Explanation of Position Detector Linearity

Position Detector Linearity, or PD Linearity, is a measure of the accuracy of the position detector at all positions in the galvanometer field. At any given mechanical angle, the position detector should output a value representing that angle. The PD output should have a linear scale against the true mechanical position. However, any position detector device has some measurement error that changes slightly throughout the measurement field. PD linearity is a measurement of that error.

When PD linearity is tested at CTI, the galvo is steadily rotated with constant velocity along its operational field. The galvo is rotated using a precision motor with a quadrature position encoder that provides a position measurement accurate to 3.6 arcseconds. This instrument is used to provide an absolute position value with which the measured PD output can be compared. PD Scale or PD Sensitivity, which is nominally 0.5000V/Degree, is calculated using a least squares linear fit of measured PD data against the absolute position values. The slope of the least squares fit is used to convert the PD output, in volts, to mechanical angle in degrees. This least-squares fit provides a perfectly linear data set to which the actual data is compared for linearity.

$$Linearity(\%) = 100 - \left(\frac{Position_{LSF} - Position_{PD}}{FieldSize} \right) * 100 \quad Nonlinearity(\%) = \left(\frac{Position_{LSF} - Position_{PD}}{FieldSize} \right) * 100$$

The nonlinearity formula provides a calculation that shows where the scanner will actually be positioned in an application for any given intended position, taking into account that the galvo will be under servo control. At CTI, linearity is calculated at hundreds of measurement points evenly spaced throughout the scanner field. The result is a linearity curve that shows the linearity error of the scanner in a form that can be easily related to an application.