Hydroacoustics UPDATE:

Computing Minimum Time Between Pings

(ping-to-ping interference)

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NOTE: *This test is not intended to be completed before every measurement. When using mode 12, if the maximum depth is greater than 6.5 m for a 1,200 kHz unit or 8 m for a 600 kHz unit it is recommended that the test described herein, be used to increase the minimum time between pings, if necessary. Evaluation of the frequency of occurrence, associated site conditions, and effect of ping-to-ping interference is on going and more detailed guidance will be provided when it is available.*

INTRODUCTION

Random noise or variation can be averaged and the variation is reduced proportional to the square root of the number of sample averaged. Therefore, to reduce the variation in velocity and discharge measurements, it is usually desirable to use as high a ping rate as possible, which will allow greater averaging to achieve a measurement with lower variance. A higher ping rate also gets the water- and bottom-track pings closer together in time. This has the effect of reducing the noise on the calculation of the water velocity. The maximum ping rate (minimum time between pings) may be limited by the ADCP's ability to process data. For a profile with a large number of bins, the time it takes the ADCP to process the data from the bins may be the limiting factor on the ping rate. Mode 12 is a high ping-rate mode that averages pings prior to transformation. For mode 12, the limiting factor is often ping-to-ping interference. Ping-to-ping interference occurs when the energy from a previous ping (usually a reflection from the streambed) interferes with the reception of the current ping. A ping is initiated by a transmitted pulse. This pulse propagates through the water column and is reflected back (backscattered) by scatterers in the water column and also by the bottom, by structures and by vessels in the vicinity of the ADCP, and perhaps the banks of the river. These other reflections can be stronger than that from the water column. It is not unusual for a signal that travels from the ADCP to the bottom, back to the surface, back to the bottom, and back again to the ADCP to be larger than the signal from the water column. This phenomenon is called "second bounce". In fact, many "bounces" may be required for the signal level to dissipate enough so that it doesn't interfere with the current ping. Similar interference can come from other reflectors in the vicinity. The important point is that one cannot start a new ping until this interference from the previous ping has diminished to the point where it won't interfere with a new ping. A typical result of ping-to-ping interference is that the measured water velocities will be biased low.

It is impossible to give definite guidelines for the minimum time between pings that work for every location because of the large variations in bed material, bed roughness, the existing in-the-water structures, and the variation in absorption losses at different locations. Additionally, scatterers, such as weeds, riverbanks, channel walls, etc, vary widely in the vicinity of the instrument at different measuring locations. The scattering characteristics of the channel bed can vary by more than 30dB and the absorption losses between fresh water and salt water vary by another 10dB. Additionally, the water backscattering can vary by another ±20dB. Boundaries can have a wide range of scattering values. Therefore, an accurate value for the time between pings can only be obtained by conducting an on-site test.

DESCRIPTION OF FIELD TEST

The objective of the field test is to determine at what range the intensity and correlations reach the system noise level and stay there for the rest of the profile.

Using WinRiver configure the ADCP as you normally would for data collection at the site, then in the “User Commands” section of the configuration wizard enter the following commands:

CR1
BP0
WP1
WS100
WN128
TE00000000
TP000000

These commands configure the ADCP to use no bottom ping, one water ping, 128 1-meter long cells with no time between pings. The length of the cells and the number of cells (maximum of 254 for a Rio Grande) may need to be adjusted for shallow water or very deep water. The length of the cells multiplied by the number of cells should be deep enough to see the intensity decrease to the noise level of the instrument (approximately 40 counts). Typically the length of the cells multiplied by the number of cells should be at least 6 times the depth of the water.

Set up WinRiver to use SI units and display the Intensity Profile and the Average Intensity Contour Plot (see figure 1). You must uncheck ‘Mark Below Bottom “Bad”’ in the ‘*Configuration Settings*’ under the’ *Processing*’ tab. You may need to adjust the depth scaling for the two graphics windows.

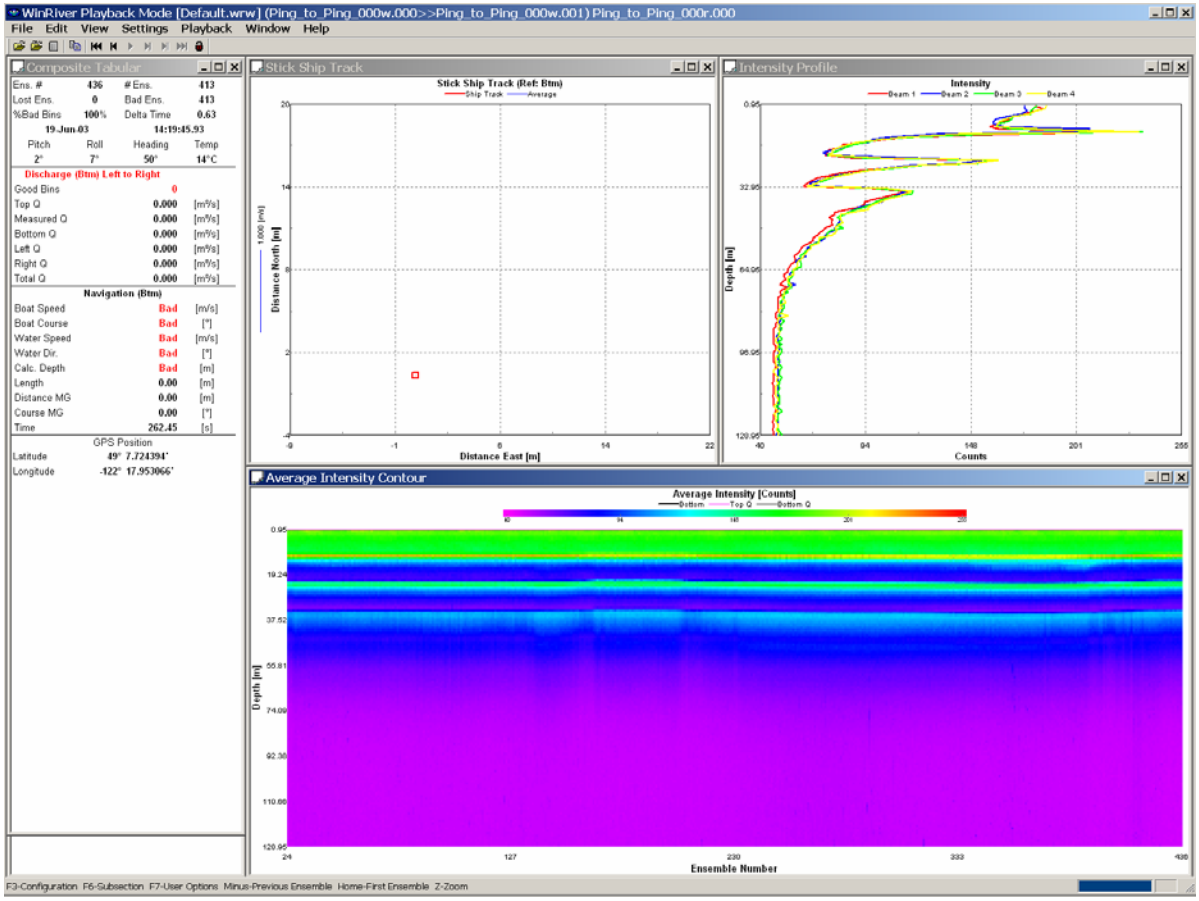

Figure 1. Ping-to-ping workspace in WinRiver.

Press F4 to start pinging and F5 to record the data. First monitor the intensity profile plot (figure 2). You should see the intensity decrease with depth and then spike when the ping reflects from the bottom. The ping will then travel upward and reflect from the water surface and again spike when it strikes the bottom a second time. Depending on site conditions, the ping may again travel upward and reflect from the water surface. There may then be a spike the third time the ping reflects from the bottom. Additional reflections are possible for some hard bottoms and low acoustic absorption environments. For soft bottoms and high acoustic absorption environment the third reflection may not be present. Eventually the ping will dissipate and the instrument will register only the system noise (approximately 40 counts). Although the graphs show depth on the y-axis, you are actually observing the intensity value versus time. To determine the minimum time between pings, multiply the range where the intensity reaches system noise by 1.5 milliseconds per meter. For the example in figure 2 this would be about 75 meters * 1.5 milliseconds per meter = 112.5 milliseconds.

The color contour plot shown in figure 3 displays the same information but for all of the pings recorded. If several locations or the entire cross section were recorded in one file the color contour plot would allow identification of the worst

condition. Usually using both the color contour plot and the profile plot helps determine the best estimate of depth (time) to reach the instrument noise level.

NOTE: This test should be conducted at different locations on your planned transect. Changing depths, bed material types, and paths to obstacles all affect the minimum time between pings. The longest ping time obtained for the cross section should then be used.

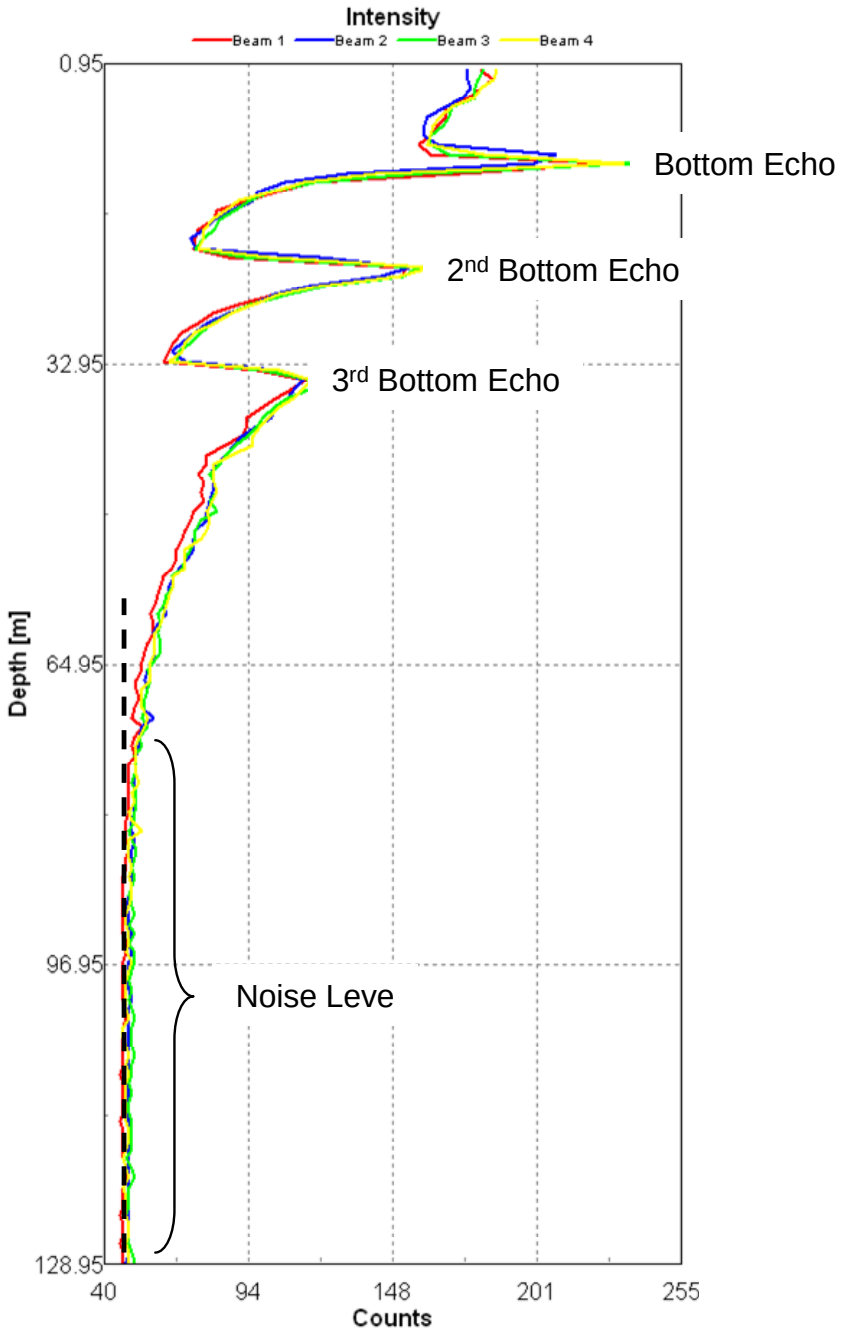

Figure 2. Typical intensity profile during ping-to-ping test.

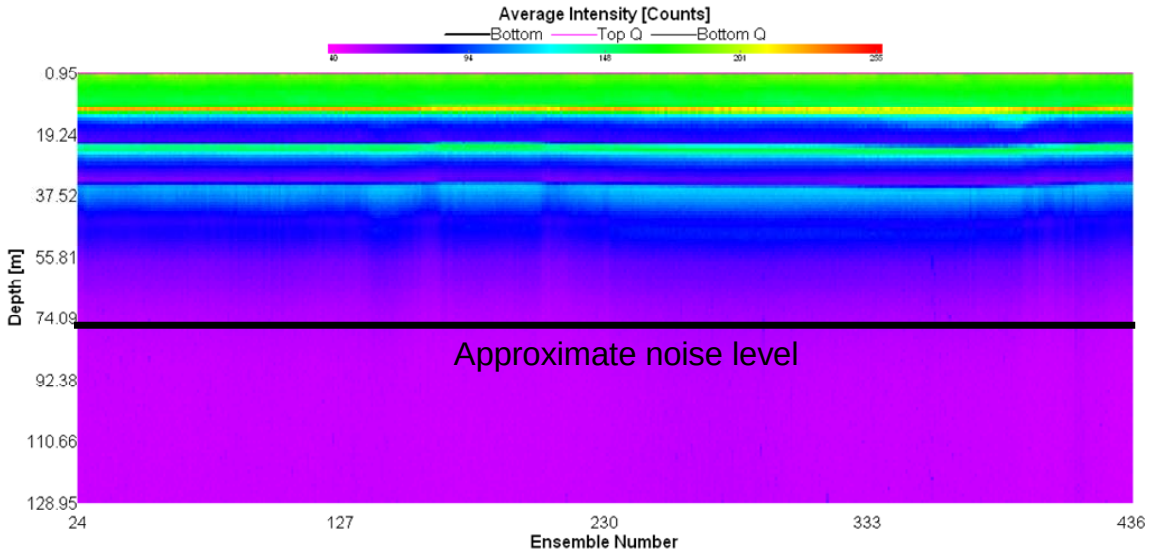

Figure 3. Typical intensity contour plot for a ping-to-ping test as a stationary location.

APPLICATION TO ADCP CONFIGURATION FOR DATA COLLECTION

The minimum time between pings is important for all water modes, but due the faster ping rate in water mode 12, it is especially important for mode 12.

Water Modes 1, 5, 11

For all water modes, except mode 12 the minimum time between pings is set by the TP command. The format for the TP command is:

TPmmsshh

where

mm is minutes;
ss is seconds; and
hh is hundredths of a second.

All digits are important so leading zeros are necessary. For the example in figures 2 and 3, the minimum time between pings is 112.5 milliseconds or rounding up, 12 hundredths of a second. Thus, the user would enter TP000012 in the user commands section of the configuration wizard.

Water Mode 12

The minimum time between pings (subpings) for water mode 12 is set in the WO command. The format of the WO command is:

WOppp,hhhh

where

ppp is the number of subpings; and
hhhh is time between subpings in hundredths of a second.

Leading zeros are not important in the WO command. For the example in figures 2 and 3, the minimum time between pings is 112.5 milliseconds or rounding up, 12 hundredths of a second. If 10 subpings were being used in mode 12 the user would enter WO10,12 in the user commands section of the configuration wizard.

SUMMARY

This Hydroacoustic Update includes information on the cause and effect of ping-to-ping interference and describes how to calculate the minimum time between pings to help prevent the problem. If ping-to-ping interference occurs, it typically causes the measured velocities to be biased low. Due to the wide variability in site conditions, it is not possible to provide a minimum time between pings that allows optimal data collection for all sites. A simple on-site test is described that allows the user to determine the minimum time between pings for the site and conditions that exist at the time of the measurement. If the computed minimum time between pings is greater than the default value the computed value should be entered in the TP command for modes 1, 5, and 11 and in the WO command for mode 12. If the computed minimum time between pings is less than the default value, it is recommended that the default value be used. If you have any questions, please contact David Mueller (dmueller@usgs.gov or 502-493-1935) or email the USGS Hydroacoustics Work Group, hawg@simon.er.usgs.gov.