near-shore, harbors, and lakes.

Real-Time use refers to the fact you are viewing the data as the WorkHorse 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. Use *PlanADCP* to create the command file to set the values for the various WorkHorse profiling parameters and *WinADCP* to view the data.

Software Overview

You will need several software programs to test and collect data with the WorkHorse ADCP.



WinSC & PlanADCP

WinSC and *PlanADCP* are designed to set up a Sentinel WorkHorse ADCP for collecting data. Specifically, *PlanADCP* will set the WorkHorse commands correctly.

The *PlanADCP* screen shows you an overview of your setup and the resulting consequences of your deployment.

For more information see the *WinSC* and *PlanADCP* User's Guide and "Collecting Self-Contained Data," page 32 or "Collecting Real-Time Data," page 43.

Check the transducer faces are clean and free from defects

Inspect the WorkHorse ADCP for damage. There should be no cracks or peeling surfaces.

Seal the WorkHorse for Deployment

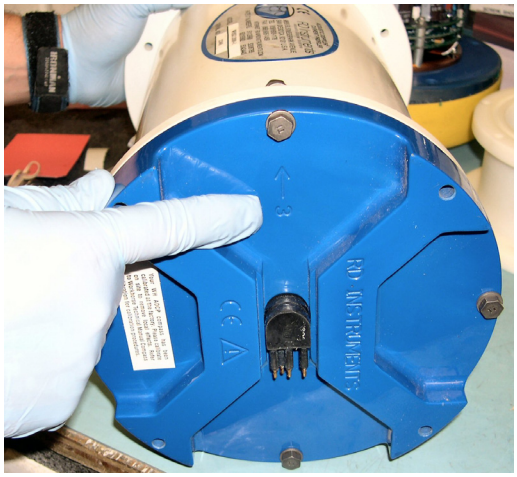
Before you put the WorkHorse ADCP into the water, you must prepare it for deployment.

- Install and connect the battery (WorkHorse Sentinel ADCP only)
- Replace the desiccant inside the WorkHorse
- Install new o-rings; use silicone lubricant
- Check all mounting hardware is installed

NOTE. Only the end-cap removal instructions are included in this Quick Start Guide. If you need access to the WorkHorse electronics, the transducer head must be removed. Please refer to the WorkHorse Technical Manual for instructions.

Install and Connect the Sentinel Battery

To install the WorkHorse Sentinel battery pack, do the following steps. Read the WorkHorse Technical Manual for details.

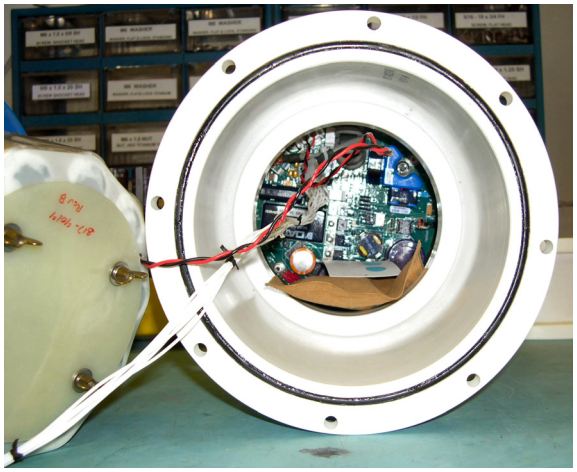


Place the WorkHorse Sentinel ADCP on its side.

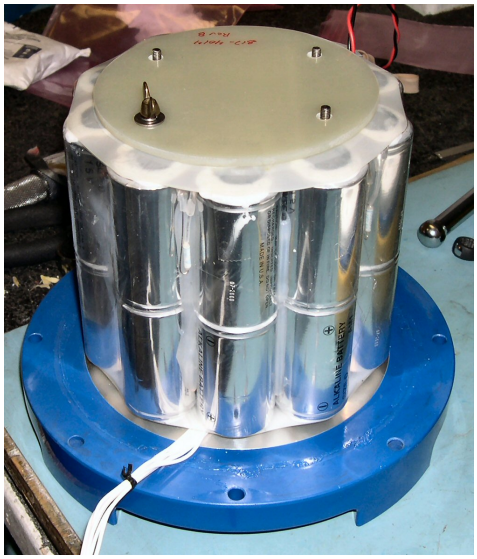
Make note of the location of Beam 3. The Beam 3 mark on the end cap should be aligned with the label on the housing and the Beam 3 mark on the transducer.

Loosen and remove the four M6 bolts holding the end-cap to the housing.

Gently slide the end-cap and battery assembly out of the housing. The two cables are long enough to allow the assembly to be placed next to the housing (see next photo).



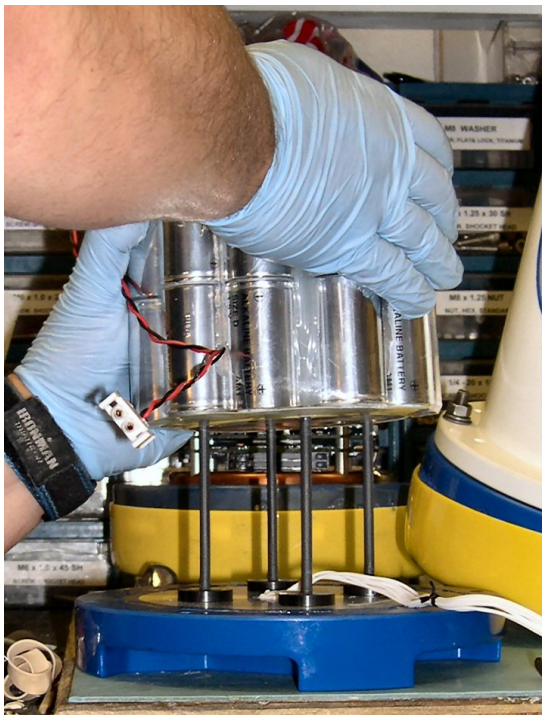
Disconnect the battery cable and internal I/O cable going to the common mode choke on the top PC Board.



Remove the four wing nuts, lock washers, and washers holding the battery pack onto the posts.

Remove the support plate.

Slide out the used battery pack.



Slide a new battery pack onto the four posts. Make sure the I/O cable is not pinched by the battery pack.

Use the large rubber bands (supplied with each new pack) to hold the cables in place.

Test the battery pack voltage by measuring across the battery connector under no-load conditions. The voltage should be +42 VDC for a new battery pack.

Position the support plate over the four posts.

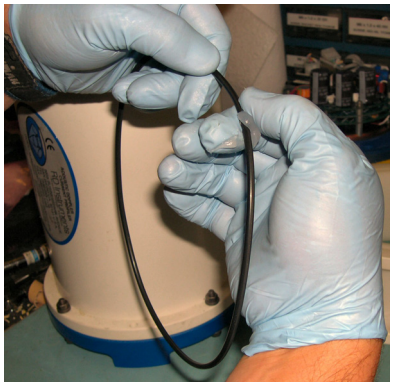
Place a flat washer, lock washer, and wing nut on each of the four posts. Tighten the wing nuts firmly to hold the battery in place.

Place a battery pack rubber band (two spare rubber bands are provided with each new battery) around all four wing nuts. This will prevent the wing nuts from backing off the post.

CAUTION. The WorkHorse Sentinel battery pack is held in place by four sets of washers, lock washers, and wing nuts. If the wing nuts are not tight, the assembly of washers and wing nut can become loose and eventually fall onto the PIO board. **This has caused the PIO board to short out.** Place a rubber band around the wing nuts to help hold them in place.

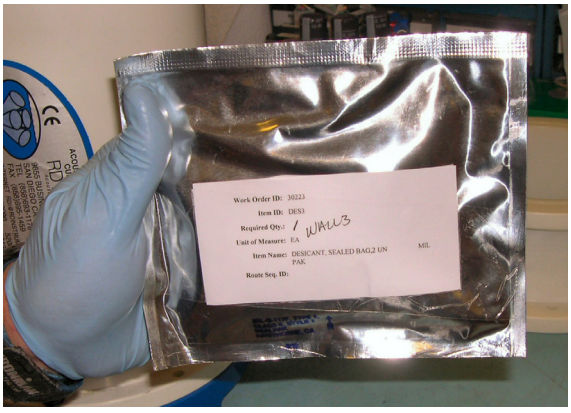
Clean the O-ring groove. Be sure the groove is free of foreign matter, scratches, indentations, or pitting. Use lint free wipes or a wood scrapper to clean the groove.

Never use Q-tips to clean the O-ring groove; loose fibers or lint can provide a leakage path.



Place a small amount of silicone lube on the O-ring and spread it over the entire O-ring surface. The O-ring should appear “shiny”. Wipe off any excess lube.

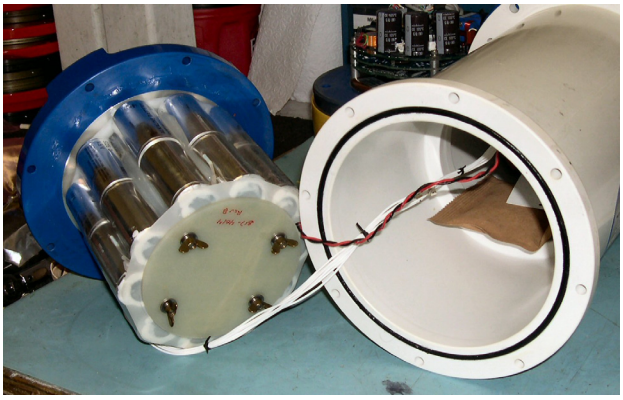
Place the O-ring in the O-ring groove on the housing.



Place a new desiccant pack and moisture indicator into the housing. Desiccant bags are used to dehumidify the housing interior.

Remove the new desiccant bags from the airtight aluminum bag.

Remove the old desiccant bags and install two new ones. Place the desiccant bags under the rubber bands on the battery pack or place on top of the PC boards.



Connect the battery and internal I/O cable going to the common mode choke.

Slide the end-cap onto the housing making sure that the beam 3 mark is aligned with the label on the housing and the beam 3 mark on the transducer head.

Make sure no wires become pinched or that the O-ring falls out of the groove.

It may be easier to tip the WorkHorse on the transducer head when connecting the end-cap to the housing. Make sure to protect the transducer faces and prevent the WorkHorse from tipping over.

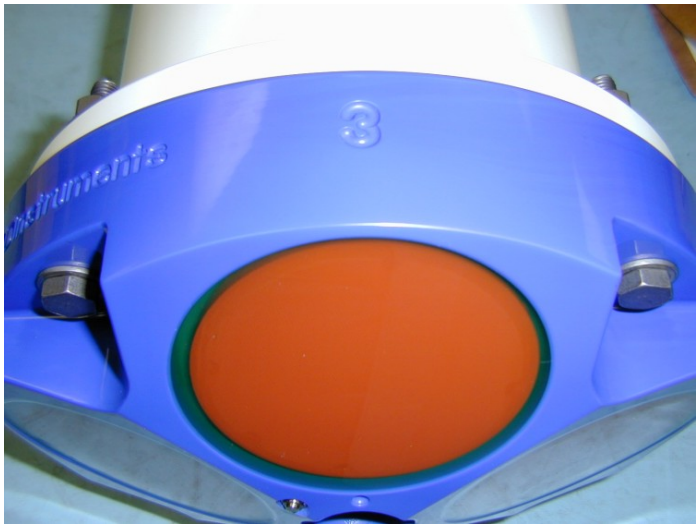
Install all four sets of hardware until “finger-tight.”

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).

Check all Mounting Hardware is Installed

If the housing is not properly sealed prior to deployment, the WorkHorse ADCP will be destroyed.



Transducer Head to Housing Seal

Visually inspect the mating surfaces of the housing to transducer head to ensure that there are no obstructions. The faces should be parallel to one another and there should be no gaps. Check to ensure that the titanium fasteners holding the housing together are tight.

The recommended torque value for the transducer head 8-mm bolts is 9.6 Newton-meters (85 pound-inches).

End-Cap to Housing Seal

Visually inspect the mating surfaces of the end-cap to housing to ensure that there are no obstructions. The faces should be parallel to one another and there should be no gaps. Check to ensure that the titanium fasteners holding the housing together are tight.

The recommended torque value for the end-cap 6-mm bolts is 5.6 Newton-meters (50 pound-inches).

CAUTION. Do not replace the titanium hardware with any other hardware. Corrosion will result.

If the WorkHorse was opened, read the WorkHorse Technical Manual – Maintenance section for details on WorkHorse re-assembly.

Bench Test

The bench-testing process ensures that the WorkHorse ADCP is working properly before you put it in the water. The bench-test procedure will involve powered tests that will verify that the WorkHorse ADCP's electronics and transducers are functioning.

This Section Covers:

- Setup the WorkHorse ADCP
- Test the WorkHorse ADCP
- Compass alignment

Setup the WorkHorse ADCP

You will now connect the WorkHorse ADCP to a power supply and a computer with the TRDI software installed.

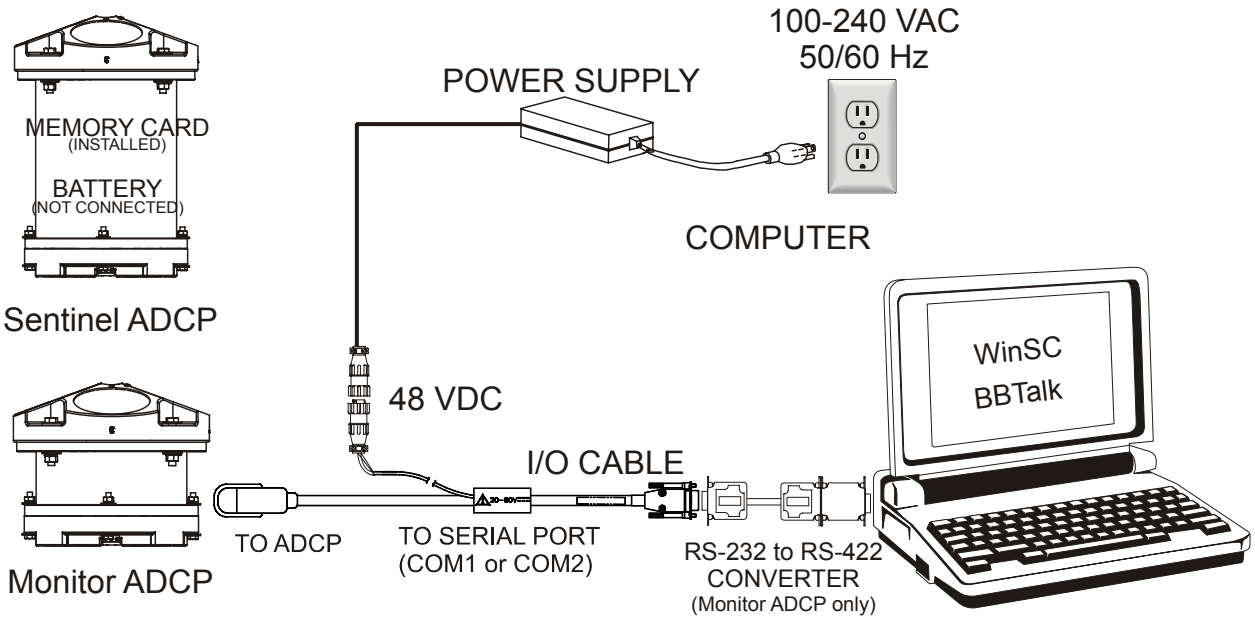


Figure 7. WorkHorse Connections

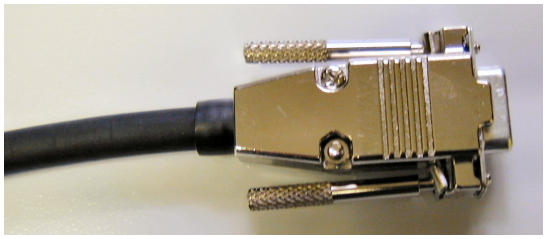
CAUTION. WorkHorse Sentinel batteries are shipped inside the WorkHorse ADCP but not connected. **Connect the battery and seal the WorkHorse ADCP before deployment.**

For testing, the battery can be disconnected to save battery power. If the battery is connected, use the AC adapter to override the battery voltage to conserve the battery (see "Battery Packs and Power Overview," page 3**).**

Connect the I/O Cable to WorkHorse

If you have not done so, connect the I/O cable to the WorkHorse ADCP. Do so by pushing straight in against the connector. Roll the retaining strap over the connector.

Place a light amount of silicone lubricant on the connector pins (rubber portion only). This will make it easier to connect or remove the I/O cable and dummy plug.



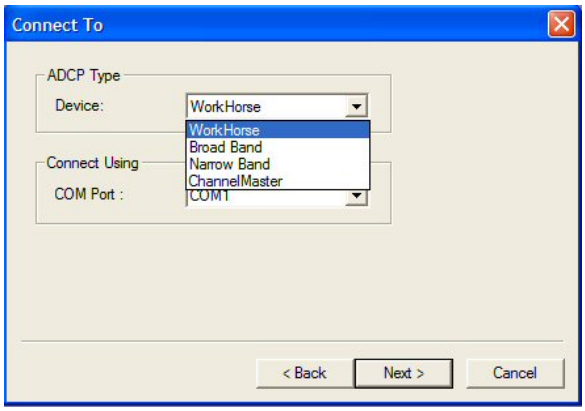
Connect the I/O Cable to Computer and Power Supply

Attach the I/O cable to your computer's communication port. The standard communications settings are RS-232, 9600-baud, no parity, 8 data bits and 1 stop bit. Self-contained applications receive no benefit from setting a faster baud rate.

Connect the power supply to the power cable.

Connecting to the WorkHorse

Use these next steps to “talk” to the WorkHorse ADCP.



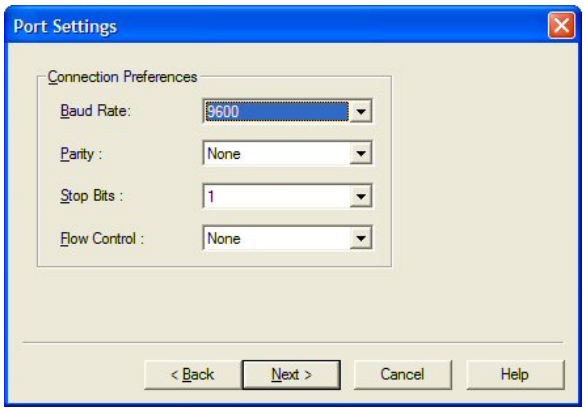
Start BBTalk

Start the *BBTalk* program (for help on using *BBTalk*, see the RDI Tools User's Guide).

On the **Connect To** screen, select **WorkHorse**.

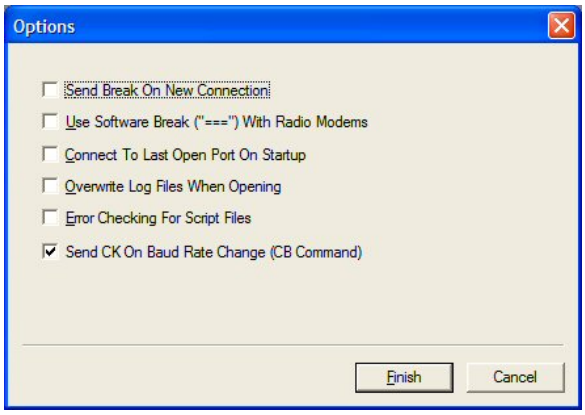
Select the COM port the WorkHorse ADCP cable is connected to.

Click **Next**.

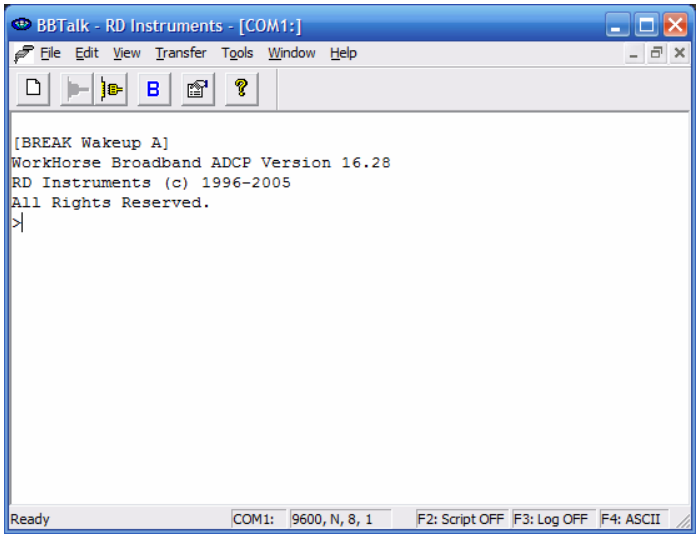


Enter the **Baud Rate**, **Parity**, **Stop Bits**, and **Flow Control**. If you are unsure of the settings, leave them at the default settings.

Click **Next**.



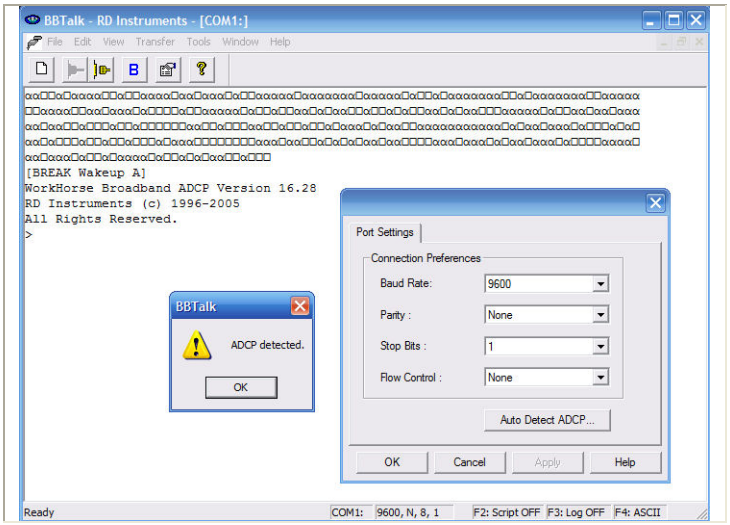
Click **Finish**.



Wakeup

On the **File** menu, click **Break** (you can also press the **End** key to send a break or press the **B** button on the Toolbar).

You should see the wakeup message appear on the log file window.



If the wakeup message is not readable, do the following.

On the **File** menu, click **Properties**. Click the **Auto Detect ADCP** button. Click **OK** when the WorkHorse is detected. Try to wakeup the WorkHorse again.

What if the WorkHorse Does Not Respond

If your WorkHorse ADCP does not respond, check the serial port, cables, AC power, and battery connection (Sentinel only). If necessary, refer to the Troubleshooting section in the WorkHorse Technical Manual.

CAUTION. WorkHorse Sentinel batteries are shipped inside the WorkHorse ADCP but not connected. **Connect the battery and seal the WorkHorse ADCP before deployment.**

Changing the Baud Rate in the ADCPs

The ADCP can be set to communicate at baud rates from 300 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 *BBTalk* that is supplied by Teledyne RD Instruments.

```
[BREAK Wakeup A]
WorkHorse Broadband ADCP Version 16.28
RD Instruments (c) 1996-2005
All Rights Reserved.
>
>cr1
[Parameters set to FACTORY defaults]
```

Connect the ADCP to the computer and apply power.

Start the *BBTalk* program and establish communications with the ADCP. Wakeup the ADCP by sending a break signal with the **End** key.

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

BAUD RATE	CB-command
300	CB011
1200	CB111
2400	CB211
4800	CB311
9600	CB411 (Default)
19200	CB511
38400	CB611
57600	CB711
115200	CB811

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

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

The CB? command will identify the communication setting.

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

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

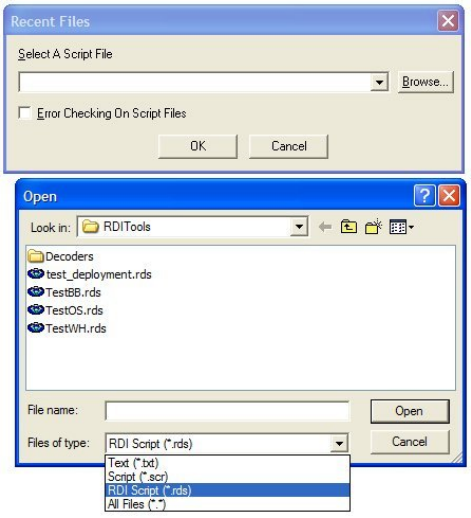
Exit *BBTalk*.

The ADCP is now set for the new baud rate. The baud rate will stay at this setting until you change it back with the CB-command.

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

Testing the WorkHorse

Before deploying the WorkHorse ADCP, it is a good idea to make sure that it is working properly. This simple test checks that the WorkHorse ADCP is able to communicate with the computer and runs the diagnostic tests.



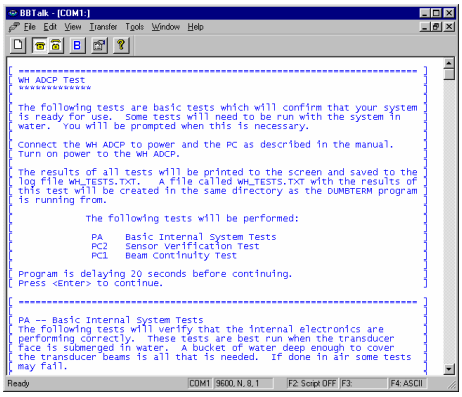
Testing the WorkHorse

Using *BBTalk*, click **File**, **Send a Break** to send the wakeup command (BREAK) to the WorkHorse ADCP.

On the **File** menu, click **Send Script File**. Click the **Browse** button "...".

On the **Files of Type** box select **RDI Script (*.rds)**.

Select the *TestWH.rds* script file and click **Open**.



Follow the prompts on the screen.

To review the test results, open the *WH_Test.txt* results log file (*.txt) with any text editor (i.e. NotePad).

Compass Alignment

The main reason for compass calibration is battery replacement. Each new battery carries a different magnetic signature. The compass calibration algorithm corrects for the distortions caused by the battery to give you an accurate measurement. You should be aware of the following items:

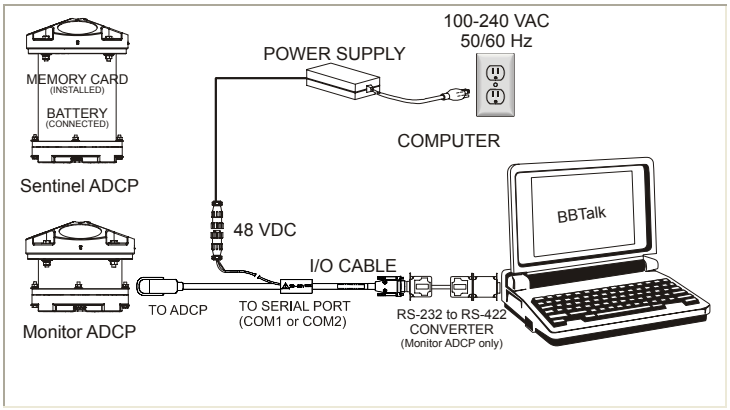
- We recommend against calibrating the WorkHorse ADCP while on a ship. The ship's motion and magnetic fields from the hull and engine will likely prevent successful calibration.
- If you think your mounting fixture or frame has some magnetic field or magnetic permeability, calibrate the WorkHorse ADCP inside the fixture. Depending on the strength and complexity of the fixture's field, the calibration procedure may be able to correct it.

NOTE. If the WorkHorse Sentinel battery module was removed and replaced back in the same orientation, the compass does not require calibration. If the battery core is replaced, you **must** verify the compass.

Battery replacement induces both single and double cycle compass errors. The compass accuracy should be **verified** after replacing the battery pack. The compass does not have to be recalibrated if the compass verification passes specification.

These compass effects can be avoided by using an optional external battery pack. The external battery housing holds two batteries, and can easily be replaced on-site. If the external battery is placed a minimum of 30 cm away from the WorkHorse ADCP, no compass calibration will be required.

Preparing for Calibration



Connect the WorkHorse ADCP as shown.

Place the WorkHorse ADCP on a piece of strong cardboard on top of a smooth wooden (non-magnetic) table. If a wooden table is not available, place the ADCP on the floor as far away from metal objects as possible. Use the cardboard to rotate the ADCP during calibration—this way you will not scratch the ADCP. Place the ADCP in the same orientation as it will be deployed.

NOTE. If you will deploy your WorkHorse ADCP looking up, calibrate it looking up. If you will deploy it looking down, calibrate it looking down.

CAUTION. If you calibrate the compass in one direction (up or down) and deploy the WorkHorse ADCP in the opposite direction (i.e. calibrate it in a downward position and deploy it in an upward position) the compass calibration will be invalid. Compass errors in excess of 5 degrees may occur.

Compass Calibration Verification

Compass calibration verification is an automated built-in test that measures how well the compass is calibrated. The procedure measures compass parameters at every 5º of rotation for a full 360º rotation. When it has collected data for all required directions, the ADCP computes and displays the results.

```
[BREAK Wakeup A]
WorkHorse ADCP Edition 43.xx
Teledyne RD Instruments (c) 1996-2006
All Rights Reserved.
                          >
```

Using *BBTalk,* send a Break to wake up the WorkHorse ADCP (press the **END** key).

```
>AX
------------------------------------------------------------------------
                    RDI Compass Error Estimating Algorithm

   Press any key to start taking data after the instrument is setup.
   Rotate the unit in a plane until all data samples are acquired...
   rotate less than 5º/sec.  Press Q to quit.
N       NE       E        SE       S        SW       W        NW       N
^                ^                 ^                 ^                 ^
```

At the > prompt, type **AX** and press the **Return** key.

```
HEADING ERROR ESTIMATE FOR THE CURRENT COMPASS CALIBRATION:
   OVERALL ERROR:
      Peak Double + Single Cycle Error (should be < 5():   ( 1.55(
   DETAILED ERROR SUMMARY:
      Single Cycle Error:                                  ( 1.54(
      Double Cycle Error:                                  ( 0.07(
      Largest Double plus Single Cycle Error:              ( 1.61(
      RMS of 3rd Order and Higher + Random Error:          ( 0.31(
```

Rotate the WorkHorse ADCP slowly 360 degrees (approximately 5 degrees per second). Pay particular attention to the Overall Error.

If the overall error is less than 2°, the compass does not require alignment. You can align the compass to reduce the overall error even more (if desired).

Compass Calibration Procedure

The built-in automated compass calibration procedure is similar to the alignment verification, but requires three rotations instead of one. The WorkHorse ADCP uses the first two rotations to compute a new calibration matrix and the third to verify the calibration. It will not accept the new matrix unless the calibration was carried out properly, and it asks you to verify that you want to use the new calibration if it is not as good as the previous calibration. While you are turning the WorkHorse for the two calibration rotations, the WorkHorse ADCP checks the quality of the previous calibration and displays the results. It compares these results with the results of the third calibration rotation.

There are two compass calibrations to choose from; one only corrects for hard iron while the other corrects for both hard and soft iron characteristics for materials rotating with the WorkHorse ADCP. Hard iron effects are related to residual magnetic fields and cause single cycle

errors while soft iron effects are related to magnetic permeability that distorts the earth's magnetic field and causes double cycle errors. In general, the hard iron calibration is recommended because the effect of hard iron dominates soft iron. If a large double cycle error exists, then use the combined hard and soft iron calibration.

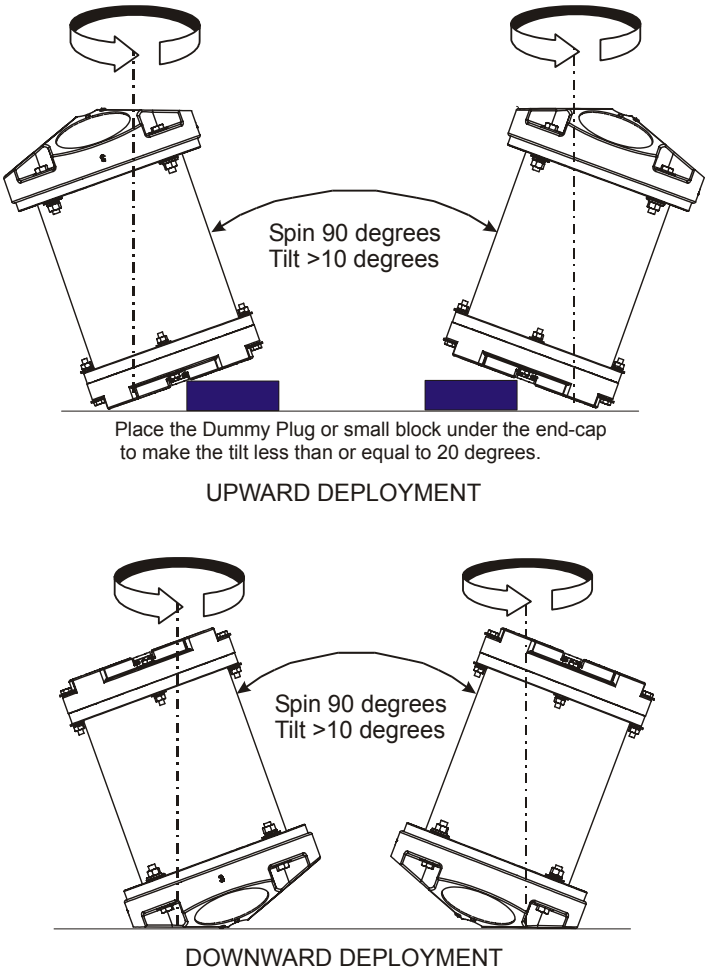


Figure 8. Compass Calibration

```
[BREAK Wakeup A]
WorkHorse ADCP Edition 43.xx
Teledyne RD Instruments (c) 1996-2006
All Rights Reserved.
>
```

Using *BBTalk,* send a Break to wake up the WorkHorse ADCP (press the **END** key).

```
>AR
Do you really want to write over the active fluxgate calibration
   data [y or n]?Y

Fluxgate Calibration Matrices Updated with Factory Original Values.

>
```

At the > prompt, type **AR** and press the **Return** key. Type **Y** to return the Fluxgate Calibration Matrices with the factory original values.

```
>AF
------------------------------------------------------------------------
                          Field Calibration Procedure
Choose calibration method:
     a.  Remove hard iron error (single cycle) only.
     b.  Remove hard and soft iron error (single + double cycle).
     c.  Help.
     d.  Quit.
```

At the > prompt, type **AF** and press the **Return** key. Choose option "b" to start the calibration procedure.

```
Tilt the unit any direction so that the combined tilt magnitude is
within the 10°-20° range indicated below.

0°                  10°                 20°                 30°
^                    ^***** ok tilt *****^                   ^
                                         ♦
  0.4° Pitch and 19.1° Roll are acceptable.  Ok to continue [y, n]?
```

Tilt the WorkHorse ADCP. Tilt an upward-looking WorkHorse with a block under one side of the end-cap. A 35-mm block will give you an 11-degree tilt. Tilt a downward looking WorkHorse by placing it on one of the beams.

Check the on-screen instructions to see if the orientation is OK. Adjust as necessary.

When prompted, press "**y"** to continue and rotate the WorkHorse ADCP slowly 360 degrees (approximately 5 degrees per second).

```
Now tilt the unit at least 10° in a different direction.

SUGGESTIONS:
  Facing up: place the block under the end cap to either side of where
  the block was for the first rotation - not on the opposite side
  of the end cap!.

  Facing down: place the ADCP facing down on either of the two beams
  that are closest to the one you just used.  Do not place the ADCP
  on the opposite beam.

-19.3° Pitch and -0.5° Roll. Tilt is OK. Press any key to continue...
```

The second rotation requires the WorkHorse ADCP to be tilted 15 degrees in another direction than from the first rotation. Follow the on-screen instructions to orient the WorkHorse ADCP correctly.

When prompted, press any key to continue and rotate the WorkHorse slowly 360 degrees (approximately 5 degrees per second).

```
Successfully evaluated compass performance after the field calibration
update.
Press any key to continue...
Making new calibration parameters permanent.
Calibration parameters have been updated in RAM and Flash.

------------------------------------------------------------------------
                          Field Calibration Procedure
                        Hard and Soft Iron Calibration

Compass field calibration procedure is complete.

>>> Total error before calibration:   2.3° <<<
>>> Total error after calibration:    0.2° <<<
```

The third rotation requires the WorkHorse ADCP to be tilted 15 degrees in another direction than from the first and second rotations. Follow the on-screen instructions to orient the WorkHorse correctly.

If the calibration procedure is successful, it records the new calibration matrix to nonvolatile memory. The WorkHorse will not change its matrix unless the calibration is properly carried out.

Optional Pressure Sensor Preparation

In order to read the water pressure (depth), water must be able to flow through the copper screw on the pressure sensor. Antifoulant paint will block the sensor's port (a small hole that is drilled through the copper screw). You should tape off the screw during anti-fouling paint application.

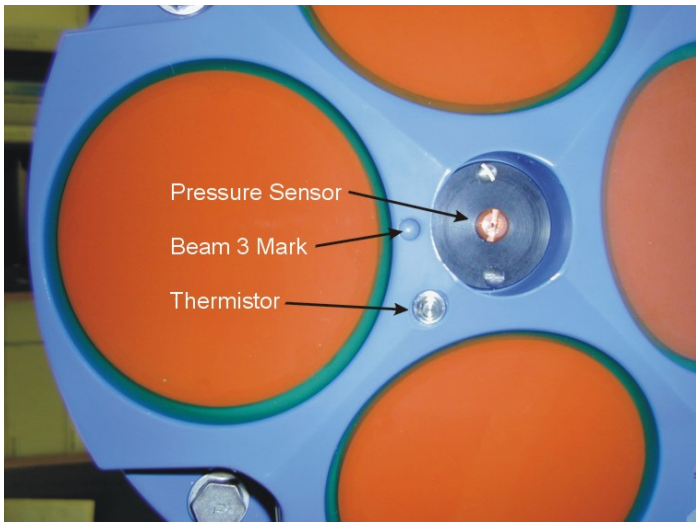
This means that the sensor port is not fully protected from bio fouling. The sensor port is surrounded by the antifouling paint, but bio fouling may build up on the screw, and eventually clog the sensor port. However, most organisms do not seem to find the small amount of unpainted surface attractive. If it is logistically possible to periodically inspect/clean the pressure sensor screw, it is highly recommended. This tradeoff situation must be analyzed for individual deployments. Unfortunately, the location of the deployment site usually dictates action in this regard.

NOTE. The pressure sensor is optional. It may not be included on your system.

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

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

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



Use the following procedure to clean the screw.

Place the WorkHorse on its' end-cap. Use a soft pad to protect the WorkHorse.

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

Gently clean out the hole in the copper screw with a needle.

Install the copper screw. Tighten the screw "finger tight" (0.226 N-m, 2 lbf-in).

CAUTION. Do not over tighten the screw or you may strip the threads on the plastic cover disc. If this happens, return the WorkHorse ADCP to TRDI for repair.

```
[BREAK Wakeup A]
WorkHorse ADCP Edition 43.xx
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>

>

>
>AZ
>
```

Zero the Pressure Sensor

Use the AZ-command to zero out the pressure sensor at the deployment site, before putting the WorkHorse into the water.

Connect and apply power to the system.

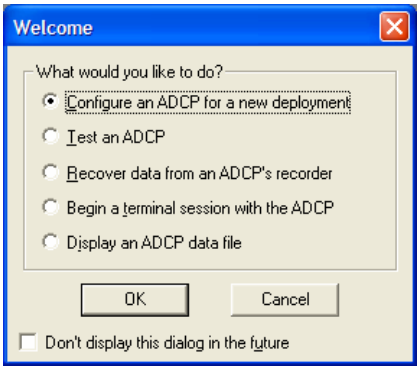
Start *BBTalk* and wakeup the WorkHorse ADCP (press the **END** key).

Type **AZ** and press the Return key.

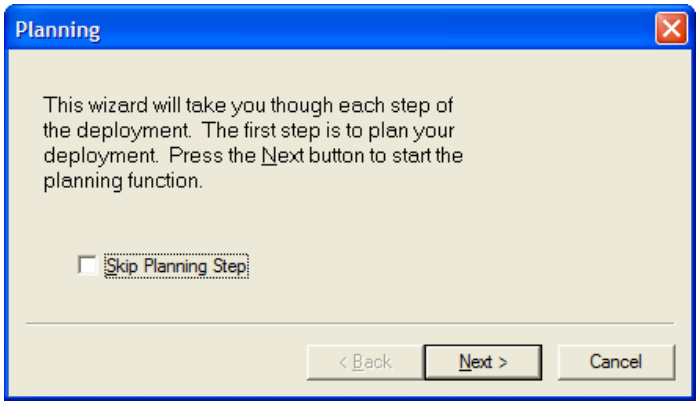
Exit *BBTalk*.

Collecting Self-Contained Data

WinSC works as a shell program to launch the *PlanADCP* program. *PlanADCP* is designed to create a command file that will be used to set up a WorkHorse ADCP for collecting data. In this example we will start *WinSC*, use *PlanADCP* to develop the command file, and then go back to the *WinSC* program to continue with the testing, deployment, and recovery of data.



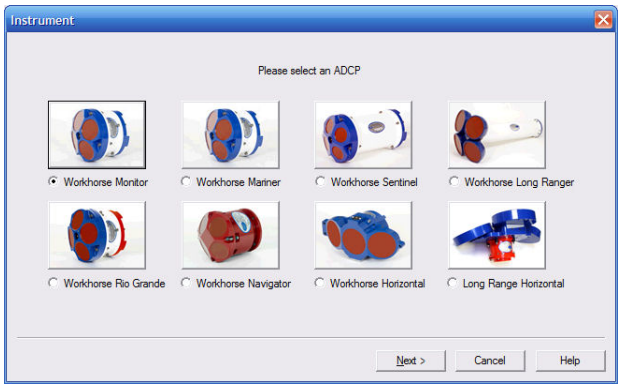
Start *WinSC*. Select **Configure an WorkHorse for a new deployment** and click **OK**.



Planning

The first step of the deployment wizard will start *PlanADCP*.

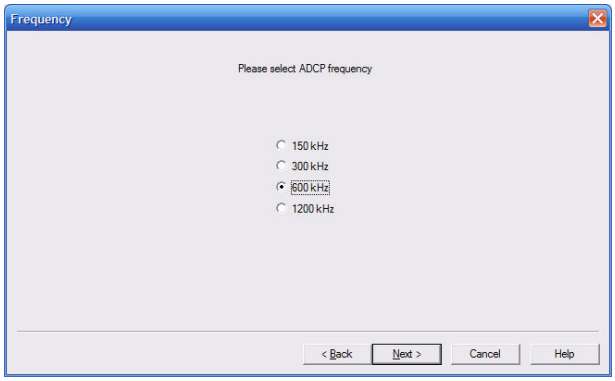
Click **Next** to continue.



Instrument

Select the type of WorkHorse ADCP you want to create a command file for.

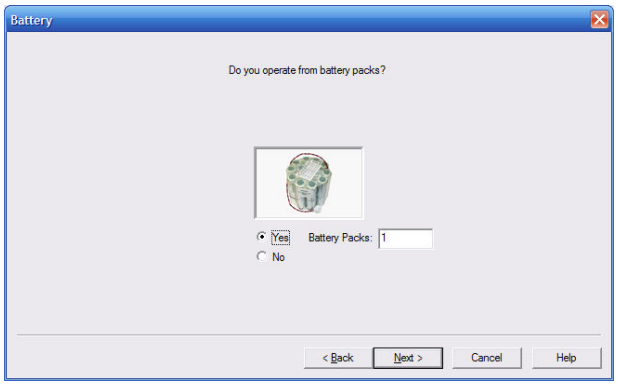
Click **Next** to continue.



Frequency

Select the frequency of your WorkHorse. The default settings and consequences are based upon the WorkHorse frequency.

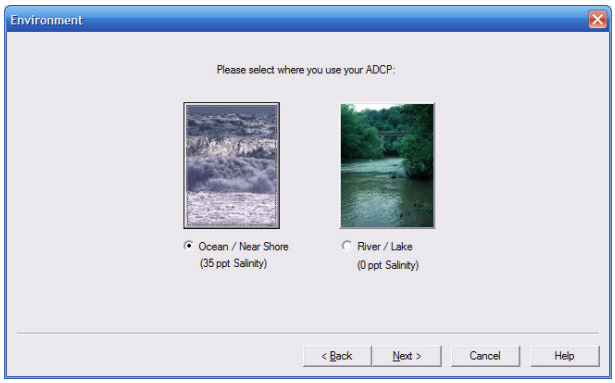
Click **Next** to continue.



Battery

Select if the WorkHorse has internal batteries. If you select **Yes**, then enter the number of battery packs you are going to use.

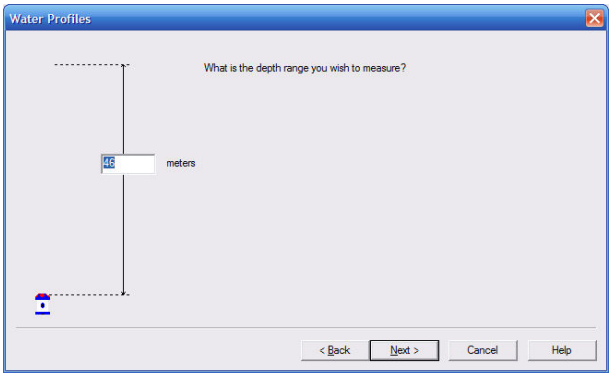
Click **Next** to continue.



Environment

Select **Ocean/Near Shore** or **River/Lake** to set the salinity. Water salinity affects the maximum range. Salt water is typically 35 ppt, fresh water is 0 ppt.

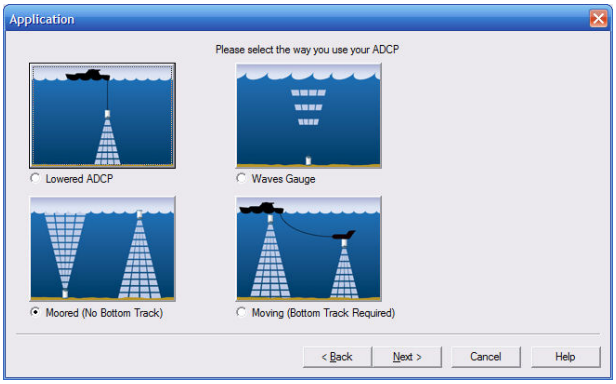
Click **Next** to continue.



Water Profiles

Select the depth range you wish to measure. The maximum depth range is dependent on the WorkHorse frequency, water salinity, water temperature, and the depth of the WorkHorse.

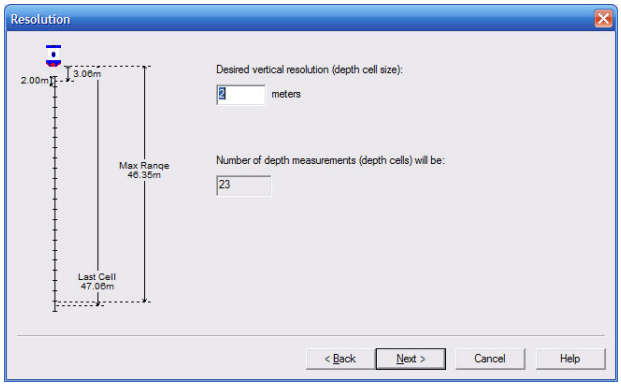
Click **Next** to continue.



Application

Select **Moored (No Bottom Track)** for a self-contained deployment.

Click **Next** to continue.

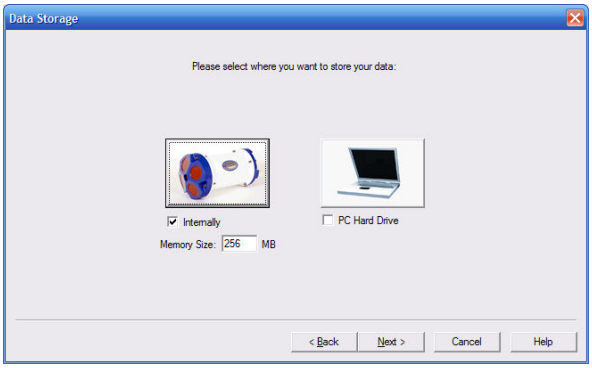


Resolution

Set the depth cell (bin) size. Adjust the depth cell (bin) size as necessary to get at least 10 depth cells (bins). A larger depth cell (bin) size decreases the standard deviation, but shallow water situations may need to use small depth cells (bins) to get more data points.

PlanADCP will set the number of depth cells (bins) so that the consequence *last depth cell (bin) range* is approximately 10% greater than the depth range set in the previous step.

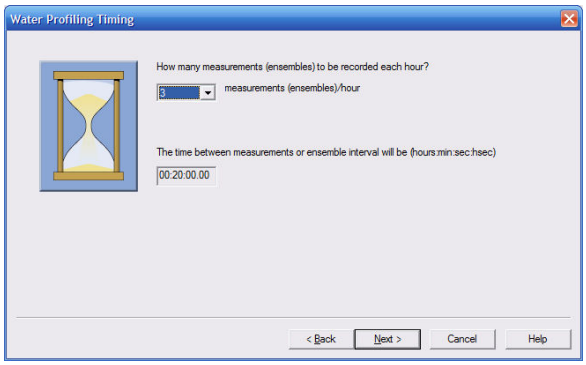
Click **Next** to continue.



Data Storage

Select where to store the data. Data can be stored internally, sent out the serial port, or both. If you selected **Internally**, enter the amount of memory installed.

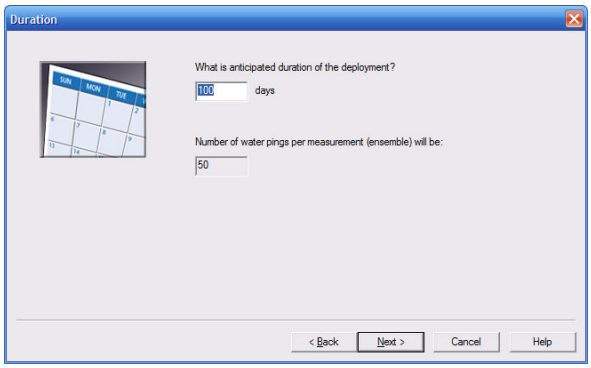
Click **Next** to continue.



Water Profiling Timing

Select how many ensembles per hour you want to record.

Click **Next** to continue.

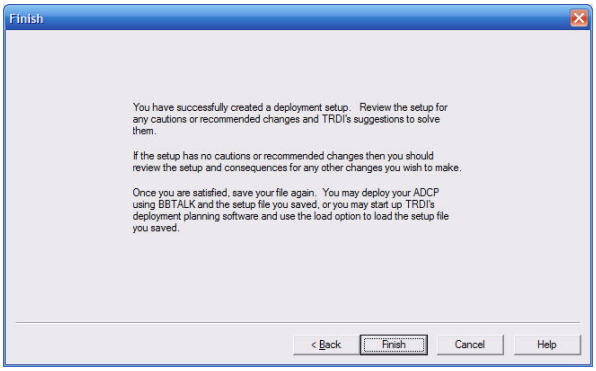


Duration

Enter the expected duration of the WorkHorse deployment from the time of the first water profiling ping (either immediately or first ping date/time). This duration *does not* produce a command to instruct the WorkHorse to stop data collection; it is for estimating consequences only. This duration is used to estimate the following *consequences*:

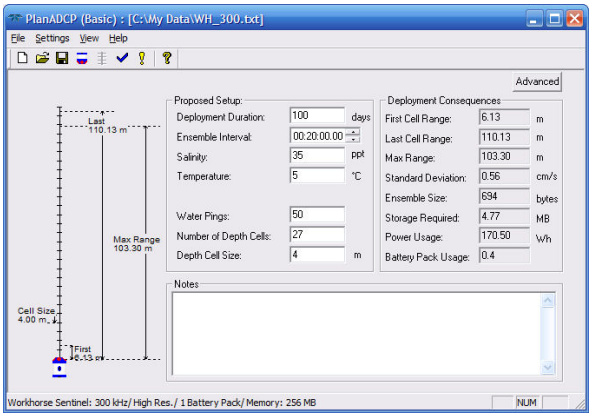
- Battery usage
- Ensembles
- Storage required

Click **Next** to continue.



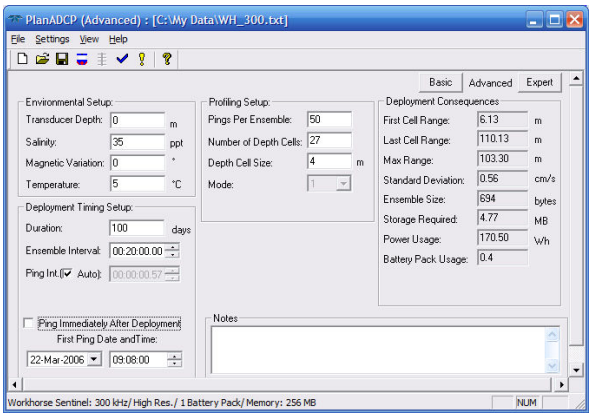
The wizard is now finished.

Click **Finish**.



The *PlanADCP* (Basic) Screen opens using the settings you selected with the wizard. Review the consequences (see the WinSC and PlanADCP User's Guide for details).

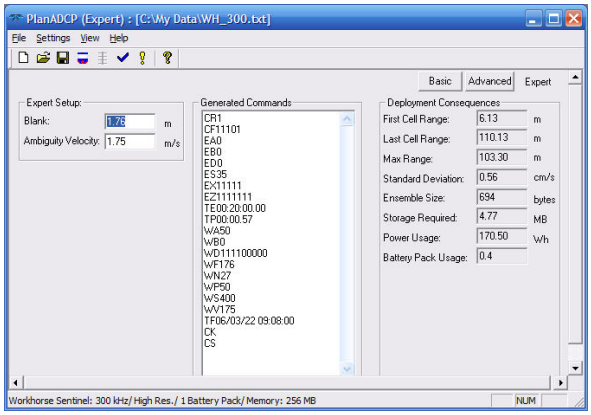
On the *PlanADCP* (Basic) Screen click the **Advanced** button to bring up the **Advanced** setting screen.



Advanced Screen

Uncheck the **Ping Immediately After Deployment** box and enter a date and time you want the WorkHorse to begin pinging.

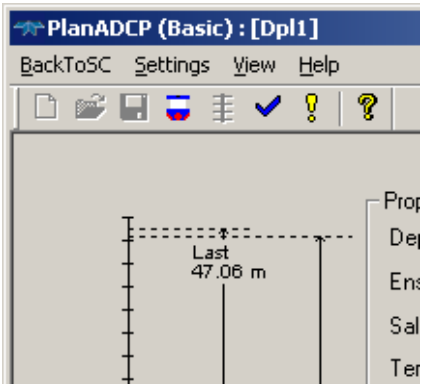
Start sample intervals on the minute by using a delayed start up. Instead of having your 10-minute sample intervals start at 12:36:47, delay startup a few minutes to have samples start at 13:00:00.



Expert Screen

On the *PlanADCP* (Advanced) Screen click the **Expert** button to bring up the **Expert** setting screen.

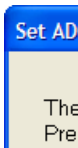
You can view the commands that will be sent to the WorkHorse.



Back to WinSC

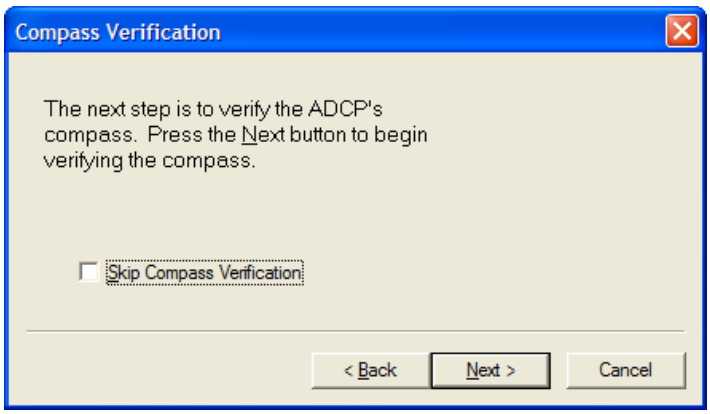
Click the **BackToSC** menu to return to *WinSC*.

NOTE. At this point, the WorkHorse ADCP should be prepared for deployment, using battery power, and sealed.



The second step will set the WorkHorse ADCP's clock to the computer's time and date using the TS-command.

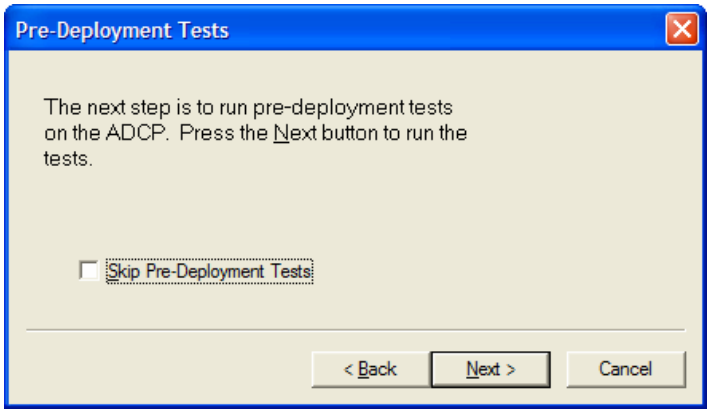
Click **Next** to continue.



The third step will verify the compass using the AX-command.

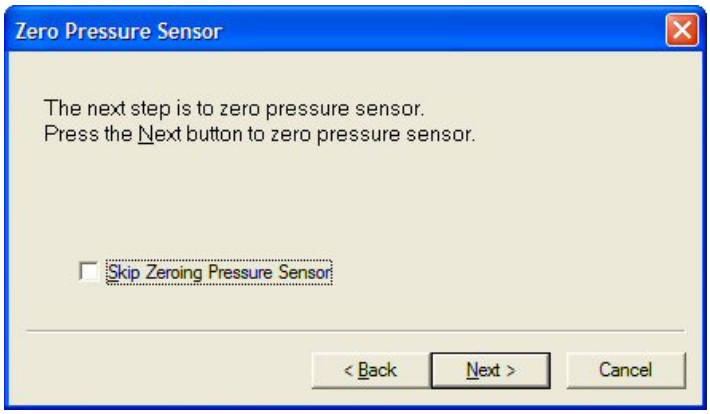
Note: If the internal batteries were replaced, this step will only *verify* the compass; you must *align* the compass prior to using the *WinSC* wizard.

Click **Next** to continue.



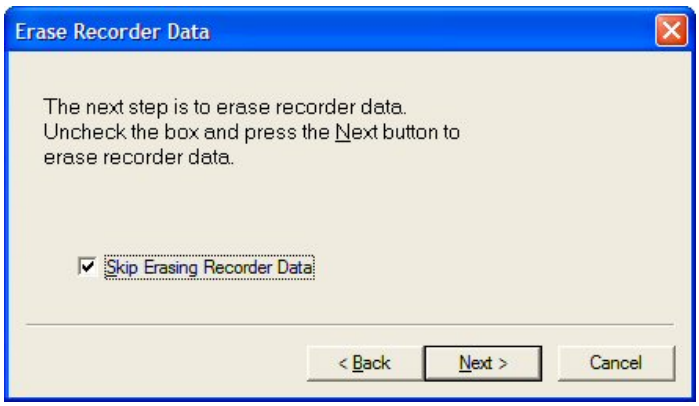
The fourth step will run the pre-deployment tests Deploy?, System?, TS?, PS0, PA, PC2, RS, and PC1-commands.

Click **Next** to continue.



The fifth step will zero the pressure sensor using the AZ-command.

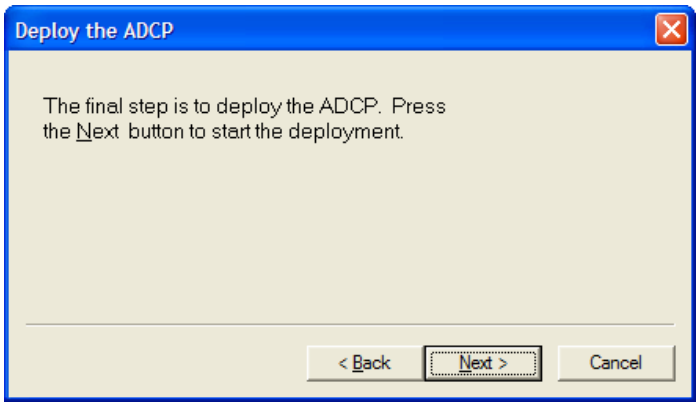
Click **Next** to continue.



The sixth step will erase the recorder using the RE-command. Uncheck the **Skip Erasing Recorder Data** box if you want to erase the data.

CAUTION: Once erased, the data is not recoverable.

Click **Next** to continue.



The seventh and final step in the Deployment Wizard will send the commands from the command file to the WorkHorse.

Click **Next** to send the commands. When the commands have been sent to the WorkHorse, you should see a message "*You have successfully deployed the ADCP*."

Click **OK**.

NOTE. The WorkHorse must be powered with the batteries, sealed, and ready to deploy before you click **Next**.

Save Deployment File

If you have not already saved the deployment file, you will be prompted to name the deployment. Choose and use Deployment Names carefully: they help you identify and organize all the data and log files associated with each deployment.

The command file and deployment log file will be saved when the deployment file is saved. For example, if you save the deployment file as *Dpl1_.dpl*, then the command file will be saved as *Dpl1_.whp* and the log file will be saved as *Dpl1_.scl.*

Before deploying the WorkHorse ADCP, scroll through the deployment log file and look for error messages. Correct as needed and re-send the commands.

Photo courtesy of J. Bornhoeft.

Deploy and Recover the WorkHorse

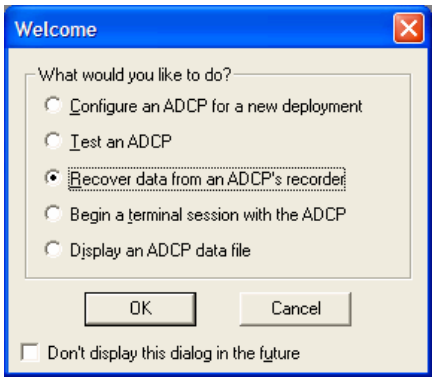
Once the commands have been sent to the WorkHorse, proceed as follows.

- Disconnect the I/O cable and install the dummy plug on the WorkHorse ADCP's end-cap.
- Deploy the WorkHorse ADCP.

CAUTION. Do not send a break, any other command, or run any other programs once the commands have been sent to the WorkHorse ADCP or your commands will be over-written.

Disconnect the I/O cable before turning off power to the computer. Some computers may send a break signal out the serial ports when shutting down.

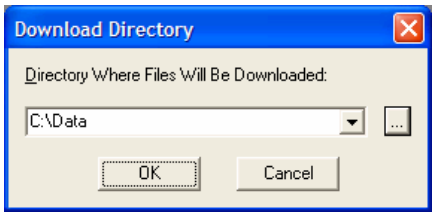
Recover Data with WinSC



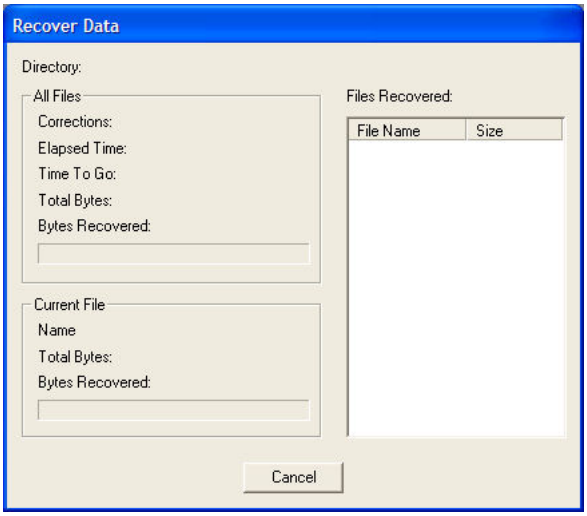
Connect and power up the WorkHorse ADCP.

Start *WinSC*.

At the **Welcome Screen** select **Recover Data from an ADCP's Recorder** or from the **File** menu, select **Recover Recorder Data**.

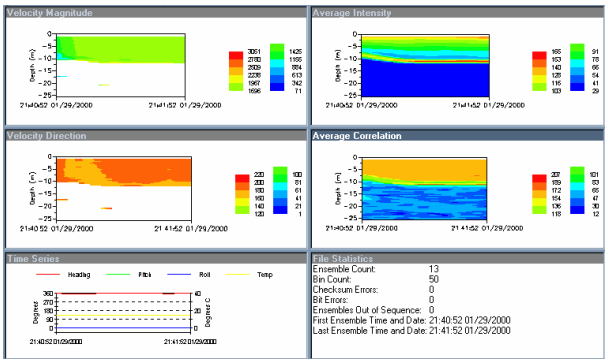


Select the directory where the data will be written.



WinSC will increase the baud rate set in the **Com Settings** window to 115200 BAUD to reduce the download time.

Viewing Data with *WinSC*

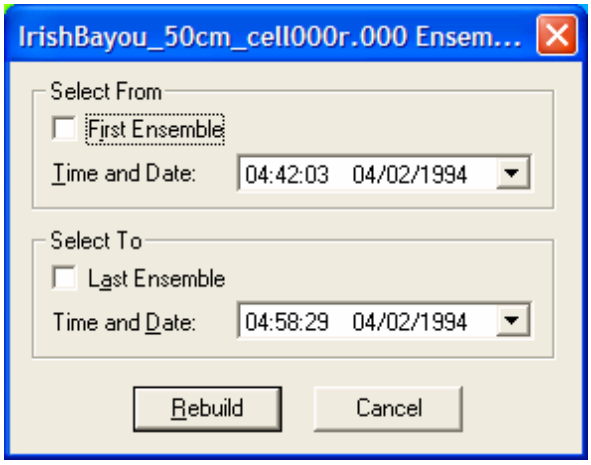


On the **File** menu, click **Open**.

On the **Files of Type** box, select **ADCP Data** (*.0*).

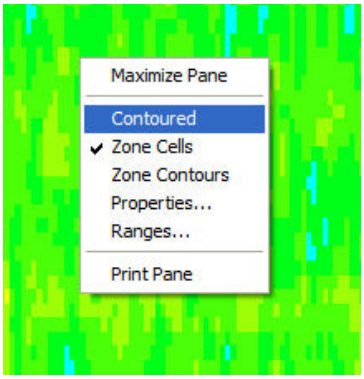
Select the file and click **Open**.

The data file will display all of the ensembles.



To select a subsection of the data file, use the **View** menu, **Ensemble Selection**.

To quickly select a section, hold the **Control** key while dragging the mouse over the area to be selected.



Display Controls.

Right-click inside any window to bring up the display menu.

To increase the size of a window, click **Maximize Pane** button.

To increase the contrast of the contoured plot, select **Contoured**.

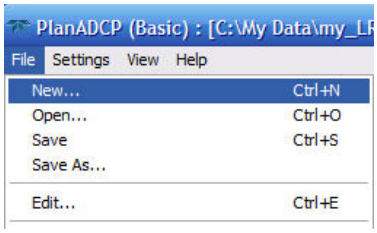
You can increase the contrast between cells and contours by using the **Zone Cells** or **Zone Contours**.

To change the colors of the plot or other plot controls, click **Properties**.

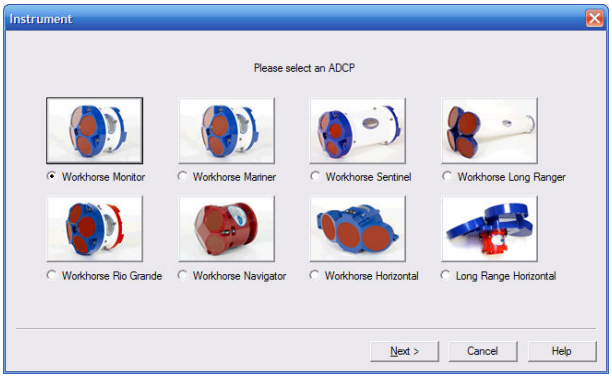
To select the range of a contoured plot, click **Ranges**.

Collecting Real-Time Data

PlanADCP is designed to create a command file that will be used to set up a WorkHorse ADCP for collecting data. In this example we will use *PlanADCP* to develop the command file, and *BBTalk* to send the commands to the WorkHorse. Then we will use the *WinADCP* program to view the data in real-time.



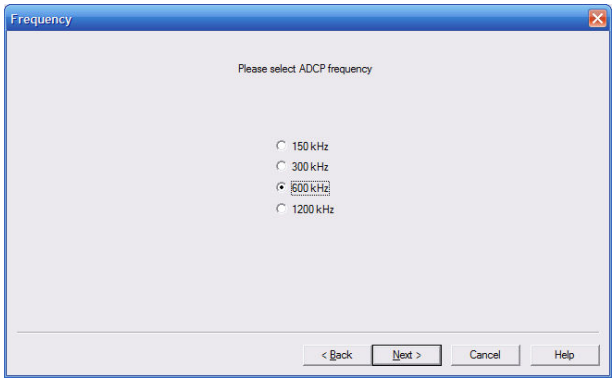
Start *PlanADCP*. On the **File** menu, click **New**.



Instrument

Select the type of WorkHorse ADCP you want to create a command file for.

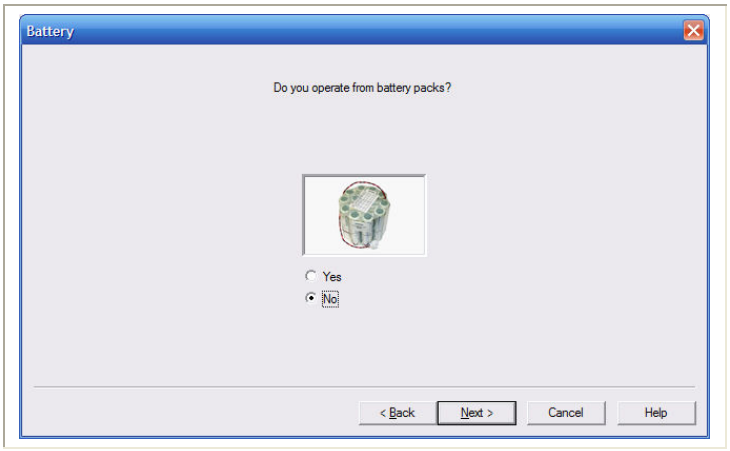
Click **Next** to continue.



Frequency

Select the frequency of your WorkHorse ADCP. The default settings and consequences are based upon the WorkHorse frequency.

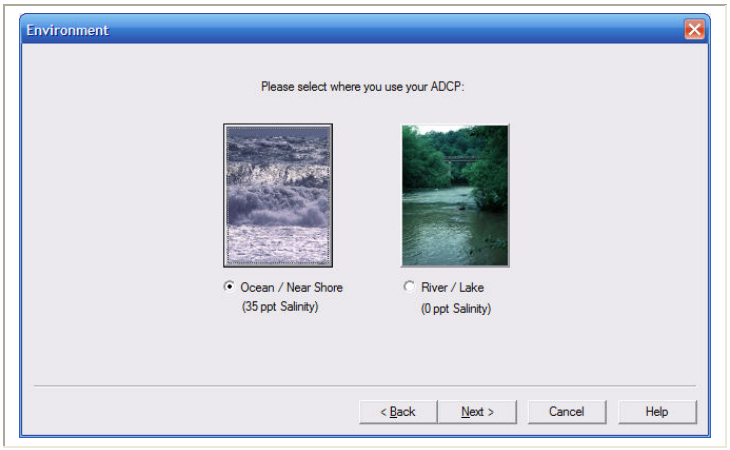
Click **Next** to continue.



Battery

Select if the WorkHorse has internal batteries. If you select **Yes**, then enter the number of battery packs you are going to use.

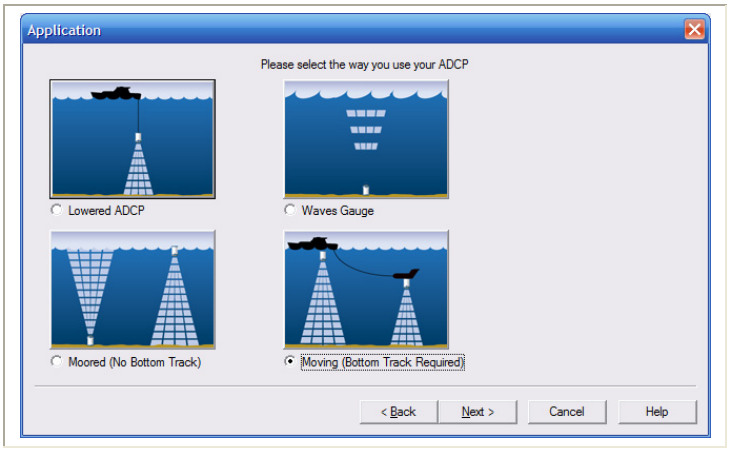
Click **Next** to continue.



Environment

Select **Ocean/Near Shore** or **River/Lake** to set the salinity. Water salinity affects the maximum range. Salt water is typically 35 ppt, fresh water is 0 ppt.

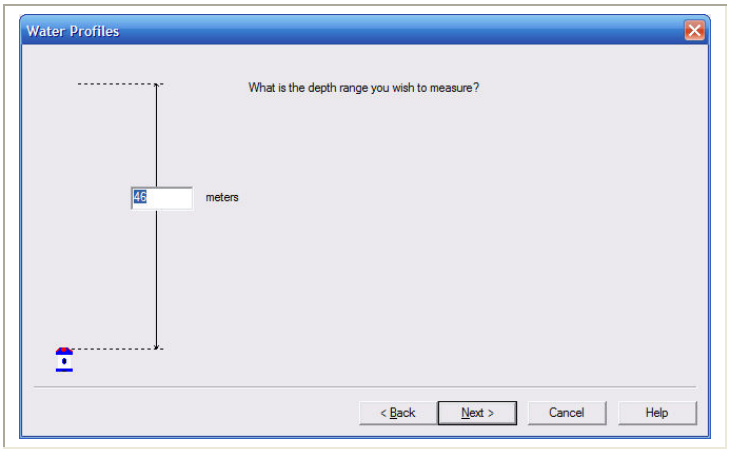
Click **Next** to continue.



Application

Select **Moored (No Bottom Track)** for a self-contained deployment.

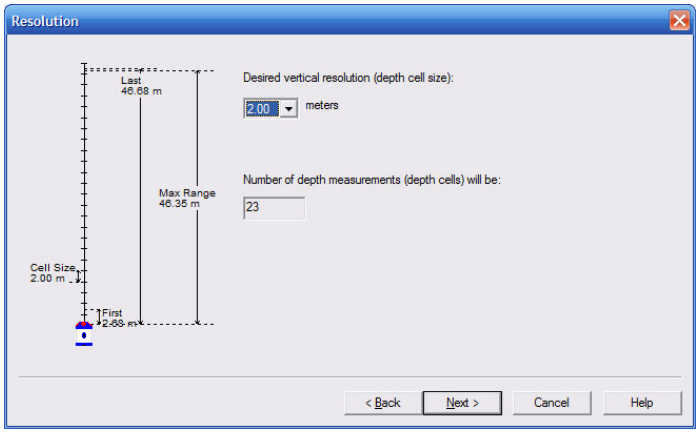
Click **Next** to continue.



Water Profiles

Select the depth range you wish to measure. The maximum depth range is dependent on the WorkHorse frequency, water salinity, water temperature, and the depth of the WorkHorse.

Click **Next** to continue.

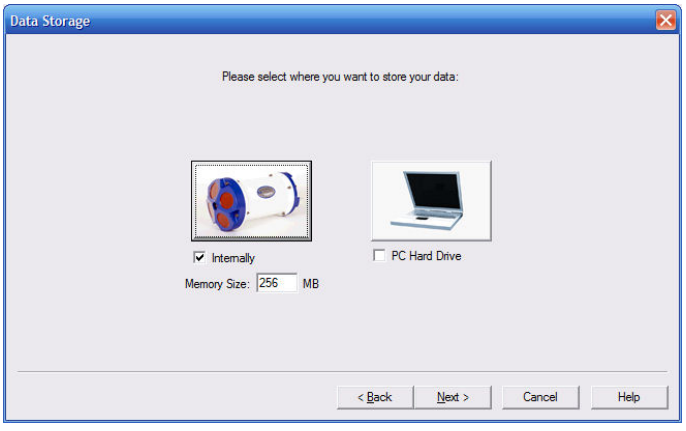


Resolution

Set the depth cell (bin) size. Adjust the depth cell (bin) size as necessary to get at least 10 depth cells (bins). A larger depth cell (bin) size decreases the standard deviation, but shallow water situations may need to use small depth cells (bins) to get more data points.

PlanADCP will set the number of depth cells (bins) so that the consequence *last depth cell (bin) range* is approximately 10% greater than the depth range set in the previous step.

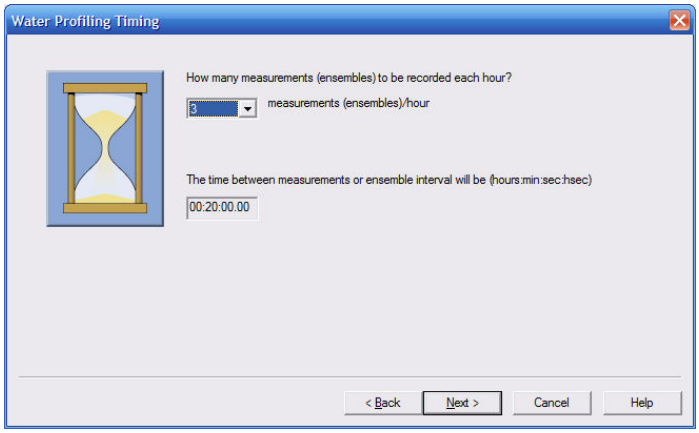
Click **Next** to continue.



Data Storage

Select where to store the data. Data can be stored internally, sent out the serial port, or both. If you selected **Internally**, enter the amount of memory installed.

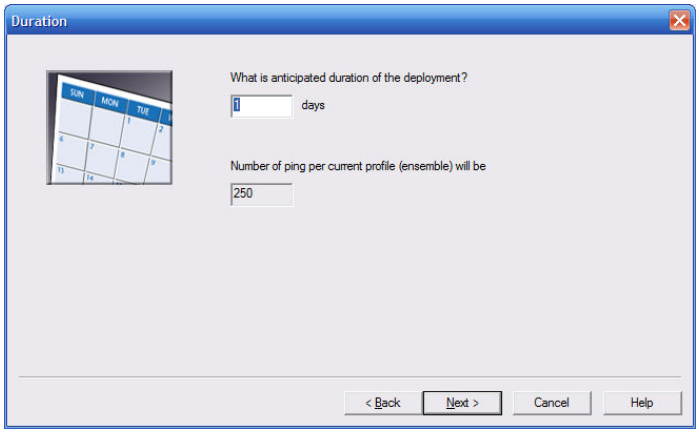
Click **Next** to continue.



Water Profiling Timing

Select how many ensembles per hour you want to record.

Click **Next** to continue.

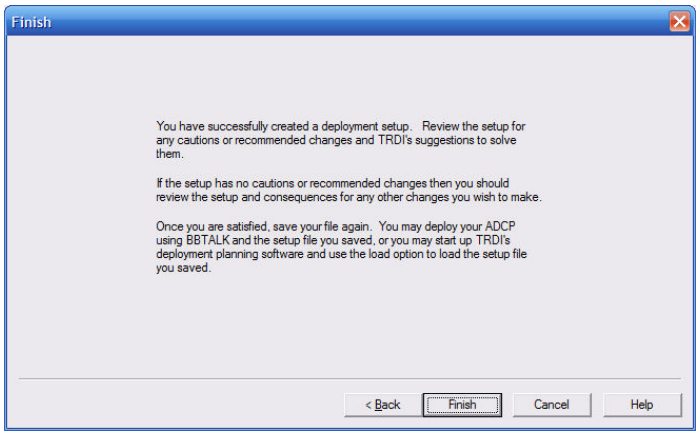


Duration

Enter the expected duration of the WorkHorse deployment from the time of the first water profiling ping (either immediately or first ping date/time). This duration *does not* produce a command to instruct the WorkHorse to stop data collection; it is for estimating consequences only. This duration is used to estimate the following *consequences*:

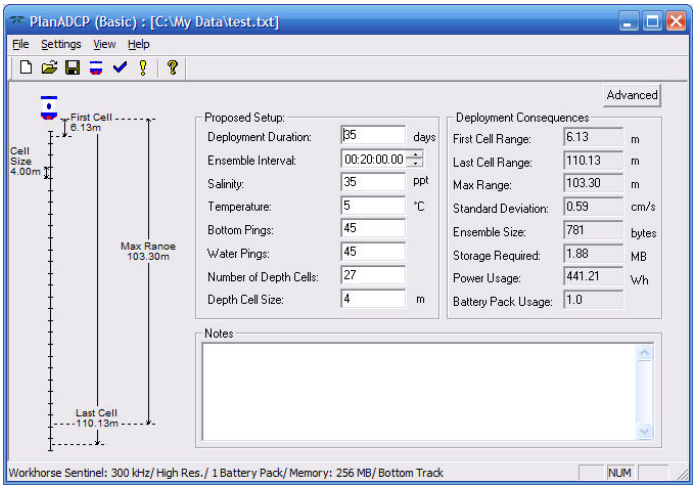
- Power requirements
- Ensembles
- Storage required

Click **Next** to continue.



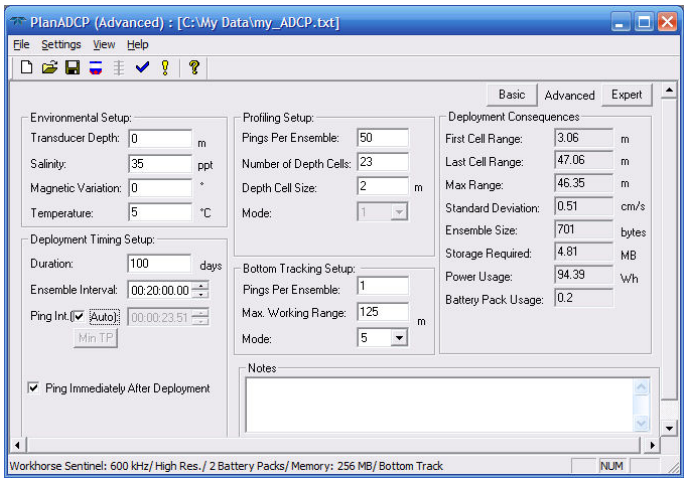
The wizard is now finished.

Click **Finish**.



The *PlanADCP* (Basic) Screen opens using the settings you selected with the wizard. Review the consequences (see the WinSC and PlanADCP User's Guide for details).

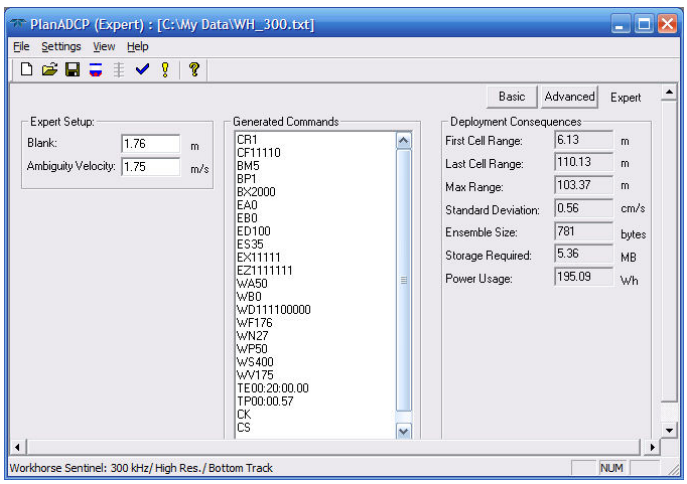
On the *PlanADCP* (Basic) Screen click the **Advanced** button to bring up the **Advanced** setting screen.



Advanced Screen

Uncheck the **Ping Immediately After Deployment** box and enter a date and time you want the WorkHorse ADCP to begin pinging.

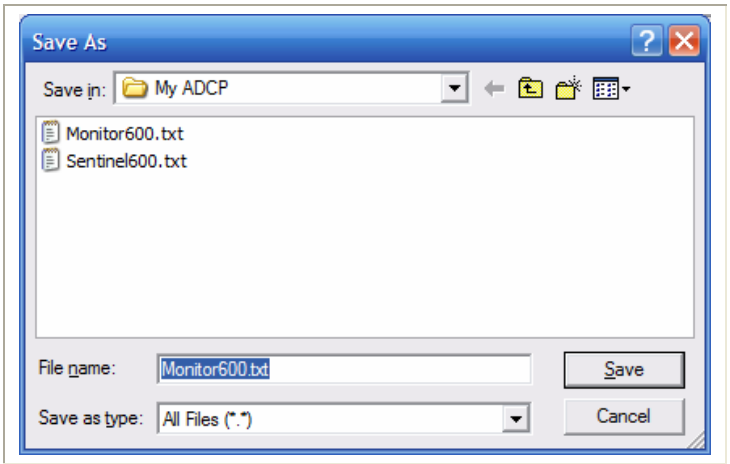
Start sample intervals on the minute by using a delayed start up. Instead of having your 10-minute sample intervals start at 12:36:47, delay startup a few minutes to have samples start at 13:00:00.



Setup Advanced Screen

On the *PlanADCP* (Advanced) Screen click the **Expert** button to bring up the **Expert** setting screen.

You can view the commands that will be sent to the WorkHorse.



Save the Command File

On the **File** menu, click **Save**. Name the command file and click **Save**.

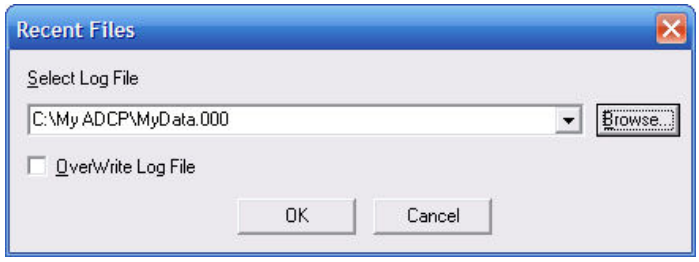
Sending the Commands to the WorkHorse ADCP

```
[BREAK Wakeup A]
WorkHorse ADCP 43.xx
Teledyne RD Instruments (c) 1996-2006
All Rights Reserved.
>
```

Wakeup the WorkHorse

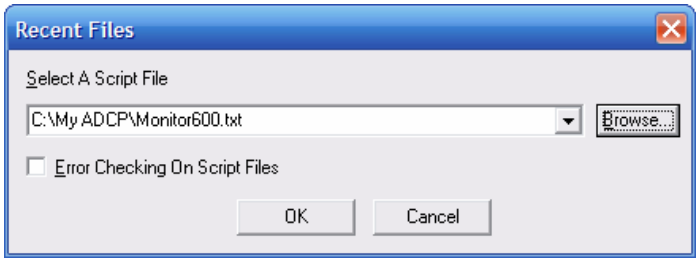
Start *BBTalk*. On the **File** menu, click **Break** (you can also press the **End** key to send a break or and press the **B** button on the Toolbar).

You should see the wakeup message appear on the log file window.



Create a Log File

Press **F3** and create a log file. Name the file and use **.000* for the file extension.



Send the Commands to the WorkHorse

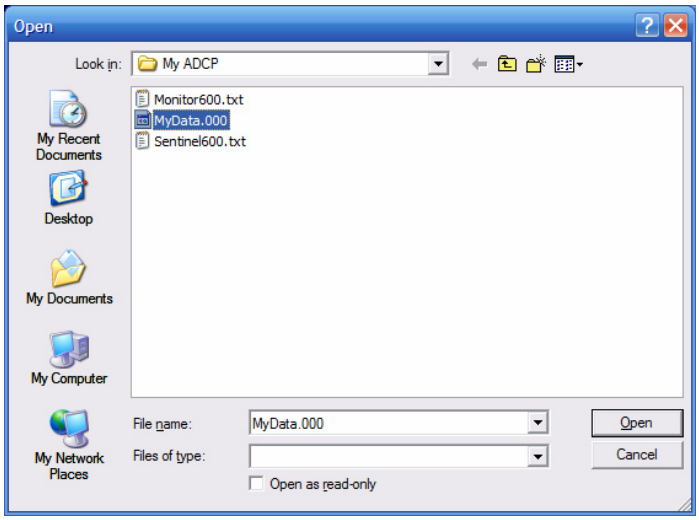
Press **F2** and use the **Browse** button to locate the command file.

You should see the commands appear on the log file window and the WorkHorse ADCP's response.

Carefully review the log file window and make sure that no command created an error message.

Viewing Data in Real-Time

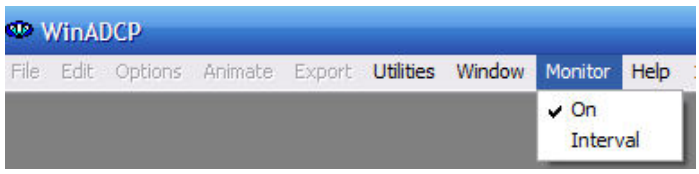
WinADCP has the ability to automatically update the reading of a file as real-time data collection is occurring. When the file size increases, (due to real-time data collection) **Monitor** will automatically reread the file at selected intervals and display the contents. When **Monitor** is enabled and the file size is changing, all menu items except **Monitor** will be unavailable.



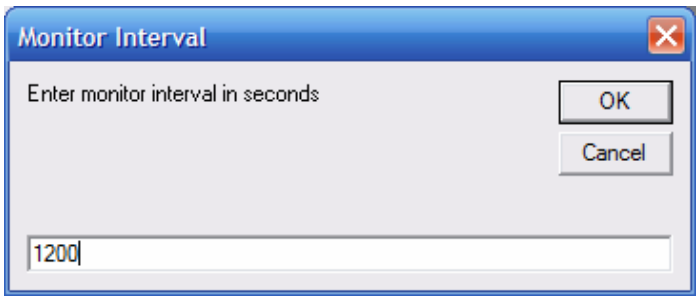
Start WinADCP

Start *WinADCP*. On the **File** menu, click **Open**.

Select the log file created with *BBTalk* (see "Sending the Commands to the WorkHorse ADCP," page 48).

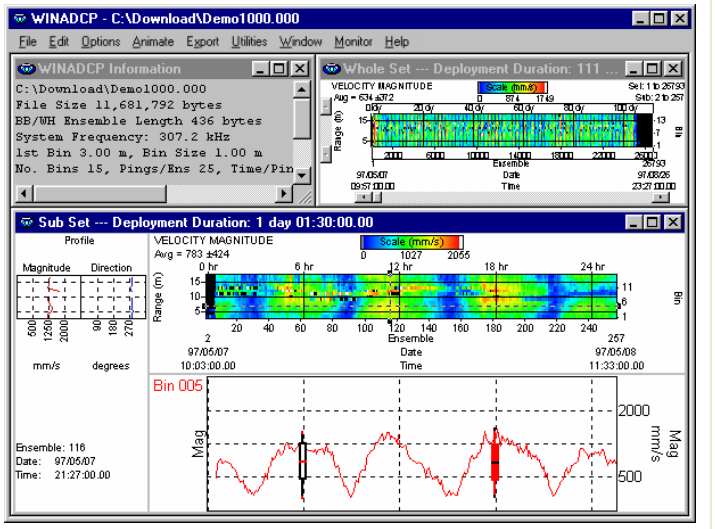


On the **Monitor** menu, select **ON**.

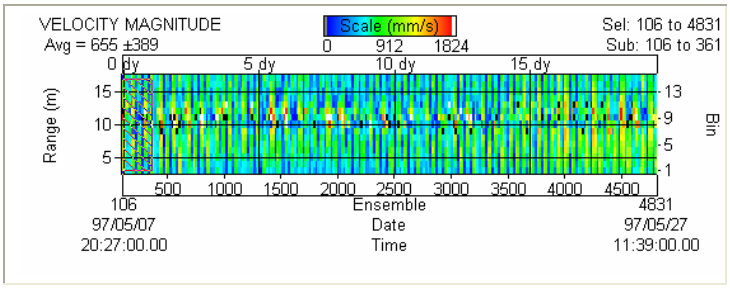


You can change the interval by clicking **Monitor**, **Interval**.

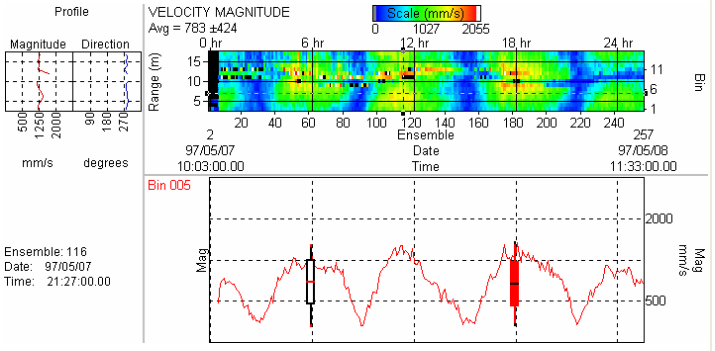
Enter the monitor interval in seconds. For example, a 20 minute ensemble would be 1200 seconds.



WinADCP has two main graphic display forms. The form located in the upper right portion of the screen is called the **Whole Set**. The form located across the bottom half of the display is called the **Sub Set**. Each of these forms displays a portion of the entire data set as a color contour. In addition to the color contour, **Sub Set** displays the user selected **Profile**, **Series**, and **Ancillary** data.



The **Whole Set** form is displayed in the upper right-hand portion of *WinADCP*. When a file containing a Binary Output Data Format is opened, the entire set of the selected data type is displayed as a color contour located within the **Whole Set** form.



By holding down the **Spacebar** and then pressing the **Left** mouse button, the user can drag the mouse to select a portion of the entire data set. When the mouse button is released, the selected portion of the **Whole Set** is marked by a blinking box outline. The blinking box outlines a set of data called the **Selected Set**.

Where to Find More Information

Congratulations! You have completed the WorkHorse Monitor/Sentinel User's Guide. For more detailed information, see the following sections in the WorkHorse Technical Manual.

Installation. Use this section to plan your installation requirements. This guide includes specifications and dimensions for the WorkHorse ADCP (including outline installation drawings).

Maintenance. This section covers WorkHorse ADCP maintenance. Use this section to make sure the WorkHorse is ready for a deployment.

Test. Use this section to test the WorkHorse ADCP.

Troubleshooting. This section includes a system overview and how to troubleshoot the WorkHorse ADCP. If the WorkHorse fails a built-in test or you cannot communicate with the system, use this guide to help locate the problem.

Commands and Output Data Format. This section contains a reference for all commands and output data formats used by the WorkHorse ADCP.

NOTES