National Institute of Standards & Technology

Certificate

Standard Reference Material® 2085

CMM Probe Performance Standard

Serial No.

This Standard Reference Material (SRM) is intended to complement and augment the 10 mm sphere and sphere mounting system that is a part of SRM 2084. SRM 2085 consists of a precision 25 mm stainless steel sphere mounted on a tungsten carbide stem. When used in conjunction with SRM 2084, this SRM is designed to aid in assessing the point-to-point probing performance of a coordinate measuring machine (CMM) in accordance with the current version of the American National Standard "Methods for Performance Evaluation of Coordinate Measuring Machines" ANSI/ASME B89.1.12M-1990 [1] soon to superceded by ANSI/ASME B89.4.1 [2]. The design of the SRM lends itself to additional probe and probe subsystem performance testing which extends beyond the current scope of the ASME Standard.

Expiration of Certification: Each sphere is individually calibrated for both size and form (roundness), and carries a unique serial number on the stem for the purpose of identification. The certified values are given in Table 1. It is recommended that periodic recalibration of the sphere be performed on a five year cycle. In the event of damage or suspected damage the sphere should be removed from service until recalibrated. The values obtained from the recalibration of this artifact would then supersede those given by this certificate.

Table 1. Certified Sphere Values

Characteristic	Certified Value	Expanded Uncertainty (k = 2)	Certified Max. Out-of-Roundness (k = 2)
Out-of-Roundness	≤ 0.076 µm	0.051 µm	≤ 0.127 µm
Diameter	mm	0.000141 mm	

The uncertainties of these certified values were calculated in accordance with ISO and NIST procedures which establish the measurement uncertainty as the root-sum-square of the contributing sources multiplied by a coverage factor k = 2 [3,4]. This analysis recognizes two components of uncertainty, those evaluated through statistical means (Type A), and those evaluated by other means (Type B). The sources of measurement uncertainty for these calibrations are given in Tables 2 and 3.

SRM 2085 was developed by S.D. Phillips, G.W. Caskey, and B.R. Borchardt of the NIST Precision Engineering Division.

Sphere calibration was conducted by E.S. Stanfield, under the supervision of R.C. Veale, both of the NIST Precision Engineering Division.

Guidance on statistical analysis was provided by K.R. Eberhardt of the NIST Statistical Engineering Division.

The technical and support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the NIST Standard Reference Materials Program by R.J. Gettings.

Gaithersburg, MD 20899
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Measurement Procedure: The sphere size was assessed through two-point (parallel planes) comparison with NIST master spheres of the same nominal diameter. The comparison was made on a high precision bench micrometer using a redundant measurement technique designed to minimize extraneous influences.

The sphere roundness deviations are assessed through a series of five traces made on a roundness measuring instrument. For these measurements, a spatial cutoff frequency of 50 undulations/revolution was employed. The traces consist of a single equatorial trace and four great circle traces inclined at 45° to the equator. The inclined traces are made in orthogonal pairs with a 90° phase difference between the two pairs. (For the above roundness trace description, the equator is defined as the great circle perpendicular to the axis of the stem.) The out-of-roundness of this SRM is presented as a worst case, where spheres with a single trace measured value greater than 0.076 µm were rejected. Therefore, the spheres have a certified out-of-roundness of less than 0.127 µm (maximum allowable out-of-roundness plus measurement uncertainty).

The methodologies for the use of SRM 2085, in accordance with the ANSI/ASME standard [1,2] can be found in Section 5.3 (Repeatability) and section 6 (Probing Analysis). Additional information on the proper care and use of this artifact, and supplemental probe performance test methodologies are given in NIST Special Publication 260-120 [5].

Table 2. Out-of-Roundness Measurement Uncertainty

Source	Type	Standard Uncertainty (1σ) (µm)	
Spindle Out-of-Roundness	B	0.024	
Operator Interpolation	B	0.007	
Measurement Repeatability	A	0.006	
Combined Standard Uncertainty		0.026	
Expanded Uncertainty - Coverage Factor $k = 2$			0.051

Table 3. Diameter Measurement Uncertainty

Source	Type	Standard Uncertainty (1σ) (μm)	
Master Sphere Uncertainty	B	0.039	
Transfer Uncertainty			
Differential Thermal Expansion	B	0.012	
Differential Deformation	B	0.021	
Repeatability of Comparison	A	0.017	
Transducer Linearity	B	< 0.001	
Geometry Conversion			
Sphere Out-of-Roundness	B	0.044	
Uncertainty in Out-of-Roundness	A	0.026	
Combined Standard Uncertainty		0.071	
Expanded Uncertainty - Coverage Factor $k = 2$			0.141

REFERENCES

[1] ANSI/ASME B89.1.12M, "Methods for Performance Evaluation of Coordinate Measuring Machines," American Society of Mechanical Engineers, New York, NY, (1990).

[2] ANSI/ASME B89.4.1 "Methods for Performance Evaluation of Coordinate Measuring Machines," American Society of Mechanical Engineers, New York, NY, (In Press).

[3] International Organization for Standardization (ISO), Technical Advisory Group 4 (TAG 4), Working Group 3 (WG 3), *Guide to the Expression of Uncertainty in Measurement*, ISO, Geneva, Switzerland, (1993).

[4] 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, (1993).

[5] Caskey, G.W., et.al., "A Users' Guide to SRM 2084: CMM Probe Performance Standard," NIST Special Publication 260-120, National Institute of Standards and Technology, Gaithersburg, MD, (1994).