Alignment Mode

This document describes the Alignment Mode for BEI PSSC's nanoSeries® AIME-II & ARA absolute encoders. This mode can be entered by sending the alignment command (0X0E Hex) to the encoder. The encoder will then report the encoder alignment error in the auxiliary word position (Bits 33 – 48) of the encoder data. This mode replaces the auxiliary word in the output data stream with two interlaced signals representing relative tangential and radial linear motion between the readhead and code disk. The signals are generated using optical patterns, and thus are always available on the Encoder. When interfaced to BEI PSSC's Encoder Test Box, the Alignment Visualization Tool & Alignment Lissajous (see Figure 3) provides the information necessary to align the encoder in both the radial and tangential direction based on the linear motions between the readhead and code disk. The user can also use the definitions below to interpret the signals for custom use. The use of Alignment Mode is subject to compliance with the appropriate Encoder Mechanical Interface Control Drawing. Without first meeting the ICD, the alignment signals cannot be guaranteed to meet the following specifications.

Signal Definitions

- Tangential Sensor — Encoder-generated signal representing relative readhead & disk tangential alignment error
- Radial Sensor — Encoder-generated signal representing relative readhead & disk radial alignment error
- Both signals are 13-bit signed integers representing ranges of -0.004 to +0.003999 inches

Data Transmission Sequence, Alignment Mode

During alignment mode, the auxiliary word (BIT 33) of the encoder data stream indicates that alignment mode is active, BIT 34 – 35 indicate alignment index and the remaining bits produce alignment information:

Table 1: Auxiliary Output word

BITS	CONTENTS	MEANING	
33	ALIGNMENT MODE	1	BITS 1-15 CONTAIN ALIGNMENT DATA
34-35	ALIGNMENT INDEX	00	RADIAL
		01	-
		10	TANGENTIAL
		11	-
36-48	ALIGNMENT INDICATION	1000000000000	-4 MILS ALIGNMENT ERROR
		0000000000000	NO ALIGNMENT ERROR
		0111111111111	+3.999 MILS ALIGNMENT ERROR

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Radial Sensor

The radial sensor is sensitive to motion between the readhead and disk in the axis shown in **red** in Figure 1. This signal is unaffected by encoder calibration and exhibits outstanding linearity within the ±0.003 inch range (see Figure 2). The radial sensor provides the best means for centering the code disk.

Tangential Sensor

The tangential sensor is sensitive to motion between the readhead and disk in the axis shown in **blue** in Figure 1. This signal is broadband and is sensitive to position errors that are harmonics of the encoder signal frequencies. In a poorly calibrated encoder state, this signal could produce substantial error. After a successful encoder calibration, the signal accuracy is markedly increased. This sensor is adequate for alignment of the readhead to the axis-of-rotation as well as centering the code disk. It is adequate for forming the Alignment Lissajous, but any quantitative analysis should be performed with the radial sensor.

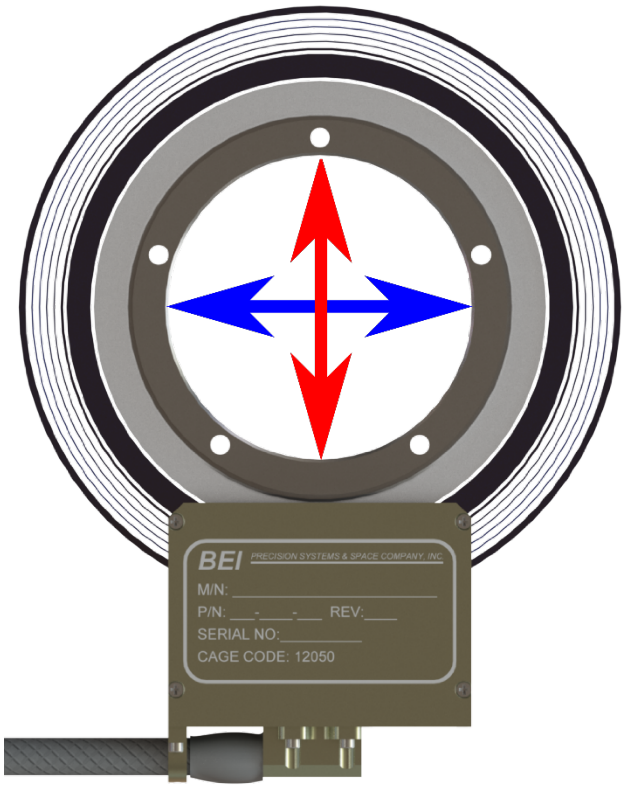

Figure 1: Alignment Sensor Orientation – Tangential in Blue, Radial in Red

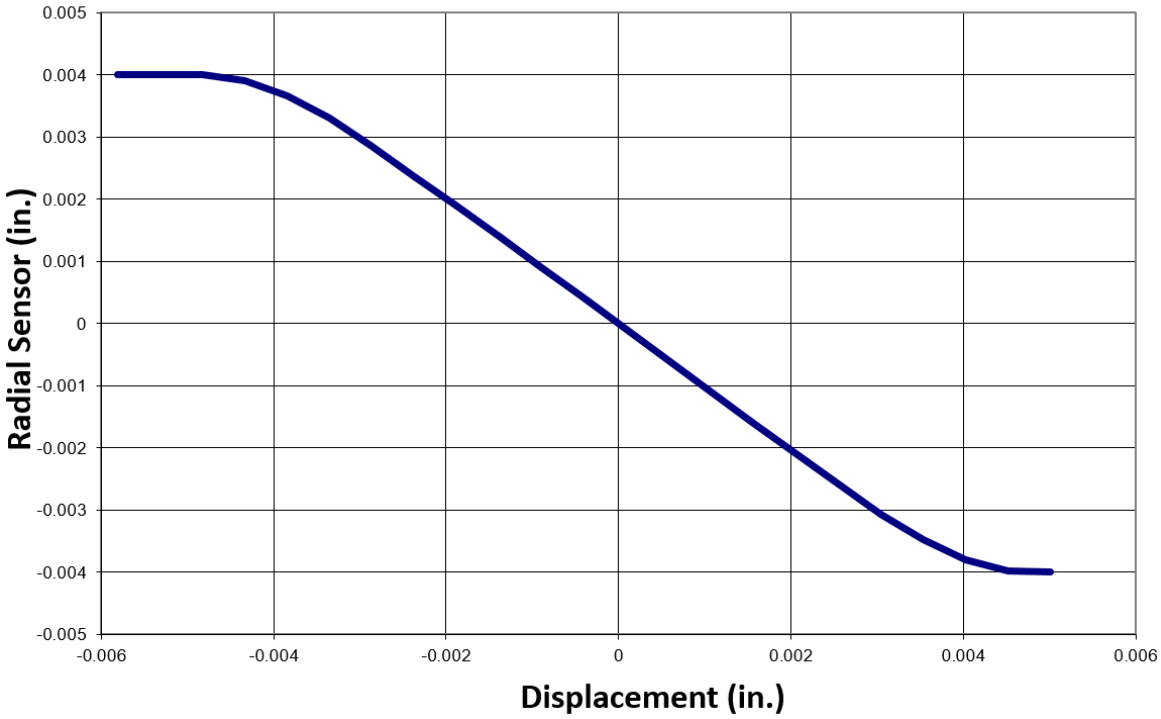

Figure 2: Radial Sensor Typical Linearity

Alignment Lissajous

The Alignment Lissajous is formed when the two sensor signals are plotted versus each other. The Lissajous is shown in Figure 3 plotted on a ±4 thousandth-of-an-inch square Cartesian grid with the tangential sensor plotted on the horizontal axis, and the radial sensor plotted on the vertical axis. Due to the nature of the tangential sensor, it is best practice to calibrate the encoder before using the Alignment Lissajous. Figure 3 demonstrates the BEI PSSC User Interface software interpreting alignment data from the Encoder. As can be seen, the encoder has been placed in Alignment Mode. When an eccentrically mounted code disk rotates through one revolution, the radial and tangential sensors create orthogonal sine waves. Thus, the Lissajous forms a circle with its radius representing the peak disk centering error. Figure 3 shows approximately 0.5 thousandths-of-an-inch of disk centering error.

Readhead Alignment

The center location of the Lissajous is equal to the readhead to axis-of-rotation alignment error. In Figure 3, the readhead is approximately 0.5 thousandths-of-an-inch to the right of the axis, and 1.25 thousandths-of-an-inch too close. Moving the readhead to the left and back by these amounts, respectively, will align the readhead.

Code Disk Centering

The code disk can easily be centered using the Alignment Visualization tool. To do so, rotate the spindle until the instantaneous alignment error (active pixel on the Alignment Lissajous) is at the bottom of the Lissajous. Lightly tap the code disk or hub until the pixel is near the center of the Lissajous thus decreasing the radius of the Lissajous. This process can be repeated until the Lissajous resembles a point on the graph.

Key Points

- Radius of Alignment Lissajous is equal to peak disk centering error
- Center position of Alignment Lissajous equals readhead to axis-of-rotation alignment error

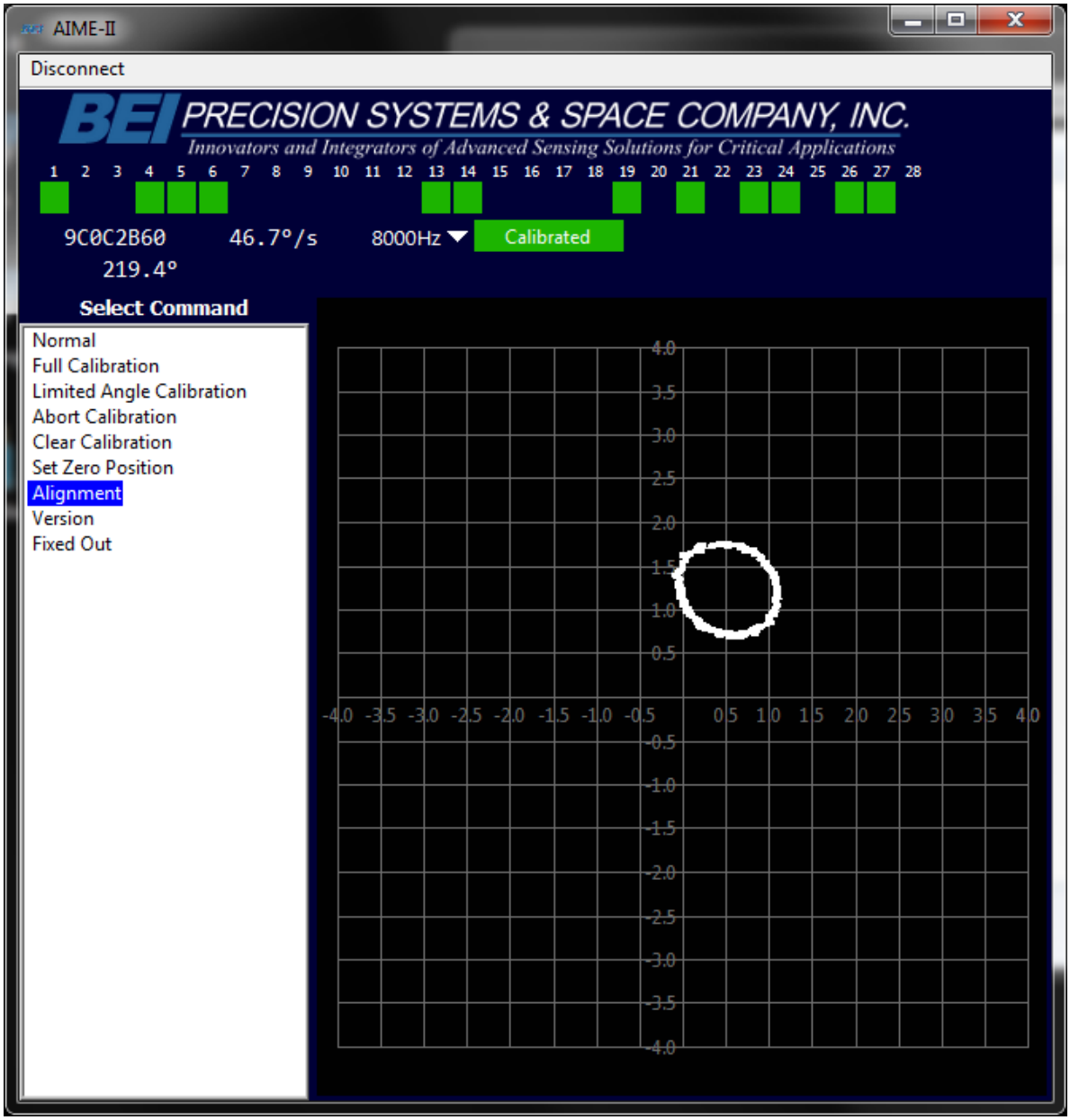

Figure 3: Alignment Visualization Tool & Alignment Lissajous