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

Part 8: CMMs with optical distance sensors

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

Partie 8: MMT avec détecteurs optiques sans contact

Reference number
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Foreword

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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. www.iso.org/directives

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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, *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*

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 link 5 of the chains of standards on size, distance, radius, angle, form, orientation, location, run-out and datums. For more detailed information of the relation of this part of ISO 10360 to other standards and the GPS matrix model, see Annex E.

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.

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 optical distance sensor and

b) to test the errors of the optical distance sensor.

Optical distance sensors treated in this standard are classified into two types,

— point measuring sensors, and

— area measuring sensors (e.g. laser point scan, laser line scan, fringe projection)

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

This part of ISO 10360 parallels that of ISO 10360-2 and ISO 10360-5, which is for CMMs equipped with contact probing systems. The testing methodology between these three parts of ISO 10360 is designed to be intentionally similar. The differences that exist may be eliminated in future revisions of this part or in ISO 10360-2.

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

Part 8: **CMMs with optical distance sensors**

1 Scope

This part of ISO 10360 specifies the acceptance tests for verifying the performance of a CMM (coordinate measuring machine) when measuring lengths 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 with optical distance sensors. This standard does not explicitly apply to non-Cartesian CMMs, however, the parties may apply this part of 10360 to non-Cartesian CMMs by mutual agreement.

NOTE This part of ISO 10360 is not intended to apply for CMMs whose measuring volume is significantly smaller than the size of the test sphere, however, the principle, artefacts, and procedure of the test described in this part of ISO 10360 are useful for the acceptance and reverification tests of those CMMs either as it is or with modifying the parameters such as the size of the test artefacts and the number of the measurements.

This part of ISO 10360 specifies:

— performance requirements that can be assigned by the manufacturer or the user of the CMM,

— the manner of execution of the acceptance and reverification tests to demonstrate the stated requirements,

— rules for verifying conformance, and

— applications for which the acceptance and reverification tests can be used.

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 10360-2:2009, *Geometrical product specifications (GPS) — Acceptance and reverification tests for coordinate measuring machines (CMM) — Part 2: CMMs used for measuring linear dimensions*

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

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

3.1
optical distance sensor
non-contacting probing system which determines a corrected measured point by means of optical distance measurement principle

Note 1 to entry: Typical measurement principles are triangulation and coaxial distance measurement. The former includes structured line projection, Moiré, slit light projection, point scanning, etc., and the latter includes interferometry and confocal systems.

3.2
local test flat
flat form standard used for evaluating the probing form error when testing the probing performance

Note 1 to entry: A local test flat is used in addition to the test sphere which is used for evaluating both the probing form and probing size errors.

Note 2 to entry: A local test flat is useful for testing probing performance when a calibrated test sphere with larger size suitable for an optical distance sensor with larger sensor area is practically difficult to obtain. Figure 5 shows a flow chart for material standard selection.

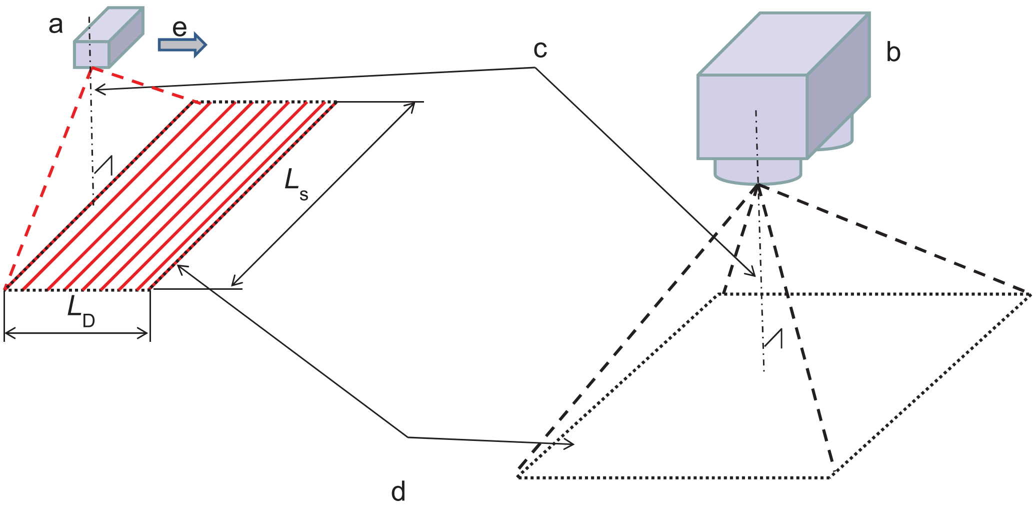
3.3
global test flat
flat form standard used when testing the flat form measurement error

Note 1 to entry: Global test flat is intended and encouraged to test form measuring performance of a CMM equipped with an optical distance sensor when the system is used for measuring a larger area than the sensor area.

3.4
sensor area
area illuminated by the optical distance sensor when a two-dimensional image-projection-type sensor is used

Note 1 to entry: The sensor area is determined not only by the length of the projection line of the sensor but also by the length of the sensor movement realized by the CMM when line scan or point scan sensors are used.

See Figure 1.



a) Example of line scan or point scan sensor

b) Example of two dimensional image projection sensor

Key

L_S length of the projection line

L_D length of the sensor movement

a line scan or point scan sensor

b two dimensional image projection sensor

c sensor axis

d sensor area

e sensor motion

Figure 1 — Definition of the sensor area

3.5
probing form error

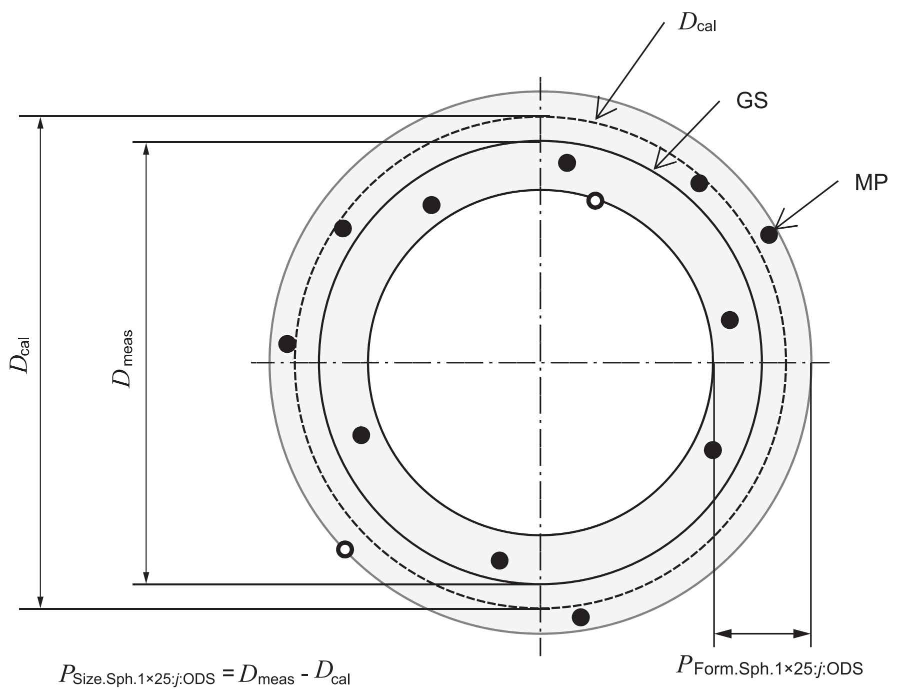
$P_{Form.Sph.1×25:j:ODS}$

error of indication within which the range of either the radial distances that can be determined by a least-squares fit (Gaussian associated feature) of points measured on a spherical material standard of size or those supplemented with the normal distances that can be determined by a least-squares fit of points measured on a local test flat

Note 1 to entry: The symbol “*P*” in $P_{Form.Sph.1×25:j:ODS}$ indicates that the error is associated with the probing system performance, the qualifier “Form.Sph” indicates that it is associated with the probing form error and the qualifier “ODS” indicates that it is associated with the optical distance sensor. The qualifier “*j*” identifies the measuring conditions of the CMM. $P_{Form.Sph.1×25:Tr:ODS}$ is the optical probing form error translatory, which is given when the sensor is moved by the CMM and measurements are taken at several positions. $P_{Form.Sph.1×25:Art:ODS}$ is the optical probing form error articulating, which is given when the alignment of the sensor is additionally modified by means of an *articulating* system. $P_{Form.Sph.1×25:St:ODS}$ is the optical probing form error *stationary*, which is given when the sensor is not moved by the CMM during measurements (see Figure 3).

Note 2 to entry: The probing form error is determined by the errors of the sensors (such as noise, digitizing errors, image distortion, optical interaction with the surface of the material standard, calibration errors of the sensor, faulty algorithms in measured data processing) and those of the CMM.

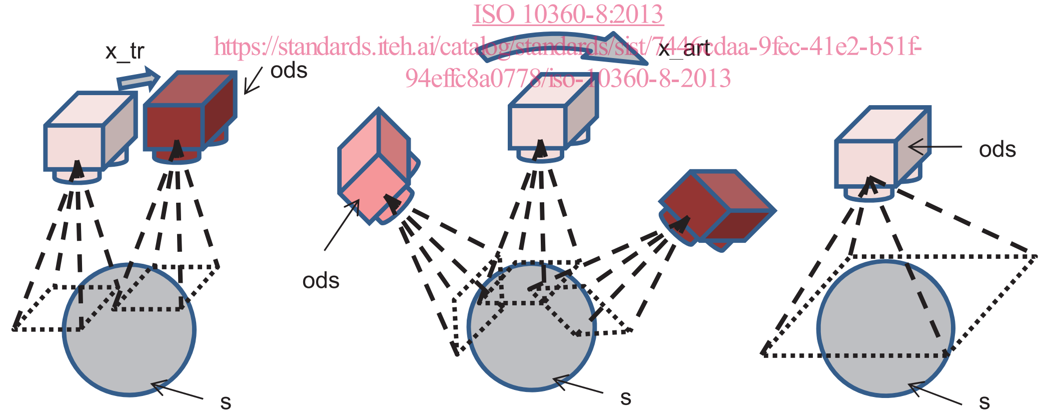
See Figure 2.



Key

D_{cal}	calibrated diameter of test sphere	GS	Gaussian associated sphere
D_{meas}	measured diameter of test sphere	MP	measured point

Figure 2 — Illustration of $P_{Form.Sph.1\times25:j:ODS}$ and $P_{Size.Sph.1\times25:j:ODS}$



a) Translatory **b) Articulating** **c) Stationary**

Key

ods	optical distance sensor	x_art	articulation
s	test sphere	x_tr	translation

Figure 3 — Illustration of Tr, Art and St

3.6
probing dispersion value

$P_{\text{Form.Sph.D95\%:}j\text{:ODS}}$

smallest width of a spherical shell or smallest separation of two parallel planes that encompasses 95 % of all the data points

Note 1 to entry: The symbol “*P*” in $P_{\text{Form.Sph.D95\%:}j\text{:ODS}}$ indicates that the error is associated with the probing system performance, the qualifier “Form.Sph” indicates that it is associated with the probing form error, the qualifier “D95%” indicates that it is associated with the dispersion of the probing points with 95 % population and the qualifier “ODS” indicates that it is associated with the optical distance sensor. The qualifier “*j*” identifies the measuring conditions of the CMM. $P_{\text{Form.Sph.D95\%:Tr:ODS}}$ is the probing dispersion value translatory, which is given when the sensor is moved by the CMM and measurements are taken at several positions. $P_{\text{Form.Sph.D95\%:Art:ODS}}$ is the probing dispersion value articulating, which is given when the alignment of the sensor is additionally modified by means of an *articulating* system. $P_{\text{Form.Sph.D95\%:St:ODS}}$ is the probing dispersion value *stationary*, which is given when the sensor is not moved by the CMM during measurements (see Figure 3).

Note 2 to entry: The dispersion of the probing system is also called the range or thickness of the probing (point) cloud.

Note 3 to entry: 5 % of the measured points are eliminated to determine $P_{\text{Form.Sph.D95\%:}j\text{:ODS}}$. Outlier data points that might be present in the measurement data may also be eliminated by this operation.

Note 4 to entry: For this particular definition, the plane is thought of as a sphere of infinite radius.

3.7
probing size error

$P_{\text{Size.Sph.1×25:}j\text{:ODS}}$

error of indication of the difference between the diameter of a least-squares fit of 25 representative points on a test sphere and its calibrated diameter

Note 1 to entry: The symbol “*P*” in $P_{\text{Size.Sph.1×25:}j\text{:ODS}}$ indicates that the error is associated with the probing system performance, the qualifier “Size.Sph” indicates that it is associated with the probing size error and the qualifier “ODS” indicates that it is associated with the optical distance sensor. The qualifier “*j*” identifies the measuring conditions of the CMM. $P_{\text{Size.Sph.1×25:Tr:ODS}}$ is the optical probing size error *translatory*, which is given when the sensor is moved by the CMM and measurements are taken at several positions. $P_{\text{Size.Sph.1×25:Art:ODS}}$ is the optical probing size error *articulating*, which is given when the alignment of the sensor is additionally modified by means of an articulating system. $P_{\text{Size.Sph.1×25:St:ODS}}$ is the optical probing size error *stationary*, which is given when the sensor is not moved by the CMM during measurements (see Figure 3).

Note 2 to entry: Probing size error is determined by the errors of the sensors (such as noise, digitizing errors, image distortion, optical interaction with the surface of the material standard, calibration errors of the sensor, faulty algorithms in measured data processing) and those of the CMM.

See Figure 2.

3.8
probing size error All

$P_{\text{Size.Sph.All:}j\text{:ODS}}$

error of indication of the difference between the diameter of a least-squares fit of all points measured on a test sphere and its calibrated diameter

Note 1 to entry: The symbol “*P*” in $P_{\text{Size.Sph.All:}j\text{:ODS}}$ indicates that the error is associated with the probing system performance, the qualifier “Size.Sph” indicates that it is associated with the probing size error, the qualifier “All” indicates that all measuring points are used for the calculation and the qualifier “ODS” indicates that it is associated with the optical distance sensor. The qualifier “*j*” identifies the measuring conditions of the CMM. $P_{\text{Size.Sph.All:Tr:ODS}}$ is the optical probing size error *translatory*, which is given when the sensor is moved by the CMM and measurements are taken at several positions. $P_{\text{Size.Sph.All:Art:ODS}}$ is the optical probing size error *articulating*, which is given when the alignment of the sensor is additionally modified by means of an articulating system. $P_{\text{Size.Sph.All:St:ODS}}$ is the optical probing size error *stationary*, which is given when the sensor is not moved by the CMM during measurements (see Figure 3).

Note 2 to entry: Probing size error All is determined by the errors of the sensors (such as noise, digitizing errors, image distortion, optical interaction with the surface of the material standard, calibration errors of the sensor, faulty algorithms in measured data processing) and those of the CMM.

3.9
length measurement error
$E_{Bi:j:ODS}$
$E_{Uni:j:ODS}$
error of indication when measuring a calibrated test length

Note 1 to entry: The symbol "E" in $E_{Bi:j:ODS}$ or $E_{Uni:j:ODS}$ indicates that the error is associated with the measurement error, the qualifier "Bi" or "Uni" indicates that it is associated with the bidirectional or unidirectional length measurement error and the qualifier "ODS" indicates that it is associated with the optical distance sensor. The qualifier "j" identifies the measuring conditions of the CMM. $E_{Bi:Tr:ODS}$ or $E_{Uni:Tr:ODS}$ is the length measurement error using optical probe translatory, which is given when the sensor is moved by the CMM and measurements are taken at several positions. $E_{Bi:Art:ODS}$ or $E_{Uni:Art:ODS}$ is the length measurement error using optical probe articulating, which is given when the alignment of the sensor is additionally modified by means of an articulating system. $E_{Bi:St:ODS}$ or $E_{Uni:St:ODS}$ is the length measurement error using optical probe stationary, which is given when the sensor is not moved by the CMM during measurements.

Note 2 to entry: A calibrated test length may be either bidirectionally calibrated or unidirectionally calibrated. See Annex B for detail.

3.10
flat form measurement error
$E_{Form.Pla.D95\%:j:ODS}$
smallest distance between two parallel planes that envelope 95 % of the points measured on a global test flat

Note 1 to entry: The symbol "E" in $E_{Form.Pla.D95\%:j:ODS}$ indicates that the error is associated with the measurement error, the qualifier "Form.Pla" indicates that it is associated with the flat form measurement error, the qualifier "D95%" indicates that it is associated with the dispersion of the measuring points with 95 % population and the qualifier "ODS" indicates that it is associated with the optical distance sensor. The qualifier "j" identifies the measuring conditions of the CMM. $E_{Form.Pla.D95\%:Tr:ODS}$ is the optical probing flat form measurement error *translatory*, which is given when the sensor is moved by the CMM and measurements are taken at several positions. $E_{Form.Pla.D95\%:Art:ODS}$ is the optical probing flat form measurement error *articulating*, which is given when the alignment of the sensor is additionally modified by means of an articulating system.

3.11
maximum permissible probing form error
$P_{Form.Sph.1\times25:j:ODS,MPE}$
extreme value of $P_{Form.Sph.1\times25:j:ODS}$ permitted by specifications as maximum permissible error

Note 1 to entry: The maximum permissible error of the probing form error $P_{Form.Sph.1\times25:j:ODS,MPE}$ may be expressed in one of three forms:

a) $P_{Form.Sph.1\times25:j:ODS,MPE}$ = minimum of $(A+L_P/K)$ and B, or

b) $P_{Form.Sph.1\times25:j:ODS,MPE} = (A+L_P/K)$, or

c) $P_{Form.Sph.1\times25:j:ODS,MPE} = B$

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 between the centres of the reference sphere and the test sphere (or flat), in millimetres;

B is the maximum permissible error $P_{Form.Sph.1\times25:j:ODS,MPE}$, in micrometres, as stated by the manufacturer.

3.12
maximum permissible limit of probing dispersion
$P_{\text{Form.Sph.D95\%:}j\text{:ODS,MPL}}$
extreme value of $P_{\text{Form.Sph.D95\%:}j\text{:ODS}}$ permitted by specifications as maximum permissible limit

Note 1 to entry: The maximum permissible limit of the probing dispersion value $P_{\text{Form, 95\%, X, MPL}}$ may be expressed in one of three forms:

a) $P_{\text{Form.Sph.D95\%:}j\text{:ODS,MPL}}$ = minimum of $(A+L_P/K)$ and B, or

b) $P_{\text{Form.Sph.D95\%:}j\text{:ODS,MPL}} = (A+L_P/K)$, or

c) $P_{\text{Form.Sph.D95\%:}j\text{:ODS,MPL}} = B$

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 between the centres of the reference sphere and the test sphere (or flat), in millimetres;

B is the maximum permissible limit $P_{\text{Form.Sph.D95\%:}j\text{:ODS,MPL}}$, in micrometres, as stated by the manufacturer.

3.13
maximum permissible probing size error
$P_{\text{Size.Sph.1×25:}j\text{:ODS,MPE}}$
extreme value of $P_{\text{Size.Sph.1×25:}j\text{:ODS}}$ permitted by specifications as maximum permissible error

Note 1 to entry: The maximum permissible probing size error $P_{\text{Size.Sph.1×25:}j\text{:ODS,MPE}}$ may be expressed in one of three forms:

a) $P_{\text{Size.Sph.1×25:}j\text{:ODS,MPE}}$ = minimum of $(A+L_P/K)$ and B, or

b) $P_{\text{Size.Sph.1×25:}j\text{:ODS,MPE}} = (A+L_P/K)$, or

c) $P_{\text{Size.Sph.1×25:}j\text{:ODS,MPE}} = B$

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 between the centres of the reference sphere and the test sphere (or flat), in millimetres;

B is the maximum permissible error $P_{\text{Size.Sph.1×25:}j\text{:ODS,MPE}}$, in micrometres, as stated by the manufacturer.

3.14
maximum permissible probing size error All
$P_{\text{Size.Sph.All:}j\text{:ODS,MPE}}$
extreme value of $P_{\text{Size.Sph.All:}j\text{:ODS}}$ permitted by specifications as maximum permissible error

Note 1 to entry: The maximum permissible probing size error All $P_{\text{Size.Sph.All:}j\text{:ODS,MPE}}$ may be expressed in one of three forms:

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

b) $P_{\text{Size.Sph.All:}j\text{:ODS,MPE}} = (A+L_P/K)$, or

c) $P_{\text{Size.Sph.All:}j\text{:ODS,MPE}} = B$

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 between the centres of the reference sphere and the test sphere (or flat), in millimetres;
- B is the maximum permissible error $P_{\text{Size.Sph.All:}j\text{:ODS,MPE}}$, in micrometres, as stated by the manufacturer.

3.15
maximum permissible length measurement error
$E_{\text{Bi:}j\text{:ODS,MPE}}$
$E_{\text{Uni:}j\text{:ODS,MPE}}$
extreme value of $E_{\text{Bi:}j\text{:ODS}}$ or $E_{\text{Uni:}j\text{:ODS}}$ permitted by specifications as maximum permissible error

3.16
maximum permissible flat form measurement error
$E_{\text{Form.Pla.D95\%:}j\text{:ODS,MPE}}$
extreme value of $E_{\text{Form.Pla.D95\%:}j\text{:ODS}}$ permitted by specifications as maximum permissible error

Note 1 to entry: The maximum permissible flat form measurement error $E_{\text{Form.Pla.D95\%:}j\text{:ODS,MPE}}$ may be expressed in one of three forms:

a) $E_{\text{Form.Pla.D95\%:}j\text{:ODS,MPE}}$ = minimum of $(A+L_F/K)$ and B, or

b) $E_{\text{Form.Pla.D95\%:}j\text{:ODS,MPE}} = (A+L_F/K)$, or

c) $E_{\text{Form.Pla.D95\%:}j\text{:ODS,MPE}} = B$

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 largest side length of the evaluated plane in millimetres;
- B is the maximum permissible error $E_{\text{Form.Pla.D95\%:}j\text{:ODS,MPE}}$, in micrometres, as stated by the manufacturer.

3.17
articulated location value
$L_{\text{Dia.5×25:Art:ODS}}$
diameter of the minimum circumscribed sphere of the centres of all five spheres

Note 1 to entry: Where the location of a test sphere can be determined by a least-squares fit of points, the measurements being taken with five different articulating angles on the one test sphere located anywhere in the measuring volume.

Note 2 to entry: The symbol "*L*" in $L_{\text{Dia.5} \times 25\text{:Art:ODS}}$ indicates that it is a location value, the qualifier "Art" identifies the measuring conditions of the CMM and the qualifier "ODS" indicates that it is associated with the optical distance sensor.

Note 3 to entry: All the symbols used in this annex are listed in Table D.1.

Note 4 to entry: All values are absolute.

3.18
maximum permissible limit of the articulated location value

$L_{\text{Dia.5×25:Art:ODS,MPL}}$

extreme value of the *articulated location value* (3.17), $L_{\text{Dia.5×25:Art:ODS}}$, permitted by specifications, regulations, etc. for the CMM

Note 1 to entry: The maximum permissible limit of the articulated location value, $L_{\text{Dia.5} \times 25\text{:Art:ODS,MPL}}$, can be expressed in one of three forms:

a) $L_{\text{Dia.5} \times 25\text{:Art:ODS,MPL}}$ = minimum of $(A + L_P/K)$ and B; or

b) $L_{\text{Dia.5} \times 25\text{:Art:ODS,MPL}} = (A + L_P/K)$; or

c) $L_{\text{Dia.5} \times 25\text{:Art:ODS,MPL}} = B$

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 between the centres of the reference sphere and the test sphere, in millimetres;

B is the maximum permissible limit $L_{\text{Dia.5} \times 25\text{:Art:ODS,MPL}}$, in micrometres, as stated by the manufacturer.

Note 2 to entry: A maximum permissible limit (MPL) as opposed to a maximum permissible error (MPE) specification is used when the test measurements are not errors; hence, testing an MPL specification does not require the use of artefacts with a relevant calibration.

4 Symbols

For the purpose of this International Standard, the symbols of Table 1 apply.

Table 1 — Symbols

Symbol	Meaning
$P_{\text{Form.Sph.1×25:}j\text{:ODS}}$	probing form error
$P_{\text{Form.Sph.D95\%:}j\text{:ODS}}$	probing dispersion value
$P_{\text{Size.Sph.1×25:}j\text{:ODS}}$	probing size error
$P_{\text{Size.Sph.All:}j\text{:ODS}}$	probing size error All
$E_{\text{Bi:}j\text{:ODS}}$	bidirectional length measurement error
$E_{\text{Uni:}j\text{:ODS}}$	unidirectional length measurement error
$E_{\text{Form.Pla.D95\%:}j\text{:ODS}}$	flat form measurement error
$P_{\text{Form.Sph.1×25:}j\text{:ODS,MPE}}$	maximum permissible probing form error
$P_{\text{Form.Sph.D95\%:}j\text{:ODS,MPL}}$	maximum permissible limit of probing dispersion value