

# WORKHORSE

## MONITOR / SENTINEL DEPLOYMENT GUIDE



P/N 957-6285-00 (September 2023)

© 2023 Teledyne RD Instruments, Inc. All rights reserved.



<https://www.teledynemarine.com>

Use and Disclosure of Data Information contained herein is classified as EAR99 under the U.S. Export Administration Regulations. Export, reexport or diversion contrary to U.S. law is prohibited.

## TABLE OF CONTENTS

<b>WORKHORSE AND WORKHORSE II .....</b>	<b>1</b>
<b>PREPARING THE ADCP .....</b>	<b>2</b>
<b>CONNECTING TO THE ADCP .....</b>	<b>7</b>
<b>PLANNING THE DEPLOYMENT .....</b>	<b>9</b>
<b>DEPLOYING THE ADCP .....</b>	<b>11</b>
<b>RECOVERING DATA .....</b>	<b>18</b>
<b>CONCLUSION .....</b>	<b>22</b>

## HOW TO CONTACT TELEDYNE RD INSTRUMENTS

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

Teledyne RD Instruments	Teledyne RD Instruments Europe
14020 Stowe Drive Poway, California 92064	2A Les Nertieres 5 Avenue Hector Pintus 06610 La Gaude, France
Phone +1 (858) 842-2600	Phone +33(0) 492-110-930
Sales – <a href="mailto:rdisales@teledyne.com">rdisales@teledyne.com</a>	Sales – <a href="mailto:rdie@teledyne.com">rdie@teledyne.com</a>
Field Service – <a href="mailto:rdifs@teledyne.com">rdifs@teledyne.com</a>	Field Service – <a href="mailto:rdiefs@teledyne.com">rdiefs@teledyne.com</a>

Client Services Administration – [rdicsadmin@teledyne.com](mailto:rdicsadmin@teledyne.com)

Web: <https://www.teledynemarine.com>

For all your customer service needs including our emergency 24/7 technical support, call +1 (858) 842-2700

### Self-Service Customer Portal

Use our online customer portal at <https://www.teledynemarine.com/support/RDI/technical-manuals> to download manuals or other Teledyne RDI documentation.

### Teledyne Marine Software Portal

Teledyne RD Instruments Firmware, software, and Field Service Bulletins can be accessed only via our Teledyne Marine software portal.

To register, please go to <https://tm-portal.force.com/TMsoftwareportal> to set up your customer support account. After your account is approved, you will receive an e-mail with a link to set up your log in credentials to access the portal (this can take up to 24 hours).

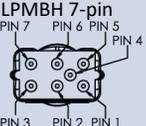
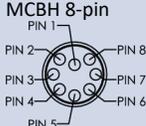
Once you have secured an account, use the Teledyne Marine software portal to access this data with your unique username and password.

If you have an urgent need, please call our Technical Support hotline at +1-858-842-2700.

# Workhorse and Workhorse II

This guide covers the original Workhorse (WH) system and Workhorse II (WHII) 6000-meter systems which include the LPMBH 7-pin connector. Repaired systems that require a PC board replacement shipped after November 2022 will ship with the WHII electronics and the WH LPMBH 7-pin end-cap connector.

**Table 1. Comparison of Workhorse II to the original Workhorse**

	WorkHorse	WorkHorse II	Notes
Connector Type	LPMBH 7-pin 	MCBH 8-pin  or LPMBH 7-pin	MCBH 8-pin improved strain relief and protection of the connector and cable.  LPMBH 7-pin maintains compatibility to user's underwater cables.
Memory	PCMCIA, 4 GB max	Compact Flash, with the maximum memory capacity not to exceed 4GB.	Use the <b>RE ErAsE</b> command to erase and format the WHII CompactFlash memory card.
LADCP WM15 Surface Tracking WM15 High-res WM11 High-speed sampling WM12	Purchased options	Standard	See the WorkHorse Operation Manual, Chapter 4 for help on installing feature upgrades.
Compass Type Compass Accuracy / Resolution / Max Tilt	Flux Gate Compass $\pm 2^\circ$ @ $60^\circ$ magnetic dip angle, $0.01^\circ$ , $\pm 15^\circ$	ISM Compass $1^\circ$ RMS, $0.1^\circ$ , $\pm 70^\circ$	The WH uses the Compass Commands to calibrate the Flux Gate compass.  Use the <i>ISM Compass Calibration</i> software to calibrate a WHII ISM compass.
Pressure Sensor / Short-term uncertainty Max. drift	Optional $\pm 0.1\%$ $\pm 0.25\%$	Standard $\pm 0.1\%$ $\pm 0.25\%$	Standard 20 Bar pressure sensor included, or 600 BAR (optional).
Raw Field Strength Recorded	NA	Firmware enabled	Use <i>Compass Post Calibration</i> software to correct for heading errors due to hard and soft iron effects in the Workhorse reference frame during the deployment.
Software	PlanADCP, WinADCP	Workhorse II Plan, ISM Compass Calibration, Compass Post Calibration, WinADCP	Use the <i>PlanADCP</i> software to create a deployment command file if the system has the original Workhorse electronics installed.  Use the <i>Workhorse II Plan</i> software to create a deployment command file for systems with Workhorse II electronics installed.

# Preparing the ADCP

## PREPARING THE ADCP INCLUDES THE FOLLOWING STEPS:

- ✔ Checking you have all the Monitor/Sentinel parts
- ✔ Installing the documentation and software
- ✔ Installing the batteries
- ✔ Checking the system is closed properly

## Identifying what's in the Box

Included with the Monitor/Sentinel system:

Part Number	Name	Description
WHS1200, 600, 300 WHM1200, 600, 300 WHSII1200, 600, 300 WHMII1200, 600, 300	Sentinel system Monitor system WH2 Sentinel WH2 Monitor	The Workhorse Monitor/Sentinel system includes the transducer, Memory card (Sentinel only), dummy plug, and protective cap. When unpacking, use care to prevent physical damage to the transducer face and connector. Use a soft pad to protect the transducer.

Included with the WorkHorse Accessories Kit:

Part Number	Name	Description
977-7005-00 977-7003-00	Shipping case Sentinel Shipping case Monitor	Shipping case with custom foam cutouts.
717-3030-xxx	I/O cable	The I/O cable is used for serial communications.
97Z-6190-00	USB to Serial Adapter	The USB adapter appears as an additional serial COM port.
717-3014-00	AC Power Adapter	The optional AC Adapter runs on any standard AC power and supplies +48 VDC.
737-3010-00	RS-422 to RS-232 Converter	Converts RS-422 to RS-232 for serial communications. (Optional for Monitor systems)
757K6023-00	Alkaline Battery Pack (Sentinel only)	WorkHorse Sentinel batteries are shipped inside the WorkHorse ADCP but <b>not connected</b> . Connect the battery and seal the WorkHorse ADCP before deployment.
977-6013-00	Memory (Sentinel only)	The WorkHorse Sentinel ADCP includes one memory card installed inside the system. Two PCMCIA memory card slots are available. Workhorse II Sentinel ADCPs come standard with one CompactFlash memory card with the maximum memory capacity not to exceed 4GB.
95Z-6007-00 957-6283-00 (part of 757K6081-xx)	Download instructions	This sheet has instructions for downloading the software and manuals.
	Getting Started	A printed sheet showing Monitor/Sentinel set up.
Download from website	TRDI Toolz	Utility and testing software package that can be used to test both WH and WHII ADCPs.
	PlanADCP WinADCP	Software for Workhorse systems
	Workhorse II Plan ISM Compass Calibration Compass Post Calibration WinADCP	Software for Workhorse II systems
757K6037-00	Spare parts and tools	Contains tools, O-Rings, and close-up hardware. See the WorkHorse Operation Manual, Maintenance chapter for a list of included parts.

## Tools and Spare Parts

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

### WorkHorse 200-meter Spare Parts

Part Number	Item Name	Where Used:
SPR84-1LB	Rubber Band	Battery pack to hold desiccant in place
5020	Silicone Lubricant, 4-Pack	Housing
97Z-6052-00	O-Ring, 2-260 (200-meter housing)	
M6WASHSPLTI	Washer, 6MM Split Lock, Titanium	
M6WASHSTDTI	Washer, Flat, Titanium 12.5MM OD	
M6X1.0NUTTI	Nut, Hex, Titanium 10MM	
M6X1.0X45HHTI	Screw, Hex Head, Titanium	
M8WASHSPLTI	Washer, Split Lock, Titanium	
M8WASHSTDTI	Washer, Flat, Titanium 22.9MM OD	
M8X1.25NUTTI	Nut, Hex, Titanium 13MM	
M8X1.25X65HHTI	Screw, Hex Head, Titanium Full Threads Length	
75ZK6001-00	Kit, Clip, Cable	
75ZK6001-01	Kit, Clip, Dummy Plug	
GMA-3A	Fuse, 5MM X 20MM 3R 250V	
DES3	Desiccant, Sealed Bag	
817-1067-00	Screw, Pressure Sensor	Pressure Sensor



For high pressure systems, see the WorkHorse Operation Manual, Chapter 4 for a list of the included tools and spare parts.

# Installing Documentation and Software

The Monitor/Sentinel system documentation and software are downloaded.

1. Follow the instruction sheet on downloading TRDI software and manuals.
2. Software is available on <https://tm-portal.force.com/TMsoftwareportal>.
  - Install *TRDI Toolz*, *PlanADCP* and *WinADCP* for WH systems.
  - The Workhorse II requires *TRDI Toolz*, *Workhorse II Plan*, *ISM Compass Calibration*, *Compass Post Calibration*, and *WinADCP* software.
  - Download application software *VmDas* or *WinRiver II* as needed.
3. Use our online customer portal at <https://www.teledynemarine.com/support/RDI/technical-manuals> to download manuals or other Teledyne RDI documentation. Download the Workhorse Operation Manual Guide and the Commands and Output Data Format guide. PDF versions of all Workhorse documentation are available for download.



Workhorse Operation Manual Guide



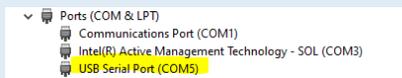
Workhorse Commands and Output Data Format guide

## Installing the USB to Serial Adapter Driver



If there is an available internet connection, Windows 10/11 will install the USB driver on first connection. If necessary, install the Virtual COM port (VCP) driver to make the USB adapter appear as an additional COM port. The free FTDI driver download page is available here: <https://ftdichip.com/drivers/>

Use Windows Device Manager® to determine the USB to Serial adapter COM port number. Remove the adapter, wait a moment, note the list of ports, reinsert the adapter and note the new port.



# Installing Batteries

To connect the battery pack:

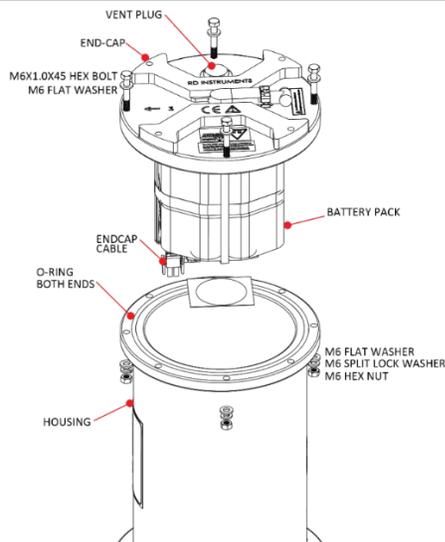


Sentinel battery packs are shipped inside the system **but not connected**. Connect the battery and seal the Sentinel before deployment.

1. Place the Sentinel ADCP with the end-cap facing up. Use a soft pad or the transducer cover to protect the ADCP.
2. Using a 7/8" socket wrench, loosen the Vent plug on the end-cap to vent any pressure inside the housing.
3. Use two 10mm combination wrenches to remove the bolts from the end-cap. Carefully lift the end-cap away from the housing.
4. Connect the battery cable to the top PC board two-pin connector.
5. Check there is a battery pack rubber band around all four wing nuts. This will prevent the wing nuts from backing off the post. Secure the desiccant pack and humidity indicator under the rubber band as shown.



The WorkHorse Sentinel battery packs are 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.



1. Place the end-cap on the housing, aligning the mating holes and the beam 3 number embossed on the end-cap with the beam 3 number embossed on the transducer head.
2. Examine the titanium end-cap assembly nuts, bolts, and washers (6-mm) for corrosion; replace if necessary.
3. Use two 10mm combination wrenches to tighten the bolts to the recommended torque value of 5.6 Newton-meters (50 pound-inches).
4. Tighten the vent plug to 6.78 Newton-meters (60 pound-inches).



For high pressure systems, see the WorkHorse Operation Manual, Chapter 4 for instructions on end-cap replacement.

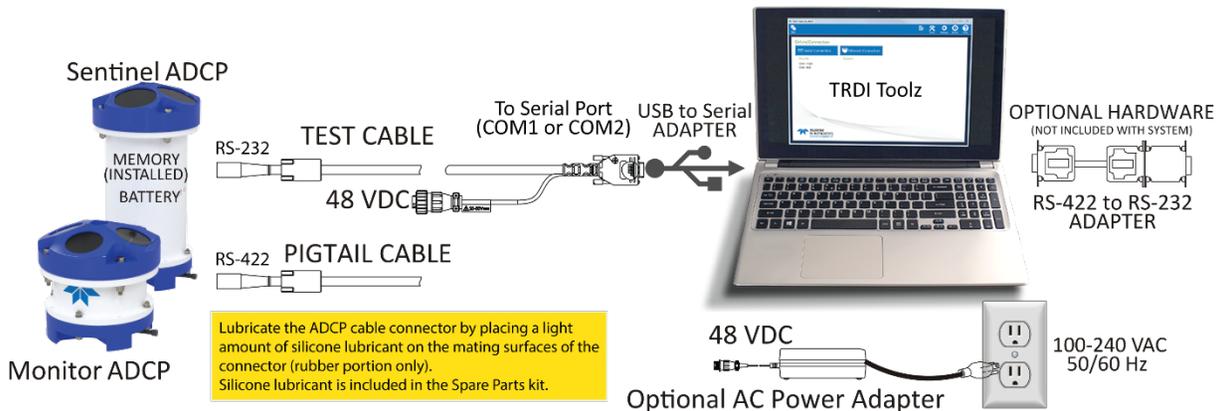
## Quick Review

	
<ul style="list-style-type: none"> <li>✓ Check that you have all the Monitor/Sentinel parts.</li> </ul>	<ul style="list-style-type: none"> <li>ⓘ If you are missing parts, contact TRDI support <a href="mailto:rdifs@teledyne.com">rdifs@teledyne.com</a> or call +1 (858) 842-2700.</li> </ul>
<ul style="list-style-type: none"> <li>✓ Check that the software and documentation is installed.</li> </ul>	<ul style="list-style-type: none"> <li>ⓘ Download and install WH or WHII software.</li> </ul>
<ul style="list-style-type: none"> <li>✓ Check that the system is closed properly.</li> </ul>	<ul style="list-style-type: none"> <li>ⓘ For more information about installing the battery and system close-up, see chapter 4 in the WorkHorse Operation Manual.</li> </ul>

# Connecting to the ADCP

## CONNECTING TO THE ADCP INCLUDES THE FOLLOWING STEPS:

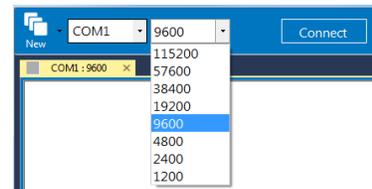
- ✔ Using TRDI Toolz
- ✔ Verify if the system is a WH or WHII



## Connecting to the ADCP

To establish communications with the WorkHorse:

1. Connect the system and apply power.
2. Start the *TRDI Toolz* software.
3. Select **New Serial Connection**.
4. Enter the ADCP's communication settings. Select the **COM Port** the serial cable is connected to and set the **Baud Rate** from the drop-down lists.
5. Click the **Connect** button. Once connected, the button will change to **Disconnect**.
6. Click the **Break** (⚡) button. From the **Break** button drop down menu, select **Soft Break** (= = =). The wakeup banner will display in the terminal window.



## How do I know if I have WH or WHII electronics?

```
[BREAK Wakeup A]
Workhorse II Broadband ADCP Version 7x.xx
Teledyne RD Instruments (c) 1996-2022
All Rights Reserved.
>
```

The system has the Workhorse II electronics installed. Use the *Workhorse II Plan* software to create a deployment command file.

```
[BREAK Wakeup A]
WorkHorse Broadband ADCP Version 5x.xx
Teledyne RD Instruments (c) 1996-2010
All Rights Reserved.
>
```

The system has the original Workhorse electronics installed. Use the *PlanADCP* software to create a deployment command file.

If you are unsure of the ADCP's baud rate, use **Tools, Find ADCP**. *TRDI Toolz* will try different baud rates until it connects to the ADCP.

```
>{i7φ²nll²²jñ~ªñδgJ Checking 9600 baud rate
Checking 115200 baud rate
==
WorkHorse II Broadband ADCP Version 7x.xx
Teledyne RD Instruments (c) 1996-2022
All Rights Reserved.

>
```

If you don't know what com port(s) were added when using a USB to serial adapter, use *Windows Device Manager*® to determine the Com port. Remove the adapter, wait a moment, note the list of ports, reinsert the adapter and note the new port.

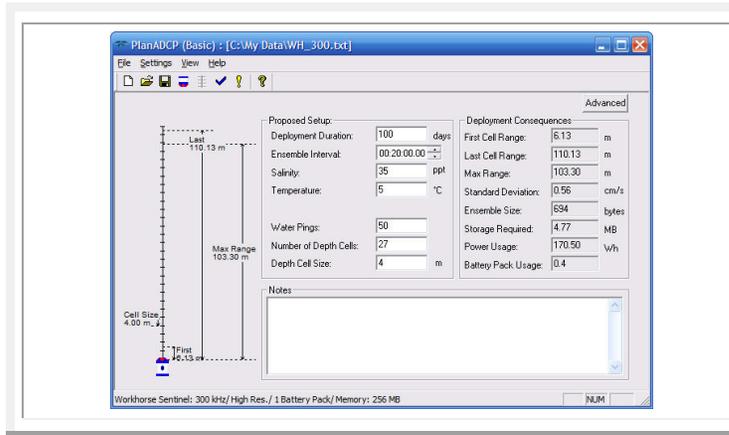
## Quick Review

	
<p>✔ Verify the wakeup banner displays</p>	<ul style="list-style-type: none"> <li>• If you are unsure of the ADCP's baud rate, use <b>Tools, Find ADCP</b>. <i>TRDI Toolz</i> will try different baud rates until it connects to the ADCP.</li> <li>• The default factory set communications settings for Sentinel is RS-232, 9600-baud, no parity, 8 data bits and 1 stop bit. Monitor systems use RS-422, 9600-baud, no parity, 8 data bits and 1 stop bit.</li> <li>• For help on using <i>TRDI Toolz</i>, click the  icon.</li> <li>• If you have any problems connecting, see the Workhorse Operation manual, Chapter 6.</li> </ul>
<p>✔ Install the USB to Serial adapter Virtual COM Port (VCP) driver</p>	<ul style="list-style-type: none"> <li>• The free FTDI driver download page is available here: <a href="https://ftdichip.com/drivers/">https://ftdichip.com/drivers/</a></li> </ul>

# Planning the Deployment

## PLANNING THE DEPLOYMENT INCLUDES THE FOLLOWING STEPS:

- ✔ Creating a command file using PlanADCP or Workhorse II Plan



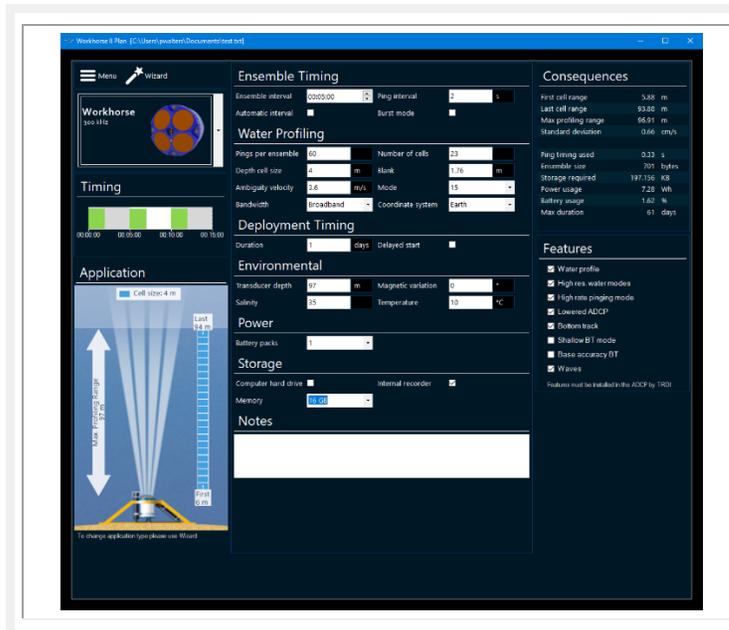
Use the *PlanADCP* software to create a deployment command file for a system that has the original Workhorse electronics.

Use the *PlanADCP* wizard to create a command file. Review the consequences. Save the command file.

See [How do I know if I have WH or WHII electronics?](#) to determine what electronics are installed in the system.



see the PlanADCP User's Guide for details



Use the *Workhorse II Plan* software to create a deployment command file for a system with WHII electronics.

Use *Workhorse II Plan* to create a command file. Review the consequences. Save the command file.

See [How do I know if I have WH or WHII electronics?](#) to determine what electronics are installed in the system.



See the Workhorse II Plan help file for details.

## Quick Review

	
<p>✔ Check that the resources for the deployment are acceptable.</p>	<p>🔗 Use the <i>PlanADCP</i> or <i>Workhorse II Plan</i> software to verify all consequences.</p>
<p>✔ Use the correct planning software</p>	<p>🔗 Use the <i>Workhorse II Plan</i> software to create a deployment command file for a system with WHII electronics.</p> <p>🔗 Use the <i>PlanADCP</i> software to create a deployment command file for a system with the original Workhorse electronics.</p> <p>🔗 See <a href="#">How do I know if I have WH or WHII electronics?</a> to determine what electronics are installed in the system.</p>
<p>✔ If you are collecting Waves data, <i>Velocity</i> can only process waves data collected at 2 Hz.</p>	<p>🔗 Use the Workhorse II Plan or PlanADCP Wizard and select Wave Gauge.</p>

# Deploying the ADCP

## DEPLOYING THE ADCP INCLUDES THE FOLLOWING STEPS:

- ✓ Setting the ADCP clock
- ✓ Testing the ADCP
- ✓ Calibrating the Compass
- ✓ Sending the commands to the ADCP

## Pre-Deployment Checks

*TRDI Toolz* has a user-friendly interface for running the pre-deployment tests and setting the Monitor/Sentinel real-time clock.



Refer to the Workhorse and Workhorse II Command Guide for a listing of all direct commands and their format.

## Setting the ADCP Clock

The real-time clock (date and time) within the Monitor/Sentinel maintains the correct time while system power is removed. The clock is powered by a lithium battery.

### To set the ADCP's clock to match the PC time:

1. Setup the communication parameters between *TRDI Toolz* and the ADCP.
2. Wake up the ADCP by pressing the  button.
3. Click **Tools, PC Time to ADCP**.
4. *TRDI Toolz* will send the TS command to set the clock.

```
>TS 22/06/17 09:50:34  
>
```

## Format the CompactFlash Card Recorder



This section applies to the WHII electronics only. See [How do I know if I have WH or WHII electronics?](#) to determine what electronics are installed in the system.

Use the **RE ErAsE** command to erase and format the CompactFlash memory card to the FAT32 format.

### To format the CompactFlash memory card:

1. Setup the communication parameters between *TRDI Toolz* and the ADCP.
2. Wake up the ADCP by pressing the  button.

3. Enter the **RE ErAsE** command and then press the **Enter** key or click on **Send**. This command is case sensitive.

```
>RE ErAsE erasing...
Recorder erased.
>
```



Use *TRDI Toolz* to download data from the CompactFlash card (see [Downloading Data Files](#)). **Once erased, data is not recoverable.** Do not format or delete files from the CompactFlash card using Windows®. This may leave hidden files on the card. Always use the ADCP's RE ErAsE command to format and delete data from the CompactFlash card recorder.

A recorder card with a file count more than 50 files will cause a noticeable delay between the first ensemble and the Start Pinging (CS) command. If this delay is a concern, ensure that unwanted files are cleared before starting the deployment.

The maximum data file size is 4GB.

## Testing the ADCP

### To run the Built-in tests:

1. Setup the communication parameters between *TRDI Toolz* and the ADCP.
2. Wake up the ADCP by pressing the  button.
3. Enter the PA direct command to send to the ADCP and then press the **Enter** key or click on **Send**.



If any of the tests fail, read Chapter 6 in the Monitor/Sentinel Operation Manual.

## Testing the Sensors

### To test the sensors:

1. Setup the communication parameters between *TRDI Toolz* and the ADCP.
2. Wake up the ADCP by pressing the  button.
3. Enter the PC2 direct command to send to the ADCP and then press the **Enter** key or click on **Send**.

Press any key to quit sensor display ...

Heading	Pitch	Roll	Up/Down	Attitude Temp	Ambient Temp	Pressure
301.01°	-7.42°	-0.73°	Up	24.35°C	22.97°C	0.0 kPa
300.87°	-7.60°	-0.95°	Up	24.36°C	22.97°C	0.0 kPa

4. Use the PC2 test to display the sensor values. Rotate and tilt the system and verify the Pitch and Roll sensor data is reasonable. Rotate the system clockwise and verify the heading increases. Validate the accuracy at 0, 90, and 180 degrees. If the heading is off by more than 2 degrees, calibrate the compass. If the Depth sensor is not zero, zero the pressure sensor.
5. If a sensor fails, contact TRDI Field Service.



See the WorkHorse Operation Manual, Chapter 5 for details on testing the sensors.

## Zero the Pressure Sensor

Zero the pressure sensor at the deployment site, prior to deploying the Monitor/Sentinel ADCP in the water.

### To zero the pressure sensor:

1. Setup the communication parameters between *TRDI Toolz* and the ADCP.
2. Wake up the ADCP by pressing the  button.
3. Enter the AZ direct command to send to the ADCP and then press the **Enter** key or click on **Send**.

## Calibrating the ISM Compass



This section applies to the WHII electronics only. See [How do I know if I have WH or WHII electronics?](#) to determine what electronics are installed in the system.

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.

To achieve the best possible field calibration of the compass, the compass calibration should be performed:

- In a “magnetically clean” environment, i.e., in an area free from stray magnetic fields (electronics, power lines, etc.) and magnetic materials such as iron.
- As close as possible to the actual deployment site (so that during calibration the instrument is measuring a magnetic field intensity and dip angle that are as close as possible to the as-deployed environment)
- With a large variety of instrument orientations (ideally tilting the instrument by 30 degrees or more during orientation).
- TRDI recommends that if you are having trouble calibrating the Workhorse II ADCP compass that you move the system and/or ensure the area around the system is clear of electrical equipment and ferrous materials.



In an oil & gas environment, it is typically impossible to meet the first two requirements above. Oil fields are full of metal structures that preclude a “magnetically clean” environment. Even in standard oceanography, for example a deep-water deployment in the open ocean, it is not possible to meet both requirements because any location reasonably near the deployment site is aboard a ship, which will be a decidedly magnetically dirty environment. Therefore, the customer typically must choose between calibrating a long way away from the deployment site or use the factory default calibration and then post-calibrate the data (see [Compass Post Calibration](#)).

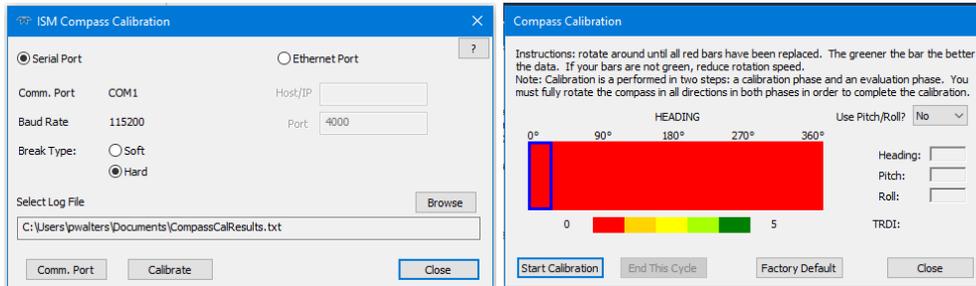
### To calibrate the internal ISM compass:

1. Go outside, away from magnetic materials.
2. Start the *ISM Compass Calibration* software and set up the communication parameters between the software and the ADCP.



 Communication errors may occur during calibration when using a slow communication Baud rate. If you receive a *Failed to get calibration data...* message, try increasing the Baud rate (115200 Baud is recommended). The Workhorse II uses a Hard break.

3. Click the **Calibrate** button.



4. Select **Use Pitch/Roll?**

- Select **No**. This calibration requires two rotations (one for calibration and one for verification).
- Select **Yes**. This calibration requires eight rotations (four for calibration and four for verification).

5. Click the **Start Calibration** button.

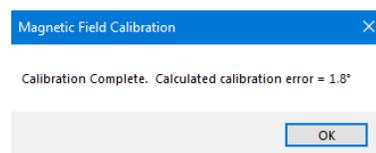
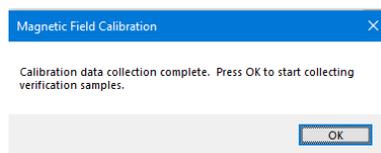
6. As you rotate the system, the bars will change color. The Blue bar indicates where you are in the rotations.



- Green – Good
- Light Green – Acceptable
- Yellow – Within parameters (one or two yellow bars for the entire rotation is OK)
- Orange – Unacceptable - Rotate slower!
- Red – Not measured

7. When the first rotation(s) are complete, click **OK** on the message box to continue with the verification samples.

8. When the second rotation(s) are complete, click **OK** on the message box. The calibration error should be less than 2 degrees.





Stability of the instrument during the calibration process, as well as a non-magnetic calibration site is essential to getting the lowest overall error value.

## Calibrating the Flux Gate Compass



This section applies to the original WH electronics only. See [How do I know if I have WH or WHII electronics?](#) to determine what electronics are installed in the system.

### To calibrate the Flux Gate compass:

1. Setup the communication parameters between *TRDI Toolz* and the ADCP.
2. Wake up the ADCP by pressing the  button.
3. At the > prompt, type **AR** and press the **Return** key. This will return the compass to the factory calibration matrix.
4. At the > prompt, type **AF** and press the **Return** key. Choose option “a” or “b” to start the calibration procedure.

#### 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. Calibration for a single tilt orientation (single + double cycle).
  - d. Help.
  - e. Quit.
5. Tilt the 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. Check the on-screen instructions to see if the orientation is OK. Adjust as necessary.



The tilts must remain constant during the rotations. The transducer beam is the center point of the rotation.

6. When prompted, rotate the ADCP slowly 360 degrees (approximately 5 degrees per second).
7. The second rotation requires the ADCP to be tilted 15 degrees in another direction than from the first rotation. Follow the on-screen instructions to orient the ADCP correctly. When prompted, rotate the ADCP slowly 360 degrees (approximately 5 degrees per second).
8. The third rotation requires the ADCP to be tilted 15 degrees in another direction than from the first and second rotations. Follow the on-screen instructions to orient the ADCP correctly.
9. If the calibration procedure is successful, it records the new calibration matrix to nonvolatile memory. The ADCP will not change its matrix unless the calibration is properly carried out.
10. If the calibration procedure is not successful, return your ADCP to the original factory calibration, by using the AR command. Try using the AR command if you have trouble calibrating your compass. In some circumstances, a defective compass calibration matrix can prevent proper calibration.



For a detailed explanation of the calibration procedure, see the WorkHorse Operation Manual, Chapter 4.



A compass calibration should be conducted at each measurement location, and whenever the mounting fixture or ancillary equipment such as batteries are changed or rearranged.

## Removing the Transducer Cover

The Monitor/Sentinel Self-Contained ADCP is shipped with a transducer cover to protect the transducer faces. Remove the cover when deploying the ADCP.



You **MUST** remove the cover to collect good data.



## Deploying the ADCP

Use TRDI's software *PlanADCP* or *Workhorse II Plan* to create and save a command file (see [Planning the Deployment](#)).

To send multiple commands to configure the ADCP and start it pinging:

1. Setup the communication parameters between *TRDI Toolz* and the ADCP.
2. Wake up the ADCP by pressing the  button.
3. On the **Tools** menu, select **Script Editor**.
4. Click the **Open** icon and select the command file to run from the list. If no extension is given for the script file, an extension of \*.txt is assumed.
5. Click the **Send** icon. Clicking the drop-down menu will show the options to **Send to current** or **Send to all**. Use the **Send to all** feature to send the same script file to all connected ADCPs.



Once the system receives the CS command (last command in the command file) and it is setup to deploy immediately, the unit will start pinging per the timing commands schedule. It will beep audibly while pinging and output data for each ensemble per the schedule based on the WD command.

If the system is setup for a delayed deployment, the ADCP sets its alarm clock to the TF command setting, goes to sleep, and waits until time TF before beginning the data collection process. Once pinging, these audible beep and data output indicators will be observable.

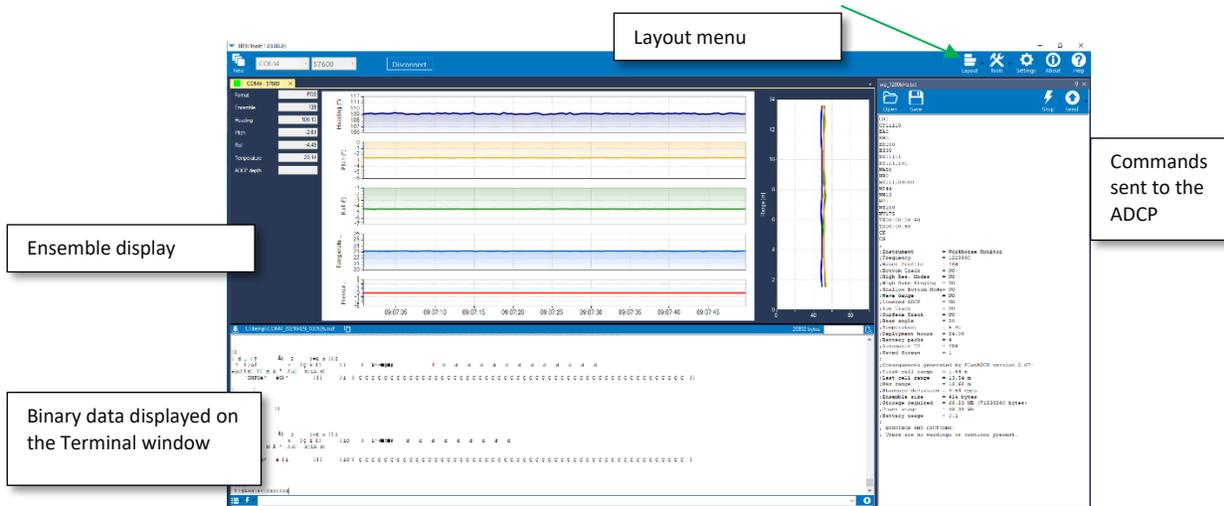
```

[CR]
CF11101
EB0
ED990
ES35
ET1000
EX11111
EZ1111101
WB0
WD111100000
WF176
WS400
WN24
WP60
WV175
TE00:05:00.00
TF00:02.00
CK
CS
;
;Instrument =
Workhorse Monitor
;Frequency = 307200
;Water Profile = YES
;Bottom Track = NO
;Base Accuracy BT = NO
;High Res. Modes = NO
;High Rate Pinging = NO
;Shallow Bottom Mode = NO
;Wave Gauge = NO
;Lowered ADCP = NO
;Ice Track = NO
;Surface Track = NO
;Beam angle = 20
;Temperature = 10
;Deployment hours = 1464.00
  
```



For more information on the commands, see the [WorkHorse Commands and Output Data Format](#) guide, available for download on <https://www.teledynemarine.com/en-us/support/Pages/rdi-technical-support-information.aspx>.

- Use the **Layout** menu to show or hide the Ensemble Display and Terminal windows. The Ensemble Display shows limited situational data (Format, Ensemble, Heading, Pitch, Roll, Temperature, ADCP depth) in tabular form from the ADCP data stream, when present.



 Note that the Ensemble Display is off when *TRDI Toolz* is first started.

## Quick Review

	
<ul style="list-style-type: none"> <li>✓ All maintenance items (as needed) were done including zero pressure sensor, and compass calibration.</li> </ul>	<ul style="list-style-type: none"> <li>🔧 TRDI recommends that if you are having trouble calibrating the Monitor/Sentinel compass that you move the system and/or ensure the area around the system is clear of electrical equipment and ferrous materials.</li> <li>🔧 You <b>MUST</b> remove the transducer cover to collect good data.</li> <li>🔧 Read Chapter 2 in the Workhorse Operation Manual for information on how to install/mount the ADCP for a deployment.</li> </ul>
<ul style="list-style-type: none"> <li>✓ The transducer cover is removed.</li> </ul>	
<ul style="list-style-type: none"> <li>✓ Send the command file to the ADCP</li> </ul>	

# Recovering Data

## RECOVERING DATA INCLUDES THE FOLLOWING STEPS:

- ✓ Downloading data files
- ✓ Viewing data using the Velocity software

## Downloading Data Files

### To download a data file:

1. Setup the communication parameters between *TRDI Toolz* and the ADCP.
2. Wake up the ADCP by pressing the  button.
3. Click **Tools, Recover Recorder**.
4. *TRDI Toolz* sends the **RY** command to recover the data. The **RY** command uploads the entire contents of the CompactFlash memory card via the serial interface to a host computer using the standard YMODEM protocol for binary file transfer. The data is transferred to the host and stored as binary files.
5. Once the data has been recovered, the recorder can be erased by sending the command RE ErAsE. This command is case sensitive. *Once erased, the data is not recoverable.*

## Compass Post Calibration



This section applies to the WHII electronics only. See [How do I know if I have WH or WHII electronics?](#) to determine what electronics are installed in the system.

Compass Post Calibration corrects for heading errors due to hard and soft iron effects in the Workhorse reference frame during the deployment. Often, post calibration will provide results more reliable than when only a pre-deployment calibration is performed.

### Some example scenarios where the post calibration is useful:

- The Workhorse is installed on a mooring and rotates freely sampling the magnetic environment throughout the deployment.
- The magnetic properties of the installation changed after the pre-deployment calibration. For example, a battery pack was added, or the Workhorse was installed in a mounting frame constructed of a ferrous material.
- The Workhorse was subject to magnetic interference during the pre-deployment calibration.

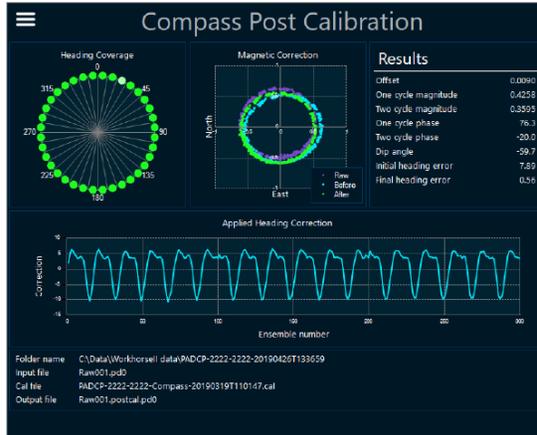
### Post calibration will not be effective if:

- The magnetic interference is not in the Workhorse reference frame. The Workhorse is deployed adjacent to a large metal structure like a bridge or ship for example.
- The magnetic properties change over the deployment.

**Heading Coverage:** Green indicates heading data was collected. Light green indicates some heading data was collected. Missing circles indicates the ADCP did not collect heading data for that direction.

**Magnetic Correction:** The Before series (shown in cyan) is the Raw data (shown in purple) with the existing magnetic correction applied, the After series (shown in green) is the Raw data with the post-calibration correction applied.

```
Example Postcal.txt file:
Date: 10/20/2021 3:05 PM
Offset: 9.02e-003
One cycle: 4.26e-001
Two Cycle: 3.60e-001
One cycle phase: -76.3
Two cycle phase: -20.0
Dip angle: -59.7
Initial heading error: 7.9°
New heading error: 0.56°
Use Post-cal: true
```



The *filename.pd0* data file and the *filename.cal* calibration file must be in the same folder.

Post Calibration will create the *filename.postcal.txt* and *filename.postcal.pd0* files.

The original raw data is not changed. Use the *filename.postcal.pd0* file to view the data with the post compass calibration correction applied.

The **Offset** is the amount by which the calibrated circle must be moved to be centered on zero.

The **One-Cycle Magnitude and Phase** are the RMS hard iron correction. That is, how big is the circle and at what angle is its origin.

The **Two-Cycle Magnitude and Phase** are the RMS soft iron correction. That is, how round (non-elliptical) is the circle and at what angle is its origin.

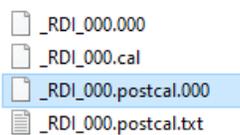
**Dip angle** is the angle made with the horizontal by the Earth's magnetic field lines.

**Initial Heading Error** is the compass error before the post calibration is applied.

**Final Heading Error** is the compass error after the post calibration is applied.

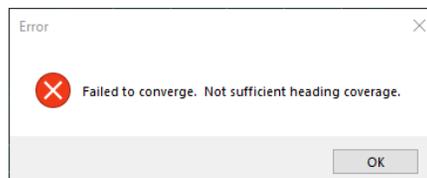
**To post calibrate the data:**

1. Use *TRDI Toolz* to download the data from the CompactFlash recorder. For example, the pd0 data file is named *\_RDI\_000.000* and the *\_RDI\_000.cal* is the post calibration file and both files are downloaded to the same folder.
2. Start the *Compass Post Calibration* software and click the **Menu** button to select the PD0 data file (\*.000).
3. *Compass Post Calibration* will create the *filename.postcal.txt* and *filename.postcal.000* files. The original raw data is not changed. Use the *filename.postcal.000* file to view the data with the post compass calibration correction applied.



The \*.cal file is created during data collection and is recorded to the CompactFlash recorder with the \*.000 pd0 data file.

Post calibration relies upon the instrument moving sufficiently during the deployment to collect "raw magnetometer" data for the heading coverage. If the \*.cal file did not have sufficient heading coverage, then the post calibration will fail to converge.



# Viewing Data

WinADCP is used to view data.

## To open a data file:

1. Start *WinADCP*.
2. Click **Open** and select a data file.



The original \*.pd0 file is never changed, moved, or overwritten.



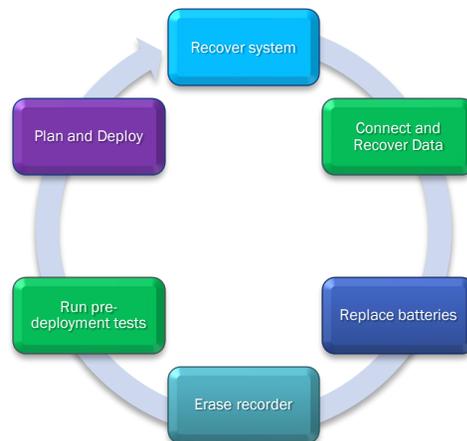
For information on using *WinADCP*, click the  icon.

To view a Workhorse II ADCP data file with the compass post-calibration data applied, open the *filename.postcal.pd0* files.

# Redeployment

The Self-Contained deployment typical turn-around involves the following tasks:

1. Recover the ADCP to the deck of the support vessel.
2. Connect to the ADCP using *TRDI Toolz*.  
Transfer the data to the laptop.
  - It is recommended that all data is downloaded and verified before the recorder is erased.
3. Replace the batteries.
4. Erase the recorder.
5. Close the self-contained housing and run the pre-deployment tests.
6. Plan the deployment with *PlanADCP* or *Workhorse II Plan* and redeploy the ADCP.



# PDDecoder Library in C language

The Teledyne Marine PDDecoder library is an open-source library written in C language to decode the PDO data formats that are commonly output by Teledyne Marine/Teledyne RD Instruments ADCPs. The definition and details of the PDO format can be found in the Workhorse II Commands and Output Data Format guide. Available for download from the Teledyne Marine software portal:

<https://tm-portal.force.com/TMsoftwareportal>.

## Quick Review

	
<ul style="list-style-type: none"> <li>✔ Download the data.</li> </ul>	<ul style="list-style-type: none"> <li>🔗 Use TRDI Toolz to download data.</li> </ul>
<ul style="list-style-type: none"> <li>✔ Post-calibrate the compass data for WHII systems</li> </ul>	<ul style="list-style-type: none"> <li>🔗 Use Compass Post Calibration software.</li> </ul>
<ul style="list-style-type: none"> <li>✔ Check and process the data</li> </ul>	<ul style="list-style-type: none"> <li>🔗 Read the <i>WinADCP</i> help file for information on how to check and process data.</li> </ul>

# Conclusion

Congratulations! You have completed the Monitor/Sentinel Self-Contained Deployment Guide. Read the following chapters in the Workhorse Operation Manual for more detailed information.

## WorkHorse Operation Manual

### Chapter 1 – At a Glance

This chapter includes an overview of the Monitor/Sentinel features, options, computer, power, software requirements, and connecting to the Monitor/Sentinel ADCP.

### Chapter 2 – Installation

Use this chapter to plan your installation requirements.

### Chapter 3 – Data Collection

Use this chapter for an overview of collecting data.

### Chapter 4 – Maintenance

This chapter covers Monitor/Sentinel ADCP maintenance. Use this section to make sure the Monitor/Sentinel is ready for a deployment.

### Chapter 5 – Testing the WorkHorse

Use this chapter to test the ADCP is functioning correctly.

### Chapter 6 – Troubleshooting

This chapter covers how to troubleshoot the Monitor/Sentinel ADCP. If the Monitor/Sentinel fails a built-in test or you cannot communicate with the system, use this information to help locate the problem.

### Chapter 7 – Returning Systems to TRDI for Service

Use this information to obtain a Return Material Authorization (RMA) number if the Monitor/Sentinel ADCP needs to be returned to TRDI.

### Chapter 8 – Specifications

This chapter includes specifications and dimensions for the Monitor/Sentinel ADCP (including outline installation drawings).



## WorkHorse Commands and Output Format Guide

### Chapter 1 – Introduction to Commands

This chapter explains how commands used by the Monitor/Sentinel ADCPs.

### Chapter 2 – Command Descriptions

This chapter defines the commands used by the Monitor/Sentinel ADCPs.

### Chapter 3 – Advanced Commands

This chapter defines the Sound Velocity Smart Sensor, Waves, Lowered ADCP, and Ping Synchronization commands used by the Monitor/Sentinel ADCPs.

### Chapter 4 - Output Data Format

This chapter explains the PDO output data format used by the Monitor/Sentinel ADCPs.

### Chapter 5 – Special Output Data Formats

This chapter explains the PD3 through PD18 output data formats used by the Monitor/Sentinel ADCPs.

### Chapter 6– How to Decode an ADCP Ensemble

This chapter explains how to decode PDO data.

