TELEDYNE RD INSTRUMENTS
A Teledyne Technologies Company

Workhorse Horizontal ADCP

System Configuration and Sales Information - March 2009

General Product Information

The WorkHorse Horizontal ADCP (HADCP) is designed to measure real-time horizontal current profiles from a permanent fixed mount. The HADCP system consists of an HADCP transducer with Standard Profiling modes, cables, and software. The input power requirements for the HADCP are +20 to 50 VDC. The HADCP system requires the addition of a Windows® compatible computer to collect data.
The transducer assembly contains the transducer ceramics and electronics. Standard acoustic frequencies are 600 kHz, and 300 kHz.

Following are specific answers to common questions on details for the Workhorse Horizontal product family.

Frequently Asked Questions

What should be considered for a complete HADCP system?
Ultimately, the system must meet its performance expectations when in use on the customer's platform. While that may seem obvious, satisfactory system performance is critically dependent upon proper installation. As a system manufacturer, Teledyne RDI can only guarantee the performance of its products, *as shipped*. Unless every effort is made to insure proper installation, the performance of the *as-installed* system may be compromised. The HADCP system should ALWAYS be considered as part of a complete package, to insure the best results.

The total package should consist of:

- The HADCP model appropriate for the user application
- The recommended computer system, or equivalent.
- Commissioning Services
- Extended Warranty or Phoenix Program
- Spare Parts
- Consideration of the provision and quality of external data input from non-Teledyne RDI sources (eg: Heading)

What is included in the System Hardware?

The product hardware consists of (2) major pieces; the ADCP and Power/Serial Communication Cable.

- The product selection consists of (2) fixed-frequency models: 300 kHz and 600 kHz.
- The 300 kHz systems are available in two different beam widths, wide and narrow. The Narrow Beam HADCP has a 10.7" transducer diameter providing a beam width of less than 1°. The Wide Beam HADCP has a 5" diameter transducer providing a beam width of 1.7°.
- The HADCP has 3 piston-style transducers mounted in the ADCP head, oriented at a 25° (5") and 20° (10.7") elevation from the centerline, arranged side by side. The Transducers are frequency-specific; they cannot be interchanged.
- Both pressure and temperature are measured as standard with the built in Thermistor and Pressure Sensor. A 50m pressure sensor is installed as standard. 100m and 200m are available if required.
- The 300 kHz and 600 kHz transducer housings are Aluminum. The ADCP Aluminum housings are (nominally) depth-rated to 100m.
- The HADCP Power/Serial Communication Cable is not frequency-specific. The STANDARD Power/Serial Communication Cable is supplied in a 25m length. The Transducer Cable length should be specified at the time of order, if a longer cable is required. Maximum Transducer cable length can be greater than 100m, and is priced by length over 25m.

What kind of communications does HADCP support?

- The HADCP is equipped at the factory to have either a RS232 or RS422 serial communications link. The default configuration is

What External Inputs are required?

- If the HADCP is mounted next to a large ferrous material such as the hull of a platform, external heading data MUST be input to the system software running on a customer-supplied computer, from a customer-supplied heading device.
    - Most newer, commercially-available heading reference instruments will provide a digital (serial) NMEA $HDT or $HDG output suitable for use with the HADCP software.

What System Software is provided?

Teledyne RDI Windows-based software is supplied with the HADCP system at no additional charge, on CD-ROM media.

- SurfaceView is the primary program, supplying system control, data acquisition, display and data logging functions. SurfaceView is compatible with Windows 95/98, Windows 2000, XP and NT operating systems. No testing has been done on Windows ME or Vista. See recommended computer specification, below.
- Teledyne RDI Tools system utility support software.
- Free software updates are available from the Teledyne RDI website.

What are the requirements for a dedicated Computer System to support the HADCP?

Teledyne RDI recommends the use of a commercial PC as the most economical approach to providing HADCP system support. Commercial PCs are generally suited for use on larger vessels and, when used in the typical shipboard lab environment, should have a useful life of about 3 years. Industrial, ruggedized, rack-mount, or military-specified computer hardware is also acceptable, but generally is much more expensive for similar technology, and not necessarily more cost-effective.

The recommended computer system, described below, will support multiple sessions of SurfaceView, to control one or more systems.

- Pentium® III Processor at 866MHz, (or similar, or more capable processor: ie: AMD, P4, etc.)
- Windows 95/98, 2000, XP or NT operating system (NOT Windows ME)
- 128MB RAM, (64MB minimum)
- 20GB HD, (12GB minimum)
- CDRW, (CD-ROM read-only, minimum)
- Ethernet Card,

- 4-port SIIG PCI Card,
- 19" Monitor. (15" minimum)

The price and availability of computer technology continues its' rapid change. A typical system, available as of January 2009, is the Dell OptiPlex® 740 Series PC. However, Teledyne RDI is not necessarily endorsing this brand of PC; it is just one example of a system that meets the PC capability requirements. Teledyne RDI cannot evaluate the many brands of PC and accessories that provide similar capability. It is probably best to choose a PC manufacturer with a significant sales volume in your region, as any PC warranty & repair issues will be handled directly between the end-user and the PC manufacturer. For small vessel operation, various models of commercially-available laptop computers may also be suitable.

Can the customer use their existing computer system to support the HADCP?
So long as the system meets the minimum specifications, above, it should be adequate. Processor speed, memory, disk space and number of serial ports are important factors in operating the system. Monitor size is important in taking advantage of the capability to display several information windows simultaneously.

Can the customer use their existing platform network to communicate with the HADCP computer?
The computer for the HADCP system should have an Ethernet card installed. SurfaceView software allows HADCP data to be saved to, or read from, any network drive the HADCP computer can see. HADCP system timing is set from the computer. If the computer has access to the network, or has its own GPS timing card, the HADCP system computer time can be synchronized with the platform time, therefore allowing the HADCP system to be synchronized with platform time.

What affects the performance of the HADCP system?
The Workhorse Horizontal (HADCP) is a Doppler sonar system, which transmits acoustic signals and listens to the echoes of those signals returned from materials floating with the currents throughout the water column. The performance of the system is generally related to the amount of energy transferred into the water, and the strength of the returned echoes in relation to other, unwanted, acoustic energy (noise). Nominal system performance, as represented in advertised specifications, can be expected so long as reasonable care is taken in system installation, good quality external sensor data (heading) is provided, and environmental conditions (backscatter material concentration) are typical. The most common cause of poor system performance is inadequate installation. Excessive platform mechanical noise, water flow noise from DP thrusters, mutual interference with other acoustic sensors in the area, and other similar chronic conditions can be minimized with proper attention to system installation. With adequate installation, system performance should be consistent with advertised specifications under typical operating conditions. System performance, generally in terms of profiling range, will vary with density and distribution of backscatter material present in the water column, and with platform attitude dynamics. Advertised performance specifications can be expected under typically-experienced conditions of sea state and backscatter intensity.

What are the choices for HADCP system installation?
Proper transducer mounting is critical to system performance. There are a few basic variations for HADCP system installation: (1) fixed mounted, (2) rail system that allows the HADCP to be moved up and down for maintenance, (3) dual taught wire system lowered via a winch, or (4) free hanging from a spreader bar lowered over the side of the platform from a winch. The two preferred methods are fixed mounted or via the dual taught wire method to eliminate any heading, roll or pitch movement. Changes in transducer orientation will cause errors in water velocity measurements. (1) and (2) result in optimal system performance, along with ease of maintenance if choosing method (2).
Consideration should be taken into account when mounting to a platform with Dynamic Positioning as there can be turbulent flow around the transducer, causing flow noise that will reduce system range performance.

What are the issues regarding interference with other platform acoustic sensors?
Multiple platform acoustic systems have the potential for mutual interference. As more sensors are installed on a particular platform, the likelihood of interference increases. Factors affecting mutual interference include the proximity of transducers, similarity in operating frequency and bandwidth, and nature of transmit/receive timing. Teledyne RDI can offer advice, based on its accumulated knowledge and judgment gained from 20 years of platform-mount ADCP installation experience, to optimize the installed performance of the HADCP

systems. However, Teledyne RDI cannot determine, before installation & testing, the exact nature of interference that might occur.

Teledyne RDI can advise on design and placement of the Horizontal ADCP. Teledyne RDI cannot be held responsible for the proper operation of non-Teledyne RDI-supplied systems. Interference from other acoustic systems, if any, which degrades the performance of the ADCP, cannot constitute a basis for failure of Workhorse HADCP acceptance tests.

Can I measure Waves with my Horizontal ADCP?
The 300 kHz Narrow Beam HADCP can be upgraded to measure Waves.

What precautions do I need to make when measuring Waves with my Horizontal ADCP?
System Orientation

- Deploy the system pointed into the wave direction as much as possible. If the system is in the shadow of the platform it may be challenging to profile outside of it.
- Waves from the side are OK but not ideal. Waves from the side can be measured; however the smallest measurable wave specification is different. Waves straight on might be measurable at 20 cm height, whereas waves from the side might need to be 1.5m height.

Obstructions

- **Avoid obstructions in the beams.** Obstructions in the beams (fish, hardware, boats, thruster wash), may challenge the measurement. If we can get good profiles we can produce both waves and currents results.
  - To avoid **fish** problems near the platform, choose range cells that are distant from the platform.
  - To avoid a **fixed obstruction**, choose range cells that are short of the obstruction.
  - Obstructing the beams close to the system is a show stopper.
  - The **bottom is a fixed obstruction** and one must choose range cells that are short of it.
  - The system is resilient to striking the **surface** at a grazing angle.
  - A very large sea state will create wave troughs that block the beams if the deployment depth is too shallow.

Know Your Heading

- **Confirm that ADCP heading is valid** (not simply pointing at the nearest large piece of steel.)
  - If the instrument heading is not ok, a fixed heading can be entered into the software if the platform heading is relatively fixed.
  - If the instrument heading is not ok, and the platform can rotate to any orientation then externally measured heading must be applied.
- **Tilts** (constant angle not dynamics)
  - A **level** deployment is **OK**.
  - Tilted **slightly up** (2-5 degrees pitch) is **OK**.
  - **Caution** if pitched **slightly down.** This can place the measurement at great depth making it impossible to measure small or higher frequency waves.
  - **Caution** if **roll is greater than 10 degrees.** If cells in the right beam are too deep and cells in the left beam are too shallow the measurement may be compromised.
  - **Caution** if **pitch is greater than 15 degrees**. While this scenario has not been tried, it is a "Horizontal" system.
- **Motion** (dynamics)
  - The system may pitch, roll, and yaw with the waves **less than +- 10 degrees.** The performance with frequency and minimum wave height has been de-rated for these kinds of dynamics. A fixed mounted system will perform better than a moving one.
  - **Pitch is the most damaging** of the types of motion. Pitch causes the depth of the range cells to move up and down in partially correlated fashion with the waves. The consequence of dynamic pitching is that the highest usable frequency will not be as good (0.2 Hz rather than 0.5Hz at 10m deployment depth).
  - **Roll** is less of a problem than pitch but still de-rates the performance.
  - **Yaw** at wave frequencies causes the directional distribution to be smeared but is not a serious problem to wave parameters. If the system is rotating (>45 degrees in 17 minutes) then expect the wave direction to be biased accordingly.
- **Deployment Depth**

- Ideal deployment depth is about 10m submergence angled slightly upward (2 degrees pitch) so that range cells at 100m are at about 3-5 m submergence.
- A large sea state will create wave troughs that block the beams if the deployment depth is too shallow. 6m waves will be a problem for a 3m deployment depth.
- A very deep deployment depth will limit the wave frequencies and wave height that can be measured.
- If a deep deployment is unavoidable a greater tilt can be used but should not exceed about 15 degrees.
- See upper cutoff frequency table below.

Platform Influence

- Floating platforms like drill ships will influence waves near the platform.
  - Long period waves will move the platform (heave). So the pressure sensor cannot be used as a reference because it will not see the long period waves.
  - Shorter period waves will reflect off the platform causing wave energy at these frequencies to be exaggerated.
  - **It is best to select range cells that are remote from the platform (60-100m)**, because the platform will reflect high frequency waves and move with low frequency waves. The ADCP can accurately measure both long and short waves, in the vicinity of the platform and remotely. Other instrumentation (such as pressure sensor, or surface tracker) attached to the platform, will not be able to accurately measure the waves because the platform partially moves with the longer period waves and reflects shorter period waves. Because the ADCP can remotely profile and because we exclusively measure the horizontal component of the waves, we can resolve the real wave environment.
  - **Set the small wave screening frequency to 0.03 Hz, if the platform is heaving with the waves.** This keeps the processing from using the pressure sensor data at wave band frequencies, since we know the pressure sensor is not accurate if it moves with the waves.
- **Highest Usable Frequency**
  - If for any reason wave direction, wave height, or wave period seems unrealistic, try setting the upper cutoff frequency to a more conservative setting (lower frequency).

Horizontal Waves Upper Cutoff Frequency				
	8m bins		4m bins	
Depth	freq	period	freq	period
5	0.35	2.86	0.32	3.13
10	0.22	4.55	0.195	5.13
20	0.13	7.69	0.12	8.33
40	0.086	11.63	0.078	12.82

- **Default Settings**
  - Set Baud Rate to ensure that data transfer can keep up with moving whole ensembles at 2Hz. 2Hz data is essential.
  - Collect data in **Broadband** mode.
  - Choose **8 meter bins.** 4m will work, but 8 are quieter.
  - Unless platform rotation rate is significant, collect 4096 samples per burst continuously. If rotation is important then collect 2048.
  - Upper cutoff frequency is default to 0.2Hz (5 second period waves). While we can often out perform this, it is a setting that will work across a wide range of deployment conditions and environments.

What installation support services are offered?

Teledyne RDI offers installation support services in the form of a "Commissioning Service". This service is quoted as a standard service product, consisting of 4 days of on-site engineer time, including travel and expenses. Teledyne RDI does NOT offer to perform the physical installation of the system hardware components. Teledyne RDI can also supervise the installation process in a short separate visit, prior to commissioning.

The full Commissioning Service is intended to:

- Survey the physical installation and HADCP system interface with external systems,
- Perform initial system start-up,
- Perform system tests, while platform is in full operating mode.
- Perform operator training.

The time required should be 4 days, depending on the platform availability schedule. One day, dockside, is enough for static system checkout, assuming all hardware is physically installed properly. There should be underway tests, to test system integration, validate overall performance against the installation, and identify any installation issues that need attention. This testing could easily stretch out over a few days, in light of other sea-trial commitments that prevent dedicated testing of the ADCP. The sea trial period should also serve as training time. Naturally, the dockside and sea trial days should be contiguous. The standard Commissioning Service does not cover extended stays, or multiple visits, however services can be purchased on a day-rate basis.

What if the customer declines to buy installation support services?
Often, customers will insist on purchasing only the HADCP system, without commissioning, or a computer. The customer may be forced by administrative rules to consider those items separately, or may already have an acceptable alternative to the computer. Installation support is so important, however, that it should be stressed that *without formal system acceptance, Teledyne RDI cannot properly address reports of poor system performance.* It is in everyone's best interest to commission every HADCP system.

What is the Factory Warranty?
Teledyne RD Instruments offers a one-year, standard, limited warranty on the Workhorse Horizontal. This warranty is intended to cover manufacturing defects, and is NOT an *as-installed* performance warranty. This warranty offers repair or replacement, at Teledyne RDI's option, for covered defects in equipment returned to the factory, shipped at the owner's expense. An Extended Warranty is available, extending the period of the original factory warranty.

Are there any recommended spare parts?
Spare parts are rarely recommended for HADCP systems, although board-level parts are available. The Power/Serial Communication Cable is recommended as a spare part, only for those clients who routinely order spares as a line item in a capital equipment procurement program.

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