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Geometrical product specifications (GPS) — Acceptance and reverification tests for coordinate measuring machines (CMM) —

Part 7:
CMMs equipped with imaging probing systems

Spécification géométrique des produits (GPS) — Essais de réception et de vérification périodique des machines à mesurer tridimensionnelles (MMT) —

Partie 7: MMT équipées de systèmes de palpage imageurs

Reference number
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Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 10360-7 was prepared by Technical Committee ISO/TC 213, *Dimensional and 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*

— *Part 9: CMMs with multiple probing systems*

The following part is under preparation:

— *Part 8: CMMs with optical distance sensors*

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

The tests of this part of ISO 10360 have two technical objectives:

a) to test the error of indication of a calibrated test length using an imaging probing system;

b) to test the errors in the imaging probing system.

The benefits of these tests are that the measured result has a direct traceability to the unit length, the meter, and that it gives information on how the CMM will perform on similar length measurements.

The structure of this part of ISO 10360 parallels that of ISO 10360-2, which is for CMMs equipped with contact probing systems. The testing methodology between these two parts of ISO 10360 is intentionally similar. The differences that exist may be eliminated in future revisions of either this part of ISO 10360 or ISO 10360-2.

All the definitions in Clause 3 will appear in the revision of ISO 10360-1:2000.

Geometrical product specifications (GPS) — Acceptance and reverification tests for coordinate measuring machines (CMM) —

Part 7: CMMs equipped with imaging probing systems

1 Scope

This part of ISO 10360 specifies the acceptance tests for verifying the performance of a coordinate measuring machine (CMM) used for measuring linear dimensions as stated by the manufacturer. It also specifies the reverification tests that enable the user to periodically reverify the performance of the CMM.

The acceptance and reverification tests given in this part of ISO 10360 are applicable only to Cartesian CMMs using imaging probing systems of any type operating in the discrete-point probing mode.

This part of ISO 10360 does not explicitly apply to:

— non-Cartesian CMMs; however, parties may apply this part of ISO 10360 to non-Cartesian CMMs by mutual agreement;

— CMMs using other types of optical probing; however, parties may apply this approach to other optical CMMs by mutual agreement;

— CMMs using contact probing systems (see ISO 10360-2 for contact probing systems).

This part of ISO 10360 specifies performance requirements that can be assigned by the manufacturer or the user of a CMM, the manner of execution of the acceptance and reverification tests to demonstrate the stated requirements, rules for proving conformance, and applications for which the acceptance and reverification tests can be used.

2 Normative references

The following referenced documents are indispensable for the application of this document. 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 10360-2:2009, *Geometrical product specifications (GPS) — Acceptance and reverification tests for coordinate measuring machines (CMM) — Part 2: CMMs used for measuring linear dimensions*

ISO 14253-1:1998, *Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for proving conformance or non-conformance with specifications*

ISO 14660-1:1999, *Geometrical Product Specifications (GPS) — Geometrical features — Part 1: General terms and definitions*

ISO/TS 23165:2006, *Geometrical product specifications (GPS) — Guidelines for the evaluation of coordinate measuring machine (CMM) test uncertainty*

ISO/IEC Guide 99, *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 10360-2, ISO 14253-1, ISO 14660-1, ISO/TS 23165, ISO/IEC Guide 99 and the following apply.

3.1
imaging probing system
probing system which creates measurement points through the use of an imaging system

NOTE 1 This part of ISO 10360 is primarily concerned with imaging probing systems that enable measurements in the lateral direction to the probing system axis.

NOTE 2 A video or vision probing system is an imaging probing system.

3.2
imaging probe CMM
CMM equipped with an imaging probing system

3.3
field of view
FOV
area viewed by the imaging probing system

See Figure 1.

NOTE The measuring limits, or size, of the FOV are stated as the limits of the object space that is reproduced in the final image.

3.4
measuring window
region of interest in the FOV that is used in the determination of the measured point(s)

See Figure 1.

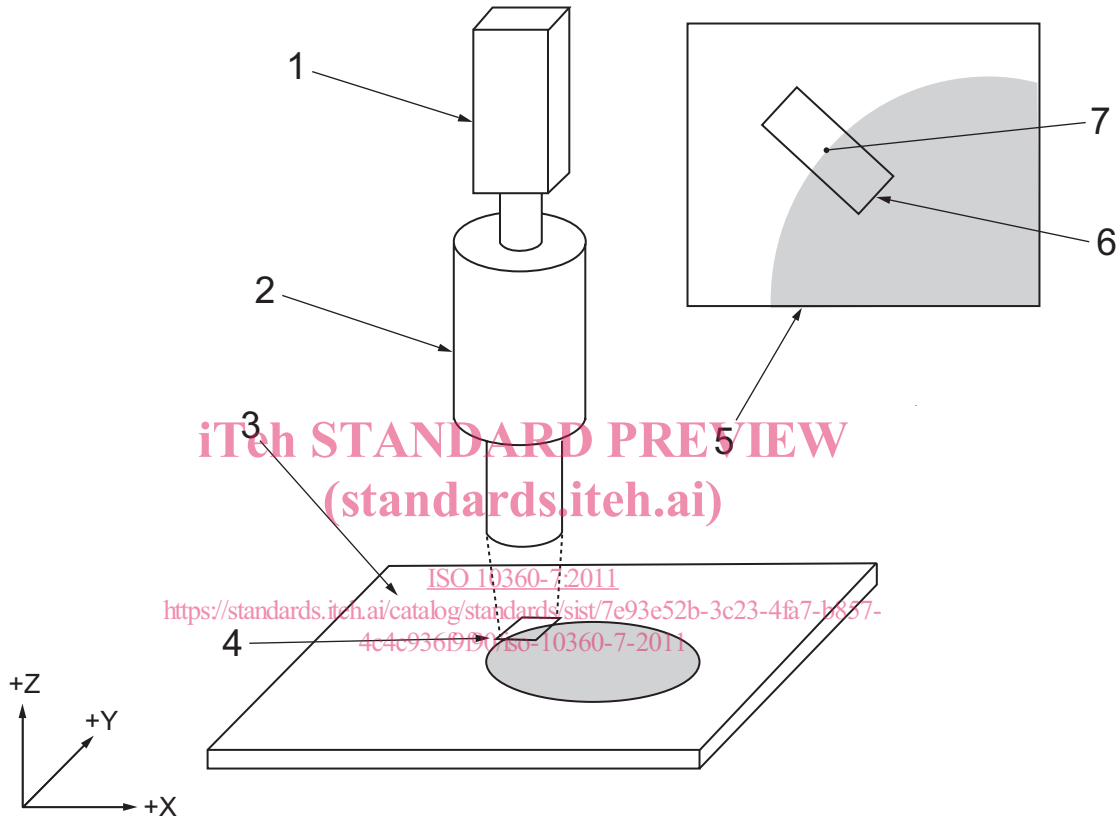
NOTE Configurations of measuring windows may vary widely between various imaging probe CMMs and for different measuring applications on the same imaging probe CMM.

3.5
measuring plane (of the imaging probing system)
two-dimensional plane defined by the FOV of an imaging probing system

3.6
coefficient of thermal expansion
CTE
α
linear thermal expansion coefficient of a material at 20 °C

3.7
normal CTE material
material with a CTE between 8×10^{-6}/°C and 13×10^{-6}/°C

3.8
test circle
circular material standard used for acceptance test and reverification test



Key
1 camera or other device for capturing an image of the measured object
2 various optical elements of the imaging probing system
3 measured object
4 FOV (object)
5 FOV (image)
6 measuring window
7 measured point

Figure 1 — Imaging probing system

3.9
bidirectional length measurement error
E_B
error of indication when measuring a calibrated bidirectional test length using an imaging probe CMM with a single probing point (or equivalent) at each end of the calibrated test length

NOTE E_B is applicable only to imaging probe CMMs that are capable of three-dimensional spatial measurements, which may not always be the case.

3.10
repeatability range of the bidirectional length measurement error
R_B
range (largest minus smallest) of three repeated length measurement errors measured by a CMM when measuring a calibrated bidirectional test length

3.11
unidirectional length measurement error
E_U
error of indication when measuring a calibrated unidirectional test length using an imaging probe CMM with a single probing point (or equivalent) at each end of the calibrated test length

NOTE E_U is applicable only to imaging probe CMMs that are capable of three-dimensional spatial measurements, which may not always be the case.

3.12
repeatability range of the unidirectional length measurement error
R_U
range (largest minus smallest) of three repeated length measurement errors measured by a CMM when measuring a calibrated unidirectional test length

3.13
Z bidirectional length measurement error
E_{BZ}
error of indication when measuring a calibrated bidirectional test length that is nominally perpendicular to the measuring plane of the imaging probe using a single probing point (or equivalent) at each end of the calibrated test length

NOTE In this part of ISO 10360, it is assumed that the machine Z-axis is nominally perpendicular to the measuring plane of the imaging probe. If that is not the case, alternative nomenclature should be used (e.g. E_{BX} or E_{BY}).

3.14
Z unidirectional length measurement error
E_{UZ}
error of indication when measuring a calibrated unidirectional test length that is nominally perpendicular to the measuring plane of the imaging probe using a single probing point (or equivalent) at each end of the calibrated test length

NOTE In this part of ISO 10360, it is assumed that the machine Z-axis is nominally perpendicular to the measuring plane of the imaging probe. If that is not the case, alternative nomenclature should be used (e.g. E_{UX} or E_{UY}).

3.15
XY bidirectional length measurement error
E_{BXY}
error of indication when measuring a calibrated bidirectional test length that is nominally parallel to the measuring plane of the imaging probe using a single probing point (or equivalent) at each end of the calibrated test length

NOTE In this part of ISO 10360, it is assumed that the machine XY plane is nominally parallel to the measuring plane of the imaging probe. If that is not the case, alternative nomenclature should be used (e.g. E_{BXZ} or E_{BYZ}).

3.16
XY unidirectional length measurement error
E_{UXY}
error of indication when measuring a calibrated unidirectional test length that is nominally parallel to the measuring plane of the imaging probe using a single probing point (or equivalent) at each end of the calibrated test length

NOTE In this part of ISO 10360, it is assumed that the machine XY plane is nominally parallel to the measuring plane of the imaging probe. If that is not the case, alternative nomenclature should be used (e.g. E_{UXZ} or E_{UYZ}).

3.17
squareness error
E_{SQ}
error of indication of the combined influence of the straightness and squareness (perpendicularity of motion) measured between the axis of motion of the imaging probe CMM that is nominally perpendicular to the measuring plane of the imaging probe and the plane of motion that is nominally parallel to the measuring plane of the imaging probe

NOTE The expected usage is where the Z-axis is nominally perpendicular to the measuring plane of the imaging probe and the XY plane is nominally parallel to the measuring plane of the imaging probe.

3.18
imaging probe bidirectional length measurement error
E_{BV}
error of indication of a calibrated bidirectional test length measured in any position within the field of view of the imaging probe, nominally parallel to the measuring plane of the imaging probe, and using a single probing point (or equivalent) at each end of the calibrated test length

NOTE 1 Testing E_{BV} does not involve motion of the imaging probe CMM.

NOTE 2 E_{BV} is applicable only to imaging probe CMMs that are capable of making measurements in the field of view of the imaging probe, which may not always be the case.

3.19
imaging probe unidirectional length measurement error
E_{UV}
error of indication of a calibrated unidirectional test length measured in any position within the field of view of the imaging probe, nominally parallel to the measuring plane of the imaging probe, and using a single probing point (or equivalent) at each end of the calibrated test length

NOTE 1 Testing E_{UV} does not involve motion of the imaging probe CMM.

NOTE 2 E_{UV} is applicable only to imaging probe CMMs that are capable of making measurements in the field of view of the imaging probe, which may not always be the case.

3.20
probing error
P_{F2D}
error of indication within which the range of radii can be determined by a least-squares fit of points measured on a circular material standard of size, the measurements being taken on the test circle located anywhere in the measuring volume by an imaging probe CMM in the discrete-point probing mode using motion of the CMM between all successive points and with all points evenly distributed across the usable field of view of the imaging probe

3.21
probing error of the imaging probe
P_{FV2D}
error of indication within which the range of radii can be determined by a least-squares fit of point measured on a circular material standard of size, the measurements being taken on the test circle by an imaging probe CMM in the discrete-point probing mode using no motion of the CMM and with all points distributed across the usable field of view of the imaging probe

NOTE P_{FV2D} is applicable only to imaging probe CMMs that are capable of making measurements in the field of view of the imaging probe, which may not always be the case.

3.22
maximum permissible error of bidirectional length measurement
$E_{B, MPE}$
extreme value of the bidirectional length measurement error, E_B, permitted by specifications

3.23
maximum permissible limit of the bidirectional repeatability range
$R_{B, MPL}$
extreme value of the repeatability range of the bidirectional length measurement error, R_B, permitted by specifications

3.24
maximum permissible error of unidirectional length measurement
$E_{U, MPE}$
extreme value of the unidirectional length measurement error, E_U, permitted by specifications

3.25
maximum permissible limit of the unidirectional repeatability range
$R_{U, MPL}$
extreme value of the repeatability range of the unidirectional length measurement error, R_U, permitted by specifications

3.26
maximum permissible error of Z bidirectional length measurement
$E_{BZ, MPE}$
extreme value of the Z bidirectional length measurement error, E_{BZ}, permitted by specifications

3.27
maximum permissible error of Z unidirectional length measurement
$E_{UZ, MPE}$
extreme value of the Z unidirectional length measurement error, E_{UZ}, permitted by specifications

3.28
maximum permissible error of the XY bidirectional length measurement
$E_{BXY, MPE}$
extreme value of the XY bidirectional length measurement error, E_{BXY}, permitted by specifications

3.29
maximum permissible error of the XY unidirectional length measurement
$E_{UXY, MPE}$
extreme value of the XY unidirectional length measurement error, E_{UXY}, permitted by specifications

3.30
maximum permissible squareness error
$E_{SQ, MPE}$
extreme value of the squareness error, E_{SQ}, permitted by specifications

3.31
maximum permissible error of imaging probe bidirectional length measurement
$E_{BV, MPE}$
extreme value of the imaging probe bidirectional length measurement error, E_{BV}, permitted by specifications

3.32
maximum permissible error of imaging probe unidirectional length measurement
$E_{UV, MPE}$
extreme value of the imaging probe unidirectional length measurement error, E_{UV}, permitted by specifications

3.33
maximum permissible probing error
$P_{F2D, MPE}$
extreme value of the probing error, P_{F2D}, permitted by specifications

3.34
maximum permissible probing error of the imaging probe
$P_{FV2D, MPE}$
extreme value of the probing error of the imaging probe, P_{FV2D}, permitted by specifications

4 Symbols

For the purposes of this part of ISO 10360, the symbols of Table 1 apply.

Table 1 — Symbols

Symbol	Meaning
E_{B}	bidirectional length measurement error
R_{B}	repeatability range of the bidirectional length measurement error
E_{U}	unidirectional length measurement error
R_{U}	repeatability range of the unidirectional length measurement error
E_{BZ}	Z bidirectional length measurement error
E_{UZ}	Z unidirectional length measurement error
E_{BXY}	XY bidirectional length measurement error
E_{UXY}	XY unidirectional length measurement error
E_{BX}	X bidirectional length measurement error
E_{UX}	X unidirectional length measurement error
E_{BY}	Y bidirectional length measurement error
E_{UY}	Y unidirectional length measurement error
E_{SQ}	squareness error
E_{BV}	imaging probe bidirectional length measurement error
E_{UV}	imaging probe unidirectional length measurement error
P_{F2D}	probing error
P_{FV2D}	probing error of the imaging probe
$E_{B, MPE}$	maximum permissible error of bidirectional length measurement
$R_{B, MPL}$	maximum permissible limit of bidirectional repeatability range
$E_{U, MPE}$	maximum permissible error of unidirectional length measurement
$R_{U, MPL}$	maximum permissible limit of unidirectional repeatability range
$E_{BZ, MPE}$	maximum permissible error of Z bidirectional length measurement
$E_{UZ, MPE}$	maximum permissible error of Z unidirectional length measurement
$E_{BXY, MPE}$	maximum permissible error of XY bidirectional length measurement
$E_{UXY, MPE}$	maximum permissible error of XY unidirectional length measurement
$E_{BX, MPE}$	maximum permissible error of X bidirectional length measurement
$E_{UX, MPE}$	maximum permissible error of X unidirectional length measurement
$E_{BY, MPE}$	maximum permissible error of Y bidirectional length measurement
$E_{UY, MPE}$	maximum permissible error of Y unidirectional length measurement
$E_{SQ, MPE}$	maximum permissible squareness error
$E_{BV, MPE}$	maximum permissible error of imaging probe bidirectional length measurement
$E_{UV, MPE}$	maximum permissible error of imaging probe unidirectional length measurement
$P_{F2D, MPE}$	maximum permissible probing error
$P_{FV2D, MPE}$	maximum permissible probing error of the imaging probe

NOTE See Clause 9 for the indications of these symbols in product documentation, drawings, data sheets, etc.