



# The Patch Test

## 1 Introduction

The alignment of the Sonic 2024 sonar head to the motion sensor and gyro is critical to the accuracy of the determined depths. It is not possible to install the sonar head in exact alignment with the motion sensor and gyro to the accuracy required ( $x.xx^\circ$ ). If GPS time synchronization is not used, the latency of the position, as reported by the GPS, must also be measured during the calibration. This being the case a multibeam calibration must be performed to measure the angular misalignment between the Sonic 2024 and the motion sensor and gyro and, if necessary, the position latency; this is called the Patch Test.

The patch test is performed with each new installation or whenever a sensor is moved. In the case of an over-the-side mount, a large number of calibration computations need to be performed to determine how well the pole goes back into the same position each time it is deployed. With more permanent mounting arrangements, a minimum of 5 separate patch tests should be conducted in order to derive a standard deviation that would indicate the accuracy of the derived values.

The patch test involves collecting data over certain types of bottom terrain and processing the data through a set of patch test tools. There are two primary methods of processing the data that are currently used: an interactive graphical approach and an automatic, iterative surface match. Each of these techniques has strengths and weaknesses and the preferred approach is dependent on the types of terrain features available to the surveyor. All modern multibeam data collection software packages contain a patch test routine. Please read the software manual for explicit information regarding the requirements for that software's patch test. The below criteria is, in general, the norm for a patch test.

### 1.1 Orientation of the Sonic 2024 Sonar Head

The orientation of the sonar head must be known in order to convert the measured slant ranges to depths and to determine the position of each of the determined depths.

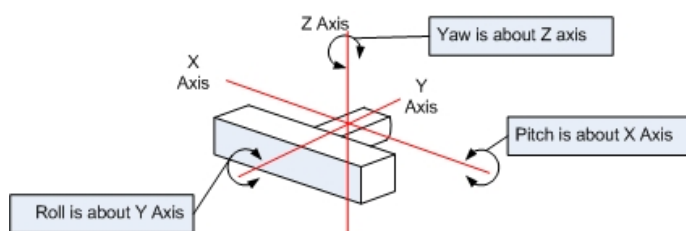


Figure 1: Sonic 2024 axes of rotation

Any error in the measured roll of the Sonic 2024 sonar head can cause substantial errors in the conversion from slant range to depth. A roll error of  $1^\circ$  on a 50 m slant range will cause a 0.6 m error in the resulting depth. Any error in the measured pitch of the Sonic 2024

head will primarily have a detrimental effect on the accuracy of the positions that are determined for each slant range/depth. A pitch error of  $1^\circ$  will cause an along-track error in the position of 0.4 meter when the sonar head is 25 meters above the seabed.



## 1.2 Patch Test Criteria

The patch test requires collecting sounding data over two distinct types of sea floor topography; a flat bottom is used for the roll computation whereas a steep slope or feature is used for the latency, pitch, and yaw data collection.

Care must be taken that the sonar head covers the same area on both data collection runs, this may not be the same as vessel position, especially with an over-the-side mount or if the sonar head rotated. Only the latency data collection requires a different speed from normal survey speed.

The data collection for Latency, Pitch and Yaw should be done in as deep water as possible. This is particularly true for the pitch computation due to the fact that in shallow water the angle of pitch may not be easily determined due to a lack of resolution.

### 1.2.1 Latency Test

The vast majority of installations will incorporate GPS time synchronisation and, as such, no latency is expected in the GPS position. However, it is necessary to complete at least one or two latency tests to prove that the latency, for all practical purposes, is zero. Most patch test programs will not yield zero latency, but the derived value would be so small so as to constitute a practical zero.

For the latency test, data is collected on a pre-defined line up a steep slope or over a well defined object (such as a rock or small wreck). The line is surveyed at survey speed up the slope, and then surveyed again, in the same direction, but at a speed that should be half of the survey speed. If the vessel can not make way at half survey speed then the fast run will need to be taken at a higher speed than normal survey speed and this can influence the latency test due to squat or settlement. The main consideration is that one line should be twice the speed of the other.

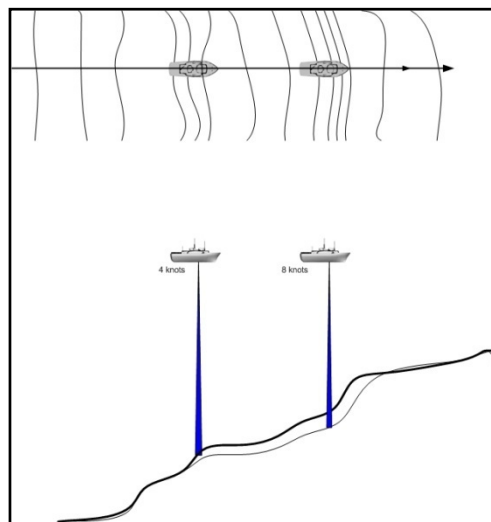


Figure 2: Latency Data collection



### 1.2.2 Roll Test

The data collection for roll has to be over a flat sea floor. One line is surveyed twice, in reciprocal directions and at survey speed.

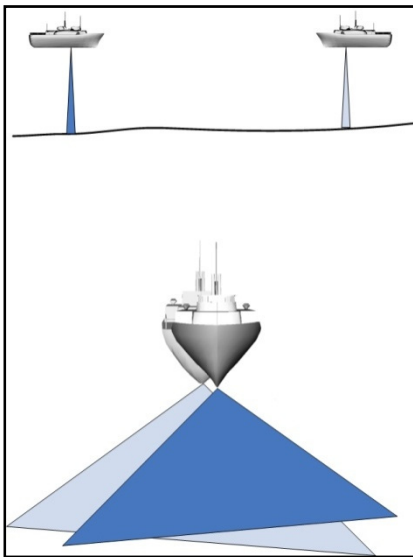


Figure 3: Roll data collection

When the data, from the two data collections, are looked at in profile, there will be two seafloors sloped in opposite directions. Most patch test programs will go through a series of iterations to determine when the difference between the two surfaces is the smallest, and this is the roll offset.

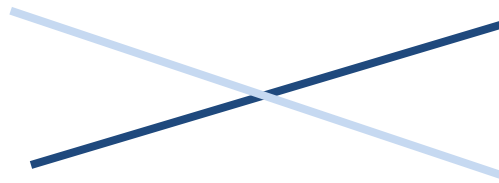
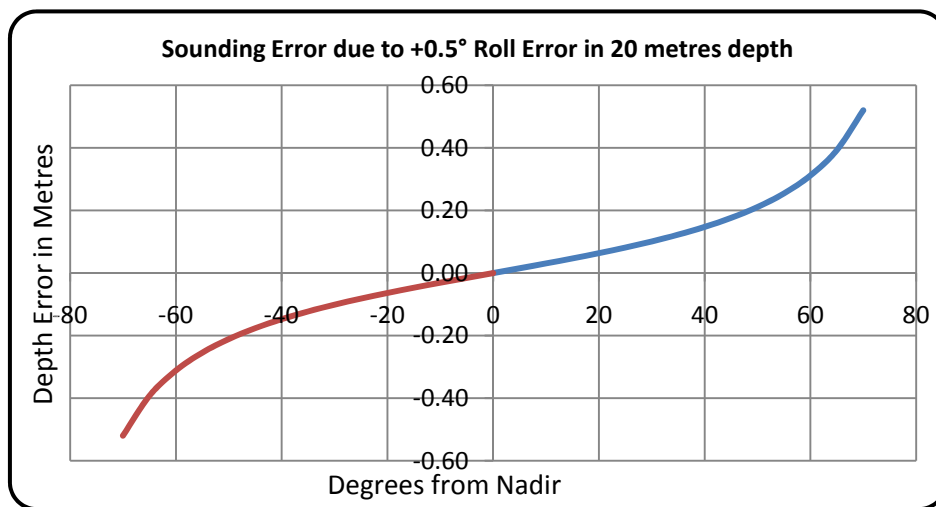


Figure 4: Roll data collections

Roll is perhaps the most critical value in the patch test routine as an error in roll will result in an error in sounding depths.

However, the computation to determine the roll misalignment is usually the easiest and most consistent.

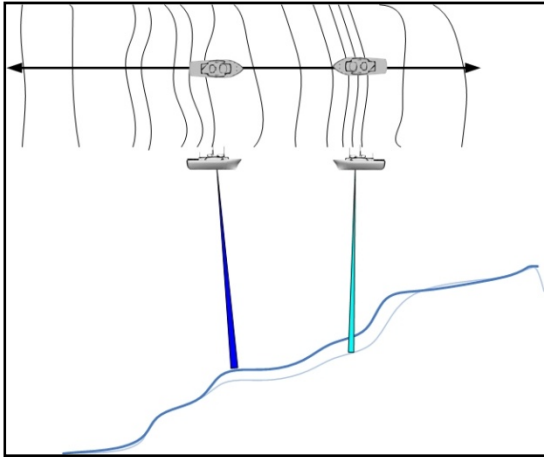


Graph 1: Depth errors due to incorrect roll alignment



### 1.2.3 Pitch Test

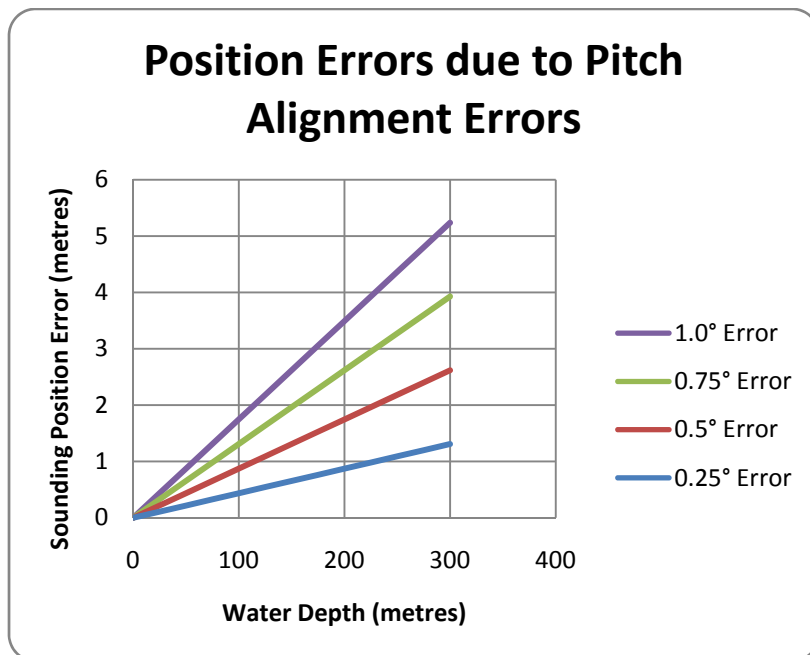
The pitch data collection is over the same type of sea floor as the latency data collection, i.e. steep slope or feature on the sea floor. One line is surveyed, twice, in reciprocal directions at survey speed. It is very critical that the sonar head passes over the same exact part of the slope on each run.



A profile of the data will show two different slopes, which represent the reciprocal data collections. The patch test software goes through a series of iterations of pitch angle corrections until the difference between the two surfaces reaches a null. Whatever the angle of correction, which results in the minima or null, that angle will be reported as the pitch misalignment.

Figure 5: Pitch data collections

A pitch error will result in an along-track position error, which increases greatly with depth

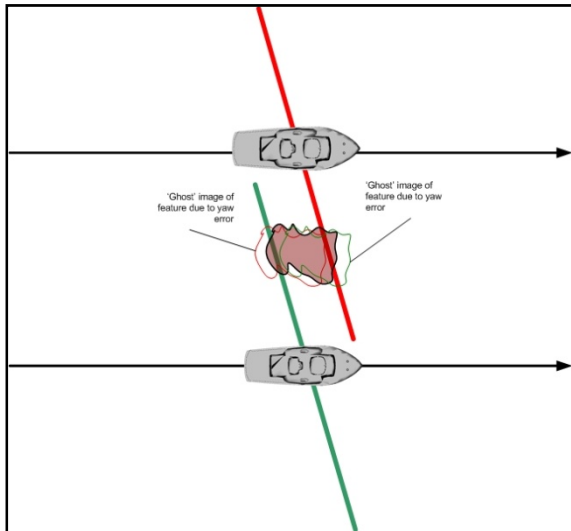


Graph 2: Position errors as a result of pitch misalignment; error can be either negative or positive



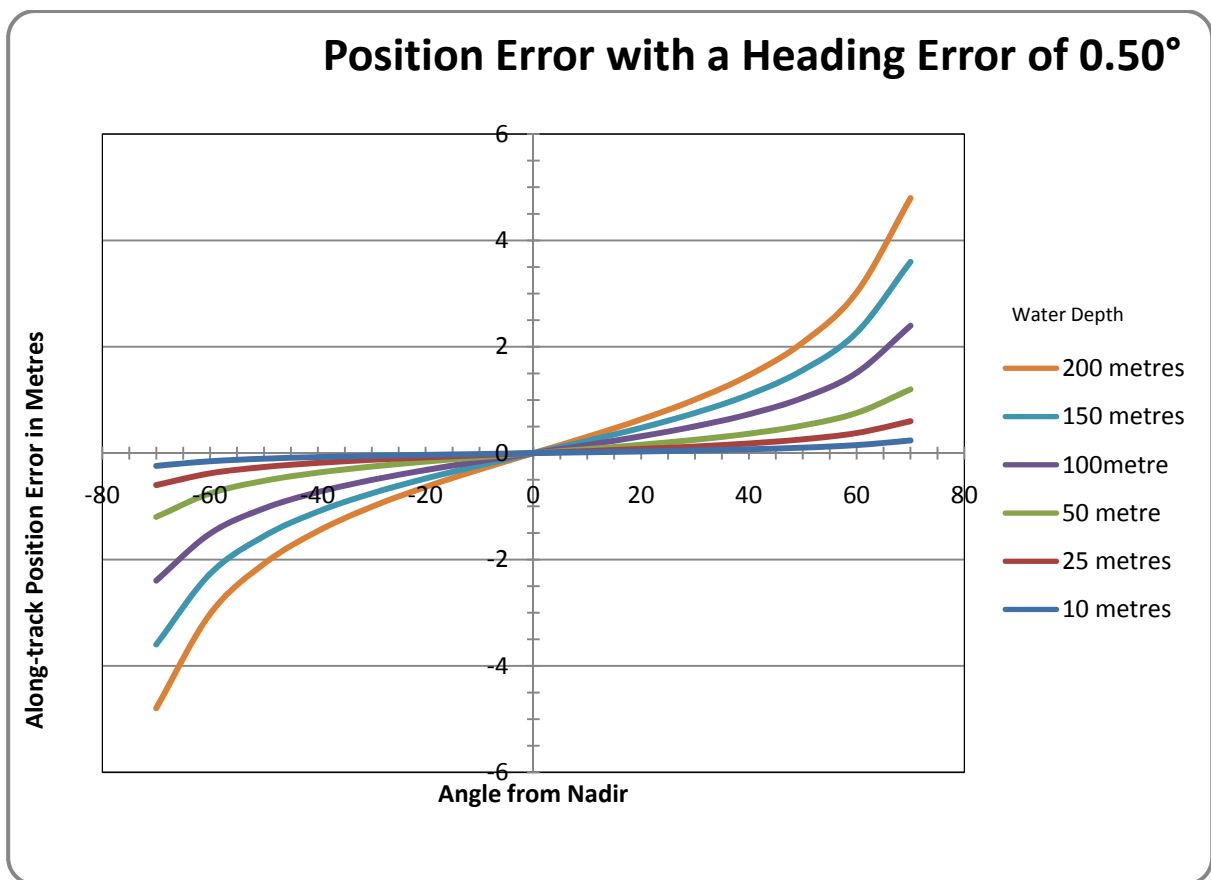
### 1.2.4 Yaw Test

The yaw data collection and subsequent solving for the yaw offset is usually the most difficult of the 4 tests that comprise a patch test. This is especially true if a slope is used for the yaw computation; a feature generally works much better. The reason for this is that the area that is used for the computation is not directly under the vessel, but in the outer beams and the slope may not be perfectly perpendicular in relation to the course of the vessel.



For the Yaw data collection two parallel lines are used, with the vessel surveying in the same direction on those lines. The lines are to be on either side of a sea floor feature or over a slope. The lines should be approximately 2 – 3 times water depth in separation. A yaw error will result in a depth position error, which increase with the distance away from nadir.

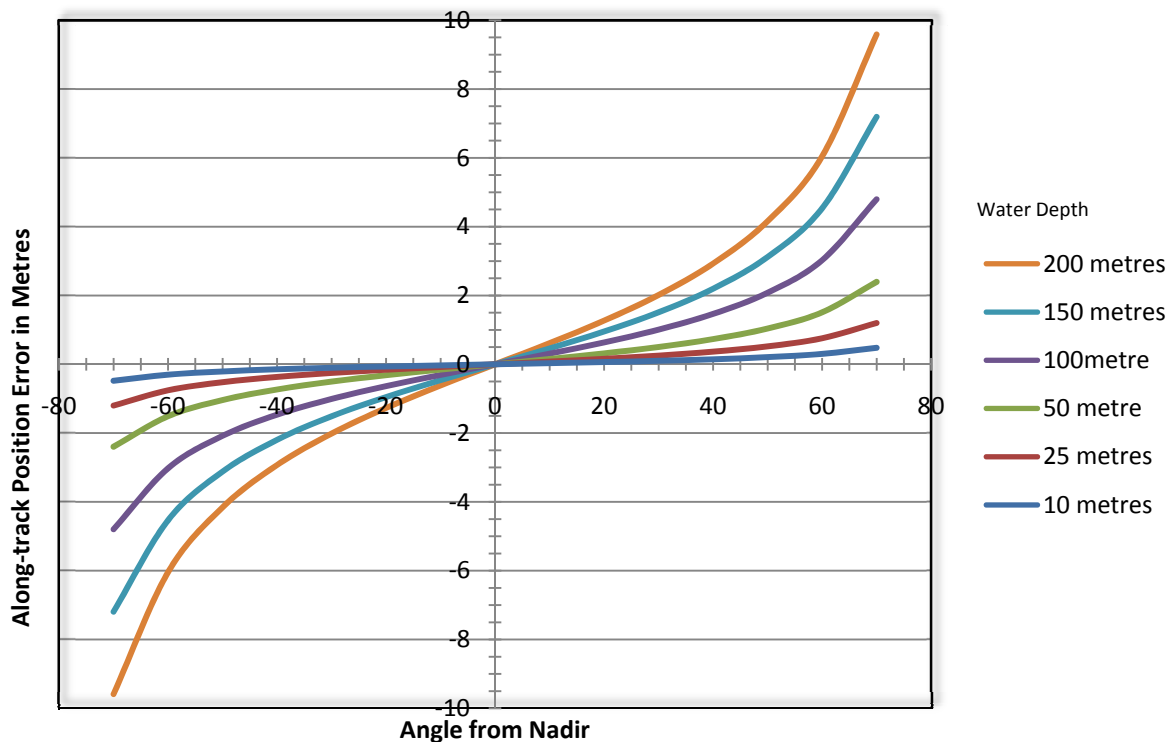
Figure 6: Yaw data collection



Graph 3: Along track position error caused by 0.5° error in yaw patch test



### Position Error with a Heading Error of 1.0°



Graph 4: Along-track position error caused by 1.0° error in yaw patch test error

### 1.3 Solving for the Patch Test

Depending on the data collection software that is employed and how it solves for the patch test, there will be a distinct order that the tests will be solved for, but this does not influence the data collection for the patch test. In general, latency will be solved before pitch; roll will be solved for before yaw. It is not uncommon that a larger than expected error in one of the tests will make it necessary to go back and resolve for all previous values. This can be the case with a large yaw offset, as this will influence to a greater degree the accuracy of the latency and pitch computations if done using a slope.

The resultant patch test values are corrections that are entered in the data collection software and not in the Sonic 2024 software, as the values are used for process data.