

Best Practices for Calibrating a TRDI RiverRay Compass

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Background

Since the TRDI RiverRay was released in 2009 the USGS, OSW has been conducting comparison measurements and compiling data from around the USGS. The data collected to date (August 2012) indicates potential inaccuracies with the Honeywell compass that, until recently (August 2012), has been shipped with all RiverRays. Users have reported apparent downstream closure on loop moving bed tests and inconsistencies in GPS-referenced data when using RiverRay, indicating a problem with the compass itself or the calibration procedures. After testing conducted by TRDI in July 2012 it was evident the Honeywell compass had a higher error than other previously used and currently available compasses. Furthermore, the compass calibration procedures for the RiverRay in the WinRiver II software lacked adequate feedback to the user, and the technique used to calibrate the compass could also be a source of the inaccuracies being observed. For this reason, this document, describing best practices for calibrating TRDI RiverRays equipped with the Honeywell compass, has been prepared. These best practices apply to RiverRays with the Honeywell compass and is based on current knowledge (August 2012), but may change as more testing is conducted on this compass.

Recommended Procedures

1. Calibrate the compass in an environment that represents the measurement conditions, including the measurement cross section and the deployment. This is especially important on a manned boat where batteries, running motors, ferrous objects and other electronics can all affect the compass. The compass should be calibrated in the same conditions as the measurement will be made, with all equipment running/not running and in the same position on the boat as it will be during the measurement.
2. In order to calibrate the compass, the RiverRay should be on a flat, level surface or in calm water. The calibration method available in the firmware that involves use of pitch and roll is not recommended unless the unit will be used in extreme pitch and roll conditions (consistently greater than 10 degrees).
3. After starting the calibration, slowly rotate the RiverRay, aiming for a 360 rotation of the instrument each 60 seconds. **While a minimum of one rotation is required, multiple rotations are recommended.**
 - a. In the calibration dialog, the number of samples is shown (Fig. 1) and one rotation may only provide 10 samples. Ideally, the compass should be calibrated so that calibration points are collected through the 360-degree range and are evenly distributed across that range. Figure 2 plots the X and Y coordinates of a good calibration with 62 points covering the 360 range. Figure 3 shows the coordinates of a calibration with only 15 valid points, leaving large gaps over most of range.
 - b. **In order to get reasonable coverage of calibration points around the 360 degree range, a minimum of 40-50 calibration points are usually needed, which would require multiple rotations of the ADCP over a period of 3-5 minutes.**

58	Mag: X	-540, Y	-540, Z	2058, valid YES
59	Mag: X	-328, Y	-741, Z	2022, valid YES
60	Mag: X	-132, Y	-861, Z	2018, valid YES
61	Mag: X	136, Y	-915, Z	2035, valid YES
62	Mag: X	451, Y	-841, Z	2032, valid YES

Figure 1: Calibration results, including the number of points and X, Y and Z offsets

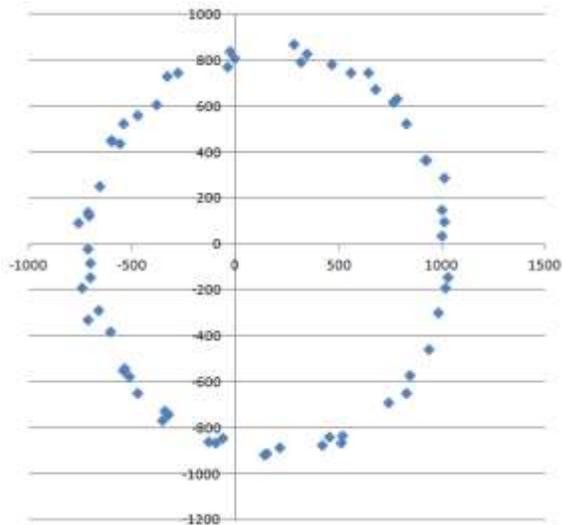


Figure 2: Plot of calibration offsets for a good calibration with over 60 points.

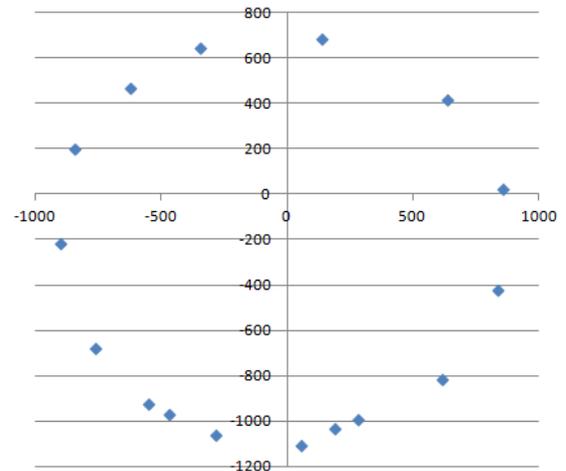


Figure 3: Plot of calibration offsets for a poor calibration with only 15 points.

4. When done rotating the instrument, stop the calibration procedure by hitting 'D'.
5. The X and Y offsets displayed should be within +/-200. It seems offsets can be within these limits and data still show signs of compass heading errors when collecting. When using the same deployment methods from site to site, you should notice relatively consistent X and Y offsets. For example, at sites with little magnetic interference and when deploying the RiverRay from the same trimaran, you would expect consistent offset values. These offsets will likely vary from instrument to instrument.
6. Hitting the 'A' key will accept the X and Y offsets. The Z offset is set to zero in this case as the calibration routine did not include pitch and roll. Often, evaluating the loop moving bed test closure direction and/or GPS data is the most reliable way to review the accuracy of the compass.

Summary

If using a TRDI RiverRay with GPS, or for a loop moving bed test, a properly calibrated compass is essential. While these best practices increase the chance for a properly calibrated compass, compass errors may still occur. TRDI is offering an ISM compass for the RiverRay, which must be installed by TRDI. This compass upgrade involves installation of the same compass found in the TRDI StreamPro (known as the ISM compass) and uses a calibration procedure that appears to provide better feedback. The OSW is currently awaiting delivery of 2 RiverRays that have been upgraded to this compass. Although tests from TRDI and experience with StreamPros equipped with the compass indicate that the ISM compass should

be more reliable, no USGS tests have been completed as yet. The OSW will begin testing as soon as the upgraded RiverRays are received and schedules and flow conditions permit. For those who will regularly be using the RiverRay with GPS or regularly use the loop moving bed test method, this compass upgrade may be recommended, pending results of USGS testing.

For RiverRays equipped with a Honeywell compass, stationary moving bed tests will be consistently more accurate than the loop test and is the preferred moving bed test. When using a calibrated Honeywell compass with GPS, it is essential to carefully review the data for compass errors. Compass errors will usually result in differences in ship track direction based on the orientation of the instrument (the errors may be for only one of the primary headings for reciprocal transects). Other evidence of compass errors include large variability in total discharges when using GPS (GGA or VTG) as the velocity reference and downstream closure for loop moving bed tests.

If you have questions on the best practices outlined in this document, please contact the Hydroacoustic Work Group (HaWG) by email at hawg@simon.er.usgs.gov.