Configuring Bottom Mode 6

1 Introduction

This application note is meant to assist in the configuration of Bottom Mode 6. Bottom Mode 6 is a very simple mode. There is no ambiguity resolving, which allows Bottom Mode 6 to operate in Narrower Bandwidths than the standard bottom tracking.

NOTE. Bottom Mode 6 is available for Navigator ADCP/DVLs only.

1.1 Benefits

Bottom Mode 6 has one benefit, Reduced Bandwidths. Bottom Mode 6 operates in 12.5% and 6.25% Bandwidths. The need for reduced bandwidth could arise to reduce interference or detectability.

1.2 Drawbacks

Bottom Mode 6, by reducing bandwidth, also reduces sample rate. This results in noisier data. Along with noisy data, comes the complexity of properly configuring the mode. Improper configuration can result in wild (unreasonable) data.

1.3 Background

1.3.1 Ambiguity Velocity

The ADCP calculates velocity from a phase measurement. The problem with a phase measurement is that the range is limited to 0° to 360°; thus 40° and 400° cannot be differentiated. The ambiguity velocity (Ua) is equivalent to limiting the phase measurement to +/- 180°. If the velocity is greater than the ambiguity velocity, it wraps around; i.e. if Ua = 180 cm/s, and the vessel velocity is 200 cm/s, the measured velocity is –160 cm/s. This is referred to as an ambiguity error. For further discussion of Phase Measurement and Ambiguity, consult the "ADCP Principles of Operation: A Practical Primer 2nd Edition for Broadband ADCPs". Keeping track of whether and how many times the ambiguity velocity has been exceeded is called Ambiguity Resolution. Ambiguity Resolution is not implemented in Bottom Mode 6.

1.3.2 Ambiguity Lane

An ambiguity lane is a manual ambiguity resolver. By making some assumptions about the conditions the ADCP will be used in, the processing algorithms can offset the zero angle to reduce the probability of an ambiguity error.

1.4 Setup

Before attempting to configure the system the following information must be available.

- ADCP Installation
  - Janus angle
  - ADCP Alignment Angle
- Approximate Range of Vessel Velocity
- Desired Bandwidth
  - Tolerance for Noise

Bandwidth and Code Length are used to determine the ambiguity velocity via the following equation:

$$Uab = \frac{1500 m/s}{Ns \cdot CPE \cdot EL}$$

Where

Uab = Ambiguity Velocity Radially along the beam

Ns = Number of Samples per Element (Always 4)

CPE = Carrier Cycles Per Element (8 = 12.5% BW, 16 = 6.25% BW)

EL = Code Length in elements (7, 15, 31, and 63)

Use the following steps to help solve the equation.

Step 1 – Determine the Ambiguity Lane Center

The Ambiguity Lane Center is the average of the limits of the range of velocities.

$$\frac{MinVelocity + MaxVelocity}{2} = Ambiguity\ Lane\ Center$$

For example, if the vessel was expected to travel forward at 14 m/s and backwards at 2 m/s, the limits would be –2 m/s and 14 m/s, and the average would be 6 m/s. Therefore the Ambiguity Lane Center is 6 m/s.

Step 2 - Determine the Vessel's Ambiguity (Uav)

The range also determines the ambiguity velocity.

$$Upper\ Limit - Ambiguity\ Lane\ Center = Uav$$

Taking the example from above; the vessel's ambiguity velocity is the upper limit (14 m/s) minus the lane center (6 m/s); or 8 m/s.

Step 3 – Determine Radial Ambiguity Velocity Along the Beam (Uab)

Given the vessel's ambiguity (*Uav*) of 8 m/s, that needs to get converted to beam radial. That is achieved using sin() and cos() functions:

$$Uab = Uav \cdot \sin(JA) \cdot \cos(EA)$$

Where

JA = Janus Angle (WorkHorse = 20°, Navigator = 30°)

EA = Alignment Angle.

Make sure that the EA command setting reflects the correct alignment angle for the ADCP installation. If the ADCP is aligned with the ship (beam three is forward), EA will be zero. If the ADCP has been rotated 45° Starboard, EA will be 4500. For this example, use 45°.

Continuing with the example above, given Uav = 8 m/s;

$$Uab = 8m/s \cdot \sin(30°) \cdot \cos(45°) = 2.828m/s$$

Step 4 – Determine the Code Length (EL)

Since Bandwidth is assumed to be pre-determined, that leaves only the Code Length to be selected. The Code Length must be 7, 15, 31, or 63. To calculate the largest possible code for the given *Uab*, use the following equation:

$$EL(CPE,Uab) \le \frac{1500m/s}{4 \cdot CPE \cdot Uab}$$

Finishing the example for 12.5% and 6.25% Bandwidths, the appropriate code lengths are

$$EL(8,2.828) \le \frac{1500m/s}{4 \cdot 8 \cdot 2.828m.s} \le 16.575$$

$$EL(16,2.828) \le \frac{1500m/s}{4 \cdot 16 \cdot 2.828} \le 8.288\,.$$

So for the 12.5% BW (8 Carrier Cycles Per Element) case, the appropriate Code Length is less than or equal to 16.575. The final result is 15, since 15 is less than 16.575 and greater than 7. The 6.25% BW (16 Carrier Cycles Per Element) case results in a Code Length of 7.

Step 5 – Determine the BM Command Format

The BH Command is the primary configuration command for Bottom Mode 6. The BH command expects three comma-separated values to set the bandwidth, code length, and Ambiguity Lane Center.

- The Bandwidth is either 1 or 3 (1 = 6.25% and 3 = 12.5%).
- The code length is entered as 0 to 3 (0 = 7, 1 = 15, 2 = 31, and 3 = 63).
- The Lane Center or Vessels Ambiguity Velocity (*Uav*) is entered in cm/s and the range is limited to 0 to 1800 cm/s.

So for the given examples of 12.5% and 6.25% bandwidths, the following BH commands would be sent to the unit.

BH 3, 1, 600 (12.5% BW)

BH 1,0,600 (6.25% BW)

1.5 Commands

BG – BM6 Transmit Restriction

Purpose	This command, if enabled, limits transmit to a specified pulse length or a percentage of the depth, whichever is shorter.
Format	BG x,yy,zzz
Range	x = Enable/Disable Transmit Restriction (0 = Restriction off; 1 = Restriction On) yy = Percent of Depth to Transmit (0 – 50%) zzz = Transmit Limitation in milliseconds (0 = Frequency Dependent Maximum) 1200kHz – 3 ms 600kHz – 9 ms 300kHz – 50 ms 150kHz – 100 ms
Default	BG 0,30,0

Recommended Setting. The default setting for this command is recommended for most applications.

Description — This command limits the length of transmit when using Bottom Mode 6 only. If transmit is not being limited (x=0), the unit will transmit yy% of the depth. If transmit is being limited (x=1), the unit will transmit the shorter of yy% of the depth or zzz milliseconds.

BH – BM6 Configuration

Purpose — This configures the following parameters of Bottom Mode 6: Bandwidth, Code Length, and Expected Velocity

Format — BH x,y,zzzz

Range — x = Bandwidth (1 = 6.25%; 3 = 12.5%)

y = Code Length (0 = 7, 1 = 15, 2 = 31, 3 = 63)

zzzz = Lane Center [cm/s] (0 – 1800 cm/s)

Default — BH 3,0,0

Recommended Setting. The default setting for this command is recommended for most applications.

Description — The command allows only Bottom Mode 6 to be setup for Low Bandwidth Applications.

NOTES