High Resolution Water Profiling Water Mode 12

Introduction

Water Mode 12 is the result of the continued evolution of the signal processing within our Workhorse products. It is effectively an improved version of Water Mode 1 (our most robust Water Mode) offering higher sampling rates (up to 20Hz) and more precise velocity measurement. Water mode 12 was designed primarily for use in short-range, small-depth cell applications, however under the right conditions it can be used anywhere Water Mode 1 is used and results in either reduced variance for a set time period or reduced power consumption.

Recommended Applications

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

Conditions where you would use Mode 12

- You require a Small Depth Cell Size (Min 1 cm)
- You require Low Standard Deviation of velocity measurement and velocities are too fast for Water Mode 11.

Mode 12 is not suitable for:

- Dynamic situations. (See Environmental Limits for more detail)

What is Required

- Update the WorkHorse ADCP firmware version to the latest version.
- Install the High Ping Rate feature upgrade in your WorkHorse ADCP.
- Add the WM12, WK (for depth cells sizes less than WS frequency dependant defaults), and the WO commands to your existing configuration command files to take advantage of this new mode.

Why is Water Mode 12 an Improvement?

- Water Mode 12 is an evolution of our existing Water Mode1.

The key Improvements are:

- Depth Cell Size can be set to 1 cm minimum (previously 5 cm for a 1200)
- Maximum number of depth cells has been increased to 255 (previously 128).
- Sampling rates up to 20Hz over a wide range of velocities

Basic Operation

Typically a workhorse transmits pulses, collects information on the returned signal and processes this information into a velocity measurement. The process is called a ping. With Water Mode 12 we shorten the procedure and transmit and receive a series of sub-pings that are not fully processed until the desired number have been accumulated (the number is determined by the WO command). The system then averages this data and completes the final processing to produce ping velocity values but the sub-ping raw data is not stored. Sensor data is read only once at the start of the ping and is applied to averaged sub-pings. The result is faster processing so more data can be collected for a given time and hence better measurement precision.

Commands Relevant to Water Mode 12 Use

WM12	Selects Water Mode 12.
WV170	Used to adjust the characteristics of the transmission pulse. A higher WV allows measurement of higher velocity currents. (100 Minimum, 480 Maximum) Default=WV170
WK1	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)
WO pp,hh	Where pp = number of Sub pings per ping and hh = minimum number of 0.01 seconds between Sub pings. A typical setting for a 1200KHz system for use in shallow water would be WO20,4, which transmits 20 sub-pings 40msec apart and then averages them to create the ping which is recorded.

NOTE. For detailed explanations of the Water Mode 12 commands, see the WorkHorse Commands and Output Data Format Guide (April 2002 revision) or Interim Change Notice ICN006.

Environmental Limits

Maximum horizontal and vertical velocity is determined by the WV command. The default WV170 gives a maximum horizontal velocity measurement of +/- 5m/sec.

If Water Mode 12 is used on a platform or mooring that experiences large accelerations during the ping sampling period then some bias may occur.

Other Considerations:

- To achieve high sampling rates (e.g. 20Hz) the number of depth cells should be less than 60 (WN command should be 60 or less).
- Maximum Sub Ping rates must be considered to avoid ping-to-ping interference.
- The sensor information is read only once at the start of the Water Mode 12 ping. Maximum duration of the Sub Pings must be considered if operating in a dynamic environment.
- Maximum duration of the Sub Pings must be considered in light of Bottom Tracking. If too much time separates the Water and Bottom pings "stripy data" may result. It is recommended to use BP2 in these situations.

Minimum Ping and Sub-Ping Times

Pinging too fast may result in ping-to-ping interference. We have always recommended that the ping rate be no faster than 1.5 times the Bottom Tracking range for a particular frequency in salt water. The result is the following ping times for open water with no boundaries:

Frequency	Minimum Ping Times Salt Water	Minimum Ping Times Fresh Water
300kHz	450ms	660ms
600kHz	180ms	330ms
1200kHz	67ms	85ms

These are very conservative numbers and, to our knowledge, have always worked. If we allow absorption and range spreading enough time to attenuate the previous ping by 25dB relative to the current ping and we are confident that there are no significant boundaries (e.g. life layer) within the frequency dependant range (Note: not the user set profiling range) of the acoustic signal then we can reduce these times. This gives the following values for open water:

Frequency	Minimum Ping Times Salt Water	Minimum Ping Times Fresh Water
300kHz	200ms	330ms
600kHz	90ms	160ms
1200kHz	30ms	40ms

When the bottom is within range, the situation is improved once the time is set so that multiple bounces off the bottom occur between pings. A bounce is described as when the previous ping has traveled to the bottom, bounced to the surface, returned to the bottom, and then back to the instrument. Each bounce dissipates energy. How much is dependant on the bottom roughness (rough is better). This loss adds to the absorption loss. We recommend the following minimum ping and sub-ping times when the bottom is within range however these are conservative and can be reduced if the user is confident there is no interference.

Maximum Bottom Depth	Minimum Ping Times (WO or TP) 1200KHz	Minimum Ping Times (WO or TP) 600KHz	Minimum Ping Times (WO or TP) 300KHz
5m	40msecs	60	80
10m	60	60	80
20m	80	80	100
50m	80	200	300
100m	NA	250	350

RDI Field Service can provide detailed advice on how to calculate the minimum ping times for particular environments.

Examples

Examples of Improved Standard Deviation of velocity measurement:

1. 1200kHz, 10cm Bin, in 5-meter bottom depth of water:
    - WM1 takes 175ms and results in a Standard Deviation of about 30 cm/s. Thus, it takes 1.6 seconds to get to 10cm/s.
    - WM12 with 9 Sub Pings gets the same performance in 0.65 seconds.
2. 600kHz, 25cm Bin, in 10 meters bottom depth of water:
    - WM1 takes 160ms and results in a Standard Deviation of about 26 cm/s. In 0.5 sec (3 Mode 1 Pings) the Standard Deviation would be ~ 16cm/s.
    - WM12 with 6 Sub Pings, Standard Deviation would be ~ 11cm/s in 0.5secs.

Examples of Improved Energy Usage:

300kHz, 4m Bin, 100 meters profile with 10 burst pings/ensemble:

- WM1 uses 13.1 W-Sec per ensemble.
- WM12 uses 11.9 W-Sec for 10 Sub Pings per Ensemble – a saving of 9%.

600kHz, 2m Bin, 40 meters profile with 10 burst pings/ensemble:

- WM1 uses 5.9 W-Sec per ensemble.
- WM12 uses 3.7 W-Sec for 10 Sub Pings per Ensemble – a savings of 37%.

NOTE. The savings are (.0024*#Bins + .14) W-Sec per Sub Ping. The % savings are higher in shorter-range profiling.

NOTES