ASME B89.4.10-2021

[Revision of ASME B89.4.10-2000 (R2011)]

Methods for Performance Evaluation of Coordinate Measuring System Software

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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Two Park Avenue • New York, NY • 10016 USA

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FOREWORD

Coordinate measuring systems (CMSs) rely upon software that processes coordinate data; often, this software computes fits of geometric elements to such data. The performance of these fits can vary among software packages, and in some cases can be a significant contributor to the overall uncertainty of measurement.

The purpose of this Standard is to provide guidelines for evaluating the quality of solutions generated by CMS software and to define minimal documentation requirements for software providers. This Standard is concerned with testing the behavior of algorithm implementation, not the testing of algorithms themselves. It is not the intent of this Standard to endorse or rate any computational method or system. A mechanism for generating collections of test data sets is specified. While a specific, static collection of standardized test data sets is not defined, the generating mechanism can produce several collections of similar character.

ASME B89.4.10-2021 was approved by the American National Standards Institute on July 22, 2021.

ASME B89 COMMITTEE
Dimensional Metrology

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CORRESPONDENCE WITH THE B89 COMMITTEE

General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions or a case, and attending Committee meetings. Correspondence should be addressed to:

Secretary, B89 Standards Committee
The American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990
http://go.asme.org/Inquiry

Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Proposing a Case. Cases may be issued to provide alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee web page.

Requests for Cases shall provide a Statement of Need and Background Information. The request should identify the Standard and the paragraph, figure, or table number(s), and be written as a Question and Reply in the same format as existing Cases. Requests for Cases should also indicate the applicable edition(s) of the Standard to which the proposed Case applies.

Interpretations. Upon request, the B89 Standards Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the B89 Standards Committee.

Requests for interpretation should preferably be submitted through the online Interpretation Submittal Form. The form is accessible at http://go.asme.org/InterpretationRequest. Upon submittal of the form, the Inquirer will receive an automatic e-mail confirming receipt.

If the Inquirer is unable to use the online form, he/she may mail the request to the Secretary of the B89 Standards Committee at the above address. The request for an interpretation should be clear and unambiguous. It is further recommended that the Inquirer submit his/her request in the following format:

Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry in one or two words.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. Please provide a condensed and precise question, composed in such a way that a "yes" or "no" reply is acceptable.
Proposed Reply(ies):	Provide a proposed reply(ies) in the form of "Yes" or "No," with explanation as needed. If entering replies to more than one question, please number the questions and replies.
Background Information:	Provide the Committee with any background information that will assist the Committee in understanding the inquiry. The Inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in the format described above may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

Moreover, ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Standard requirements. If, based on the inquiry information submitted, it is the opinion of the Committee that the Inquirer should seek assistance, the inquiry will be returned with the recommendation that such assistance be obtained.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

Attending Committee Meetings. The B89 Standards Committee regularly holds meetings and/or telephone conferences that are open to the public. Persons wishing to attend any meeting and/or telephone conference should contact the Secretary of the B89 Standards Committee. Future Committee meeting dates and locations can be found on the Committee Page at http://go.asme.org/B89committee.

ASME B89.4.10-2021
SUMMARY OF CHANGES

Following approval by the ASME B89 Committee and ASME, and after public review, ASME B89.4.10-2021 was approved by the American National Standards Institute on July 22, 2021.

In ASME B89.4.10-2021, the figures and tables have been redesignated based on their parent paragraph. ASME B89.4.10-2021 includes the following additional changes identified by a margin note, **(21)**.

Page	*Location*	*Change*
1	1	Second paragraph revised
1	1.1	Subparagraph (a) revised
1	1.3	Updated
1	2	(1) Definitions of *datum* and *least squares fit feature* revised
		(2) Definition of *datum reference frame (DRF)* deleted
2	3	Revised
3	4.1.2.1	Subparagraph (a) revised
3	4.1.2.2	(1) Subparagraphs editorially redesignated
		(2) Subparagraph (b) added
5	4.1.2.7	First paragraph editorially revised, and last two paragraphs added
7	Table 4.1.2.7-1	General Note added
8	5.2.1.2	Subparagraph (c) revised
10	5.4.6	Revised
10	5.4.7	Revised
10	5.5.1	First sentence and last paragraph revised
11	5.5.2	Revised
11	5.5.4	Penultimate sentence and last row value in the in-text table revised
11	5.5.5	(1) First paragraph of 5.5.5.1 revised
		(2) Last paragraph of 5.5.5.2 added
12	5.5.6	Revised
13	5.7	Last sentence deleted
13	5.8	First sentence in last paragraph deleted
13	5.10	Revised
14	6.3.4.4	Revised
14	6.3.6.4	Revised
15	6.3.8	Revised
17	A-1	Subparagraph (b) revised
17	A-2	(1) Subparagraph (a) added, and subsequent subparagraphs redesignated
		(2) First paragraph and subpara. (b) [formerly (a)] revised

Page	*Location*	*Change*
18	Nonmandatory Appendix B	Former Nonmandatory Appendix B deleted, and subsequent appendices redesignated
18	B-1	(1) Designator and title added, and subsequent paragraphs redesignated (2) In paragraph after Disclaimer, “0.010 in.” revised to “0.010 mm”
18	B-5.4	Subparagraph (c) deleted
19	B-6.1	“0.025 in.” revised to “0.025 mm”
19	B-6.4	Former para. C-5.4 deleted, and former para. C-5.5 redesignated as B-6.4
19	B-7	In first and second paragraphs, “βlatness” revised to “flatness”
19	B-7.3	Former para. C-6.3 deleted, and former para. C-6.4 redesignated as B-7.3
20	B-8	(a) Subparagraphs editorially resdesignated (b) In subpara. (b), “99” revised to “99.7”
20	B-9	Revised
21	C-1	(1) Designator and title added, and subsequent paragraphs redesignated (2) Last sentence in third paragraph deleted
21	C-2	Equation revised
22	C-2.2	First sentence and equation revised
22	C-3	Added
23	C-3.2	(1) Last sentence of first paragraph revised (2) Last two equations and paragraphs deleted
23	C-4.1	Second equation revised
23	C-4.2	Second equation revised
25	Nonmandatory Appendix D	Former Nonmandatory Appendix E deleted, and subsequent appendices redesignated
25	D-1	Designator and title added, and subsequent paragraphs redesignated
25	D-4.2	Revised
27	Nonmandatory Appendix E	Updated

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METHODS FOR PERFORMANCE EVALUATION OF COORDINATE MEASURING SYSTEM SOFTWARE

1 SCOPE (21)

A critical issue in industrial coordinate metrology is the measurement of a work piece to assure compliance with its dimensional requirements. When using a computerized coordinate measuring system (CMS), the usual practice is to correlate computer-calculated outputs with the dimensional requirements of the workpiece. This correlation is performed by various computer routines that process dimensional coordinate data sets consisting of measurement samples of the object being evaluated.

The purpose of this Standard is to provide guidelines for evaluating the quality of solutions generated by CMS software and to define minimal documentation requirements for software providers. Additionally, this Standard gives default definitions for collections of data sets that span a variety of real-world measuring scenarios. These data sets are dependent on the fitting algorithm being tested. This Standard is concerned with testing the behavior of algorithm implementation, not the testing of algorithms themselves. Thus, the software is treated as a black box; only the input and output are observed and evaluated. It is not the intent of this Standard to endorse or rate any computational method or system.

Software performance evaluation is useful because it

(a) allows objective validation of software

(b) reduces the possibility of error in software application

(c) defines a method of comparing CMS software

This Standard covers the following areas: input data, feature construction, software documentation, performance characterization, and test methodologies.

1.1 Assumptions (21)

The assumptions inherent in this Standard are as follows:

(a) Measurement uncertainty in coordinate samples is not addressed.

(b) Methods to input predetermined samples to the computational system are available.

(c) Personnel have adequate experience and training to implement the evaluation and understand the implications of the results.

1.2 Application

This Standard is one component required for the evaluation of CMSs. Other relevant documents can be found in Nonmandatory Appendix E.

1.3 References (21)

The following is a list of standards referenced in this Standard. Unless otherwise noted, the most recent edition shall apply.

ASME Y14.5, Dimensioning and Tolerancing
ASME Y14.5.1, Mathematical Definition of Dimensioning and Tolerancing Principles
Publisher: The American Society of Mechanical Engineers (ASME), Two Park Avenue, New York, NY 10016-5990 (www.asme.org)

See Nonmandatory Appendix E for additional, informative references.

2 DEFINITIONS (21)

algorithm: a well-defined procedure for solving a particular problem, e.g., sorting algorithms.