MetLogix

175 Canal Street / Suite 503 / Manchester, NH 03101 / **Tel** 603.836.4452 / **Fax** 603.369.6499 / **Web** www.metlogix.com

Software Quality Assurance Statement

MetLogix fully understands and appreciates the confidence you place in our products. We know that our products often perform the last step of a manufacturing process where measurement results can determine whether your parts pass or fail your specification. We acknowledge the trust you place in our products and would like to inform you of the steps we take to insure the quality of our software and the accuracy of our measurement algorithms.

We have a mature and structured product development process. This process begins with product design goals and continues through the final system testing and release of our software and the associated agency approvals and documentation. Bug reports and change requests for existing products follow the same set of standards and guidelines.

We utilize the latest software development tools and practices, bug tracking methods, and software archival tools when creating and testing our software. We perform extensive module, mathematical, and system tests before releasing our products. We perform usability testing to ensure that our software is functioning correctly, and that the user can get the results without lengthy or extensive training.

At the heart of any measure software are measurement algorithms. These math routines take raw data from measuring instrument and sensors and create the various geometric elements required. The measurement algorithms are the fundamental component of all metrology software.

To insure that our algorithms conform to of the highest standard in our industry, our algorithms have been evaluated by National Institute of Standards and Technology (NIST). NIST is the United States federal technology agency that works with industry to develop and apply technology, measurements, and standards. The test results are attached for review for both our 2D and 3D feature set.

Products covered by this statement include the M1, M2, M3, L2, S2, L2+, L3, and D-1, all versions.

If you have any question on our development practices or methods, please feel free to contact me at any time.

7/24/17

Robert M. Green
Cofounder/CEO

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-

REPORT OF SPECIAL TEST

NIST Test No: 683/290033-17

July 05, 2017

For: Metlogix, Inc.
175 Canal St, Suite 503
Manchester, NH 03101
Attn: Peter Glasson

Item: M3 v2.10.10

The least-squares fitting features of this software package were tested on 90 data sets, representing the following geometry types: spheres, cylinders, and cones. The test procedures followed are documented in ASME B89.4.10-2000 and NISTIR 5686. In the cases of cylinders and cones, in accordance with the user documentation of the software under test, each test data set contained points ordered such that the first three points and second three points form two circles, the centers of which lie approximately on the axis of the cylinder or cone.

The uncertainties associated with the reference values were evaluated following NIST Technical Note 1297, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, which is considered to be part of this Report. The expanded uncertainty U is calculated using a coverage factor $k = 2$. For a measured value of length (or angular measure), L, the true length (or angular measure) is contained in the interval $[L-U, L+U]$ with a level of confidence of approximately 95 %. The results of the test are as follows:

ASME B89.4.10-2000 Standard Default Test

Geometry Type	Mean (RMS) Deviation			
	Separation (µm)	Tilt (arc seconds)	Radius/dist (µm)	Apex (arc seconds)
Spheres	9×10^{-5}	—	2.7×10^{-5}	—
Cylinders	5×10^{-5}	6×10^{-4}	9×10^{-5}	—
Cones	6×10^{-4}	2×10^{-2}	1.4×10^{-4}	9×10^{-3}

For each of the results above, the NIST ($k = 2$) expanded uncertainty, U, is less than 10^{-8} µm or arc seconds, as applicable. This is due in part to the fact that the NIST reference results were calculated using precision that is much better than usual double precision computations.

The test conditions, particularly the specifications for the test data sets, comply with the default test specified in Standard ASME B89.4.10-2000 (Reference 1). Some conditions are summarized as:

Sampling strategy	Points were regularly spaced over the sampling region but in a randomized order with the exception of cones. For cones in this test, the points were ordered in equally-spaced rings, nominally perpendicular to the axis of the cone.
Measurement error	Uniformly random measurement error simulations were included.
Form errors	Several errors specified in the standard, including bends, sinusoidal, step errors, tapers, etc.
Range of part size	1 mm to 500 mm.
Part origin	Within 1000 mm of coordinate system origin.
Aspect ratios	Cylinders and Cones: aspect ratios between 0.02 and 10.
Partial features	Spheres: hemispheres, 90° polar patches, and 30° bands. Cylinders and Cones: 90° to 360° sweeps.

For applications of the software that are within the scope of the test conditions described above, the root mean square (RMS) value given in the table of results is a reasonable evaluation of the fitting software's standard uncertainty contribution to the uncertainty of a corresponding measurement.

While the coordinates in the test data sets are in millimeters, the results are reported in micrometers for lengths and in arc seconds for angles. The values reported in this Report of Special Test apply to the software tested only in the computing environment in which it was tested. NIST cannot guarantee that the user's software will have the same value as reported by NIST when used in another facility at a later date.

This Special Test was carried out as follows: NIST generated data sets simulating the ranges of test conditions described above in accordance with the ASME B89.4.10-2000 Standard. NIST also generated reference fit results using NIST's Algorithm Testing System internal algorithms. The customer received the NIST-generated data sets in ASCII format and generated corresponding fit results using the software under test. NIST then compared each of the customer's fits to the reference fit for the corresponding data set using procedures set forth in the Standard. The reported test results for each geometry type are the RMS value deviations between the customer's fits and the reference fits for all data sets corresponding to that geometry type. According to the Standard, when deviation results are less than 10^{-5} µm or 10^{-7} arc seconds, these values are reported as "$< 10^{-5}$ " and "$< 10^{-7}$."

The following table displays the maximum observed error (deviation) of each evaluation parameter for each geometric feature type.

Geometry Type	**Maximum Observed Deviations**					
	Separation (µm)	Tilt (arc seconds)	Radius/dist under (µm)	Radius/dist over (µm)	Apex under (arc seconds)	Apex over (arc seconds)
Spheres	4.6×10^{-4} data set 24	———	1.4×10^{-4} data set 24	4.5×10^{-5} data set 3	———	———
Cylinders	1.9×10^{-4} data set 22	2.4×10^{-3} data set 10	1.2×10^{-5} data set 10	4.8×10^{-4} data set 1	———	———
Cones	3.1×10^{-3} data set 4	1.1×10^{-1} data set 4	4.3×10^{-4} data set 21	6.0×10^{-4} data set 5	5.1×10^{-2} data set 4	1.4×10^{-3} data set 21

Detailed data concerning this Special Test are available from NIST on request. For detailed descriptions of the technical approach used for these test services and specifics on the test procedures see the following references.

[1] ASME B89.4.10-2000, *Methods for Performance Evaluation of Coordinate Measuring System Software*, B89.4.10, American Society of Mechanical Engineers, New York, NY, 2000.

[2] Diaz, C., *Algorithm Testing and Evaluation Program for Coordinate Measuring Systems: Testing Methods*, NISTIR 5686, National Institute of Standards and Technology, Gaithersburg, MD, 1995.

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[4] Hopp, T. and Levenson, M., "Performance Measures for Geometric Fitting in the NIST Algorithm Testing and Evaluation Program for Coordinate Measuring Systems," *NIST Journal of Research*, **100** (5):563-574, 1995.

[5] Rosenfeld, D., *User's Guide for the Algorithm Testing System Version 2*, NISTIR 5674, National Institute of Standards and Technology, Gaithersburg, MD, 1995.

[6] Rosenfeld, D., *Reference Manual for the Algorithm Testing System Version 2*, NISTIR 5722, National Institute of Standards and Technology, Gaithersburg, MD, 1995.

[7] Shakarji, C.M., *Least Squares Fitting Algorithms of the NIST Algorithm Testing System*, Journal of Research of the National Institute of Standards and Technology **103** (6), 633-641, 1998.

[8] Taylor, B. N. and Kuyatt, C. E., *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, NIST Technical Note 1297, National Institute of Standards and Technology, Gaithersburg, MD, 1994.

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M3 v2.10.10

Test System: NIST ATS Version 2.0 on Windows 7 Enterprise SP1, Xeon CPU E5-2609 0 @ 2.40 GHz (2 processors).

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Tests were performed by Dr. Craig Shakarji.

For the Director,
National Institute of Standards and Technology

Daniel Sawyer, Group Leader
Dimensional Metrology Group
Engineering Physics Division
Physical Measurement Laboratory

Order number: 795

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-

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