

High Resolution Water Profiling Water Mode 11

Introduction

Water Mode 11 is the result of the continued evolution of the signal processing within our Workhorse products. It is part of our High Resolution, “Pulse to Pulse coherent” options for Workhorse products that include Modes 5, 8, and 11. These options have 10 to 100 times higher precision than our standard Broadband operation. If used within their limits, you will be able to collect significantly better data with your Workhorse ADCP than ever before.

Recommended Applications

- High Resolution, Shallow water profiling in slow moving rivers, streams and estuaries.
- Boundary layer measurements.

Conditions where you would use Mode 11

- Shallow Water (4m max. 1200KHz, 8m max. 600KHz)
- Low Flow Velocity (<1m/s) (See Environmental Limits)
- You require a Small Depth Cell Size (Min 1 cm)
- You require Low Standard Deviation of velocity measurement.

Mode 11 is not suitable for:

- Deep water profiling(Improvements to the range of Water Mode 11 are currently under development)
- Relative Water velocities greater than 1m/s
- Profiling in high turbulence or shear

What is Required

- Update the WorkHorse ADCP firmware version to 16.19 (Monitor/Sentinel) and 10.12 (Rio Grande), or higher.
- Install the High Resolution Water Profiling feature upgrade in your WorkHorse ADCP (standard in a Rio Grande).

- Add the WM11 and WK (for depth cells sizes less than 5cm for a 1200 and 10cm for a 600), commands to your existing configuration command files to take advantage of this new mode.

Why is Water Mode 11 an Improvement?

- Water Mode 11 is an evolution of our existing Water Modes.

The Key Improvements are:

- Depth Cell Size can be set to 1 cm minimum (previously 5 cm for a 1200 and 10cm for a 600)
- Maximum number of depth cells has been increased to 255 (previously 128).
- Improved signal processing so Water Mode 11 has a wider performance envelope than our previous High Resolution Water Mode 5.

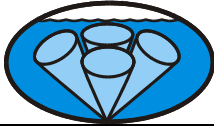
Commands Relevant to Water Mode 11 Use

For Moving Platform users with Bottom Tracking

WM11	Selects Water Mode 11 Default =WM1
BP1	Enables Bottom Tracking. With bottom tracking enabled the transmission pulse is automatically adjusted for the depth. The system effectively “tunes” WZ for the best performance down to the default minimum of WZ5. Max. Depth is 4 m for a 1200.
WZ	If Bottom Tracking is enabled it sets the Minimum Ambiguity velocity which is used. It is not necessary to change this command from the default WZ5 if bottom track is enabled. Default = WZ5
WK	Sets Depth Cell (Bin) size in cm, 1cm minimum (WK1). Overrides the WS command for small depth cells. If you never use depth cells less than 5cm for a 1200 or 10cm for a 600 then you can still use the WS command. Default =WK0 (uses WS)



NOTE. For detailed explanations of the Water Mode 11 commands, see the WorkHorse Commands and Output Data Format Guide (February 2002 revision) or Interim Change Notice ICN006.



For Fixed Platform users

WM11	Selects Water Mode 11
WZ5	Used to adjust the characteristics of the transmission pulse for improved maximum velocity at shallower depths. With a 1200KHz ZedHed™ you would use WZ15 for depths less than 1m, WZ10 for depths up to 2m, WZ5 for depths up to 4m. Default = WZ5. Note: If WZ is changed to greater than the default WZ5 and bottom track is enabled then the range will be restricted according to the value of WZ.
BP1	Enables Bottom Tracking. With bottom tracking enabled the transmission pulse is automatically adjusted for the depth. The system effectively “tunes” WZ for the best performance down to the default Minimum of WZ5. Note: Bottom Tracking Feature is an option with some instruments.
WK	Sets Depth Cell (Bin) size in cm, 1cm minimum (WK1). Overrides the WS command for small depth cells. If you never use depth cells less than 5cm for a 1200 or 10cm for a 600 then you can still use the WS command to set the depth cell size.



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Environmental Limits

For 1200 KHz systems, a useful “rule of thumb” for determining whether the water conditions are within the envelope of Mode 11 is the Depth times Velocity product. Water Mode 11 may not work if the Depth (m) times the Velocity (m/sec) product is greater than one.

Other Environmental Limits

- Maximum relative Horizontal velocity depth <1m (1200KHz) or <2m (600KHz), 100cm/sec
- The maximum relative horizontal velocity gradually reduces with depth to approx. 25 cm/sec at 4m (1200KHz) or 8m (600KHz)
- It is important to keep in mind that with water mode 11, in depths less than 1 meter, the maximum beam velocity that can be reliably measured under all circumstances is 50cm/sec (this equates to 150cm/sec relative horizontal velocity as long as no vertical components are present). What this means is that the vector combination of horizontal and vertical velocities along a beam should not exceed 50cm/sec or errors may occur. As your relative horizontal velocities approach 100cm/sec in shallow water it is important to move slowly and smoothly to minimize any

additional platform motion that might contribute to the relative velocity in the vertical or horizontal plane.

Other recommendations:

- Currently not recommended for 300KHz systems.
- Maximum Depth Cell size: 0.25m (600kHz), 0.125m (1200kHz)
- WT can be used with the 1200KHz ZedHed™ in shallow water (<1m) to reduce transmit pulse length. This is normally left at default WT = 0 (Transmit Pulse Length = Depth Cell Size) however if you are using small depth cells e.g. 5cm you could use WT2 to reduce the transmit pulse length to 2 cm and possibly get an extra depth cell in the profile.

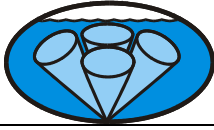
Examples of Performance

- 1200kHz in 2 meters of water, 5cm depth cell size: Standard Deviation of water velocity measurement (SD) < 1.0cm/s.
- 600kHz in 4 meters of water, 10cm depth cell size: Standard Deviation < 0.9cm/s.
- 1200kHz in 1 meter of water, 1cm depth cell: Standard Deviation < 5cm/s.
- 600kHz in 2 meters of water, 10cm depth cell: Standard Deviation < 1.6 cm/s.

Technical Description

In order to understand the advantages of Water Mode 11 we must briefly revisit the basis of Broadband processing, Water Mode 1, and the pulse coherent Water Mode 5. It is advisable that you are familiar with the primer and application note explanations of Water Mode 1 and Water Mode 5.

Pulse to pulse coherent processing used in Water Mode 11 applies a combination of the techniques used in Water Mode 1 and Water Mode 5 processing. It effectively improves the maximum relative velocity over where Water Mode 5 can operate while retaining the measurement precision. We first transmit a coded pulse and the processor listens and collects the return signal data. At a predetermined time (automatic if Bottom Tracking is enabled) the second coded pulse is transmitted and the processor continues to collect return signal data. The processor then applies autocorrelation functions to measure the approximate time separation between returned pulses and determines the approximate water speed. Phase measurement techniques are then applied to determine a more precise water speed.



Because of the large pulse separations used in Water Mode 11 as with Water Mode 5, we rely on the fact that the pulses are being affected by similar water conditions. If the conditions change between pulses beyond a certain point because of turbulence or high velocity, measurement becomes difficult (it is referred to as decorrelation) and data will be missing from the profile. If a large number of depth cells contain no velocity data then the user should switch to Water Mode 1 or 12.

NOTES