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Geometrical product specifications (GPS) — Acceptance and reverification tests for coordinate measuring systems (CMS) —

Part 9: CMMs with multiple probing systems

Spécification géométrique des produits (GPS) — Essais de réception et de vérification périodique des systèmes de mesure tridimensionnels (SMT) —

Partie 9: MMT avec systèmes de palpage multiples

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 213, *Geometrical product specifications and verification*.

ISO 10360 consists of the following parts, under the general title *Geometrical product specifications (GPS) — Acceptance and reverification tests for coordinate measuring machines (CMM)*:

— *Part 1: Vocabulary*

— *Part 2: CMMs used for measuring linear dimensions*

— *Part 3: CMMs with the axis of a rotary table as the fourth axis*

— *Part 4: CMMs used in scanning measuring mode*

— *Part 5: CMMs using single and multiple stylus contacting probing systems*

— *Part 6: Estimation of errors in computing of Gaussian associated features*

— *Part 7: CMMs equipped with imaging probing systems*

ISO 10360 also consists of the following parts, under the general title *Geometrical product specifications (GPS) — Acceptance and reverification tests for coordinate measuring systems (CMS)*:

— *Part 8: CMMs with optical distance sensors*

— *Part 9: CMMs with multiple probing systems*

— *Part 10: Laser trackers for measuring point-to-point distances*

The following parts are under preparation:

— *Part 12: Articulated-arm CMMs*

Computed tomography is to form the subject of a future part 11.

Introduction

This part of ISO 10360 is a geometrical product specification (GPS) standard and is to be regarded as a general GPS standard (see ISO/TR 14638). It influences chain link 5 of the chains of standards on size, distance, radius, angle, form, orientation, location, run-out and datums.

The ISO/GPS Masterplan given in ISO/TR 14638 gives an overview of the ISO/GPS system of which this document is a part. The fundamental rules of ISO/GPS given in ISO 8015 apply to this document and the default decision rules given in ISO 14253-1 apply to specifications made in accordance with this document, unless otherwise indicated.

For more detailed information on the relation of this part of ISO 10360 to other standards and to the GPS matrix model, see Annex B.

The acceptance and reverification tests described in this part of ISO 10360 are applicable to CMMs that use multiple probing systems in contacting and non-contacting mode. The scope of this part is to test the performance of a multiple probing system CMM when two or more probing systems are used on one measurement task. Its general approach is analogous to the multi-stylus test in ISO 10360-5, but focusing on the performance test of different probing system types, for example an imaging probe combined with a contacting probe on single ram CMMs or on multiple ram CMMs.

Geometrical product specifications (GPS) — Acceptance and reverification tests for coordinate measuring systems (CMS) —

Part 9: CMMs with multiple probing systems

1 Scope

This part of ISO 10360 specifies procedures for testing the performance of coordinate measuring machines of various designs that use multiple probing systems in contacting and non-contacting mode. It applies to

— acceptance tests for verifying the performance of a CMM and its probes as stated by the manufacturer,

— reverification tests performed by the user for periodical checking of the CMM and its probes,

— interim checks performed by the user for monitoring the CMM and its probes in between reverification tests.

It considers CMMs of single ram designs as well as multiple ram designs with small or with large overlapping measuring volume. It applies to multiple probing systems consisting of different types of probes (such as an imaging probe combined with a contacting probe, or two contacting probes of different individual performance).

The tests described are sensitive to many errors attributable to both the CMM and the probing systems; they supplement the length measurement tests and the individual probing error tests of each probing system. The length measurement tests, as well as the individual probing error tests (for example, ISO 10360-5, ISO 10360-7, or ISO 10360-8), should be performed before executing the procedures in this part of ISO 10360.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10360-1:2000, *Geometrical Product Specifications (GPS) — Acceptance and reverification tests for coordinate measuring machines (CMM) — Part 1: Vocabulary*

ISO 10360-5:2010, *Geometrical product specifications (GPS) — Acceptance and reverification tests for coordinate measuring machines (CMM) — Part 5: CMMs using single and multiple stylus contacting probing systems*

ISO 10360-7:2011, *Geometrical product specifications (GPS) — Acceptance and reverification tests for coordinate measuring machines (CMM) — Part 7: CMMs equipped with imaging probing systems*

ISO 10360-8:2013, *Geometrical product specifications (GPS) — Acceptance and reverification tests for coordinate measuring machines (CMM) — Part 8: CMMs with optical distance sensors*

ISO 14253-1:2013, *Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for proving conformity or nonconformity with specifications*

ISO/IEC Guide 99:2007, *International vocabulary of metrology — Basic and general concepts and associated terms (VIM)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10360-1, ISO 14253-1, ISO/IEC Guide 99 and the following apply.

3.1
probing system operating condition
rated operating conditions of a probing system for which the manufacturer's stated performance specifications apply

Note 1 to entry: Each probing system operating condition may be identified by an acronym by which the respective performance values can be referred to. Generally, the manufacturer will specify probing system operating conditions for each probing system, but the manufacturer is free to state several probing system operating conditions for one single probing system. This may include

— stylus length and probe extensions (if applicable),

— mounting (articulated or fixed, use of probe changer),

— illumination,

— qualification procedure,

— permissible surface slope,

— filter settings,

— permissible surface condition (roughness, reflectivity).

For CMMs with computed tomography probing systems (CT), this may also include used magnification and related measuring volume, voltage, power, pre-filtering of the X-ray radiation, and maximum material thickness to be radiographed.

3.2
probing system combination
two or more different types of probing systems and their respective operating conditions

3.3
multi-probe system
probing system with more than one probe

[SOURCE: ISO 10360-1:2000, 3.5]

3.4
multiple probing systems
two or more different types of probes and their respective operating conditions

Note 1 to entry: A probing system combination may occur within the same probing system or in different probing systems (in the case of dual ram CMMs operated in duplex mode).

Note 2 to entry: If a probing combination occurs within a same probing system, the technologies of the different probes are usually different, e.g. a tactile probe and an imaging probe, or two tactile probes with different individual performances. If all the probes are tactile and have identical individual performances, then the probing configuration is also subject to the test given in ISO 10360-5, which is deemed to be more comprehensive than that described in this part of ISO 10360.

3.5
permissible surface condition
rated operating condition of the probing system regarding material and surface characteristics of the artefact

3.6
modes of operation
measurement "in the image" without movement of the probe in alternative to a measurement "at the image" with movement of the probe

Note 1 to entry: Some CMMs, for example those equipped with optical probes or CTs, can be used in different modes of operation.

3.7
multiple probing system form error
$P_{\text{Form.Sph.}n\times25\text{::MPS}}$
error of indication encompassing the range of radial distances of points measured on a test sphere by a CMM using multiple probing systems from the unconstrained least-squares centre (Gaussian associated feature) of the point set

3.8
multiple probing system size error
$P_{\text{Size.Sph.}n\times25\text{::MPS}}$
error of indication within which the unconstrained least-squares diameter (Gaussian associated feature) of a test sphere can be determined from points measured by a CMM using multiple probing systems

3.9
multiple probing system location error
$L_{\text{Dia.}n\times25\text{::MPS}}$
diameter of the minimum circumscribed sphere of points that are the centres of the unconstrained least-squares fits (Gaussian associated features) of sets of points measured on a test sphere by a CMM using multiple probing systems

Note 1 to entry: The minimum circumscribed sphere is the sphere of minimum size that encompasses all centres. Given a set of centres, it is unique.

Note 2 to entry: The minimum circumscribed sphere is different from the minimum zone sphere and should not be confused with.

Note 3 to entry: An upper bound of the diameter of the minimum circumscribed sphere is the spatial diagonal of a minimum circumscribed parallelepiped, possibly aligned to the coordinate axis.

Note 4 to entry: A lower bound of the diameter of the minimum circumscribed sphere is the maximum pair-wise distance between any pair of centres.

Note 5 to entry: Software for evaluating the minimum circumscribed sphere may not be available in a CMM under test. In this case, a tester may decide to evaluate instead the spatial diagonal of a minimum circumscribed parallelepiped (see Note 3) to prove conformance, or the maximum pair-wise distance (see Note 4) to prove non-conformance.

3.10
maximum permissible multiple probing system form error
$P_{\text{Form.Sph.}n\times25\text{::MPS,MPE}}$
extreme value of the multiple probing system form error permitted by specifications for a CMM

Note 1 to entry: The maximum permissible value of the multiple probing system form error, $P_{\text{Form.Sph.}n\times25\text{::MPS,MPE}}$, may be expressed in one of three forms:

a) $P_{\text{Form.Sph.}n\times25\text{::MPS,MPE}}$ = minimum of $(A + L_P/K)$ and B, or

b) $P_{\text{Form.Sph.}n\times25\text{::MPS,MPE}} = (A + L_P/K)$, or

c) $P_{\text{Form.Sph.}n\times25\text{::MPS,MPE}} = B$

where

A is a positive constant, expressed in micrometres and supplied by the manufacturer;

K is a dimensionless positive constant supplied by the manufacturer;

L_P is the distance in 3D (Euclidian distance) between the centres of the reference sphere and the test sphere, in millimetres;

B is the maximum permissible error $P_{\text{Form.Sph.}n\times25\text{::MPS,MPE}}$, expressed as a positive constant in micrometres, stated by the manufacturer.

3.11
maximum permissible multiple probing system size error

$P_{\text{Size.Sph.}n\times25\text{::MPS,MPE}}$

extreme value of the multiple probing system size error permitted by specifications for a CMM

Note 1 to entry: The maximum permissible value of the multiple probing system size error, $P_{\text{Size.Sph.}n\times25\text{::MPS,MPE}}$, may be expressed in one of three forms:

a) $P_{\text{Size.Sph.}n\times25\text{::MPS,MPE}}$ = minimum of $(A + L_P/K)$ and B, or

b) $P_{\text{Size.Sph.}n\times25\text{::MPS,MPE}} = (A + L_P/K)$, or

c) $P_{\text{Size.Sph.}n\times25\text{::MPS,MPE}} = B$

where

A is a positive constant, expressed in micrometres and supplied by the manufacturer;

K is a dimensionless positive constant supplied by the manufacturer;

L_P is the distance in 3D (Euclidian distance) between the centres of the reference sphere and the test sphere, in millimetres;

B is the maximum permissible error $P_{\text{Size.Sph.}n\times25\text{::MPS,MPE}}$, expressed as a positive constant in micrometres, stated by the manufacturer.

3.12
maximum permissible multiple probing system location error

$L_{\text{Dia.}n\times25\text{::MPS,MPE}}$

extreme value of the multiple probing system location error permitted by specifications for a CMM

Note 1 to entry: The maximum permissible value of the multiple probing system location error, $L_{\text{Dia.}n\times25\text{::MPS,MPE}}$, may be expressed in one of three forms:

d) $L_{\text{Dia.}n\times25\text{::MPS,MPE}}$ = minimum of $(A + L_P/K)$ and B, or

e) $L_{\text{Dia.}n\times25\text{::MPS,MPE}} = (A + L_P/K)$, or

f) $L_{\text{Dia.}n\times25\text{::MPS,MPE}} = B$

where