



NIST Traceable
Accuracy to
 ± 0.09 arcseconds

METRA **The Ultimate Angle-Measuring System**

To verify encoder accuracy, Gurley Precision Instruments has developed a unique angle standard we call METRA - Master Encoder for Testing Rotary Accuracy. The heart of METRA is an optical encoder with a 20-inch diameter disc that is mounted to an air-bearing spindle. A multiple reading head technique eliminates virtually all errors. METRA has a resolution of 221 counts/rev, or 0.62 arcseconds per count. Its NIST-traceable accuracy is ± 0.09 arcseconds; this certified accuracy is limited by available angle standards, not by METRA itself. Because METRA's accuracy is inherent in its encoder, precise speed control is not necessary.

The electronic portion of the test stand works much like a logic analyzer or digital storage oscilloscope, but with the samples occurring at regular angle intervals dictated by the master encoder, rather than at regular time intervals according to a crystal-controlled clock. Also like a logic analyzer, the sample history of an entire revolution is stored in a high-speed RAM cache for subsequent computer analysis.

The encoder under test (EUT) is coupled to METRA with precision fixturing. As the EUT and METRA are rotated together, the position information from METRA is used to interrogate the EUT 2,097,152 times per revolution. Thus, this test verifies the location of every single output state of the EUT. This method reveals all encoder errors, and does not depend on statistical assumptions based on an incomplete data set.

A typical error plot can be viewed [here](#). The gray band represents the composite of the errors from all sources: instrument error, quadrature error and (if applicable) interpolation error. The band is composed of 512 vertical line segments, each of which represents the errors of all consecutive edges comprising 1/512th of a revolution. The top end of each line represents the maximum positive (lead) error from its group, and the lower end shows the maximum lag error. The solid dark line is the average of all errors for the group, and is a good approximation of the encoder's instrument error only; i.e., the error curve from data taken on a once-per-line-pair basis. If the EUT has an index signal, it is used to initialize the test and is therefore located at 0° rotation angle.

The error curve will tend to have a generally sinusoidal shape, with its period related to the number of read stations in the encoder. As the number of read stations in the EUT is increased, there will be a corresponding increase in the number of sub-cycles, but their amplitude will be less than in an encoder with fewer read stations. For an encoder with N read stations, the error plot will generally show N cycles per revolution.

For more information on METRA please contact us by phone at (800) 759-1844, by fax at (518) 274-0336 or by e-mail at info@gurley.com.