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Geometrical product specifications (GPS) — Surface texture: Areal —

Part 701: Calibration and measurement standards for contact (stylus) instruments

Spécification géométrique des produits (GPS) — État de surface: Surfacique —
Partie 701: Étalonnage et étalons de mesure pour les instruments à contact (à palpeur)

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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.

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 25178-701 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

ISO 25178 consists of the following parts, under the general title *Geometrical product specifications (GPS) — Surface texture: Areal*:

— *Part 2: Terms, definitions and surface texture parameters*

— *Part 3: Specification operators*

— *Part 6: Classification of methods for measuring surface texture*

— *Part 7: Software measurement standards*

— *Part 601: Nominal characteristics of contact (stylus) instruments*

— *Part 602: Nominal characteristics of non-contact (confocal chromatic probe) instruments*

— *Part 603: Nominal characteristics of non-contact (phase-shifting interferometric microscopy) instruments*

— *Part 701: Calibration and measurement standards for contact (stylus) instruments*

The following parts are under preparation:

— *Part 604: Nominal characteristics of non-contact (coherence scanning interferometry) instruments*

— *Part 605: Nominal characteristics of non-contact (point autofocusing) instruments*

Introduction

This part of ISO 25178 is a geometrical product specification standard and is to be regarded as a general GPS standard (see ISO/TR 14638). It influences chain link 6 of the chains of standards on areal surface texture.

For more detailed information of the relation of this standard to the GPS matrix model, see Annex C.

This part of ISO 25178 concerns the areal surface texture measuring instruments for which it defines

— the systematic errors linked with main metrological characteristics of the instrument if they are not given by the manufacturer,

— the calibration operation mode,

— the analysis of the results for the assessment of the potential errors, and

— the decision rules for corrective actions.

It allows the evaluation of the part of the measurement uncertainty which is linked with the metrological characteristics of the instrument and which influences the assessment of areal surface texture parameters.

These metrological characteristics are verified by testing the instrument with the measurement standards defined hereafter or with the measurement standards described in ISO 5436-1 and ISO 5436-2, and with complementary standards like optical flats.

The aim is to assess the errors in the corrected X, Y and Z quantities by using material measurement standards having simple geometry (i.e. optical flat, sphere, etc.) for which

— the uncertainty is lower than for surface texture standards,

— their characteristics are independent of the surface texture parameters.

The calibration procedure reports on the status of the measurement equipment. Depending on the report, the user can decide to perform the corrective actions or to alert the equipment manufacturer.

The method is as follows:

a) assessment of the errors on the fundamental corrected quantities X, Y and Z;

b) assessment of the uncertainty due to the mathematical algorithms used for filtering and for computation of parameters, checked with the help of software measurement standards as defined in ISO 5436-2 and ISO 25178-7.

Geometrical product specifications (GPS) — Surface texture: Areal —

Part 701: Calibration and measurement standards for contact (stylus) instruments

1 Scope

This part of ISO 25178 specifies

— the characteristics of material measures used as measurement standards,

— the estimation methods of the residual errors, and

— the calibration methods and tests for acceptance and periodical re-verification

for areal surface texture contact (stylus) measurement instruments.

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 3274, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Nominal characteristics of contact (stylus) instruments*

ISO 5436-1:2000, *Geometrical Product Specifications (GPS) — Surface texture: Profile method; Measurement standards — Part 1: Material measures*

ISO 5436-2, *Geometrical Product Specifications (GPS) — Surface texture: Profile method; Measurement standards — Part 2: Software measurement standards*

ISO 12085, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Motif parameters*

ISO 12179:2000, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Calibration of contact (stylus) instruments*

ISO/TS 12181-1, *Geometrical Product Specifications (GPS) — Roundness — Part 1: Vocabulary and parameters of roundness*

ISO/TS 12780-1, *Geometrical Product Specifications (GPS) — Straightness — Part 1: Vocabulary and parameters of straightness*

ISO/TS 12781-1, *Geometrical Product Specifications (GPS) — Flatness — Part 1: Vocabulary and parameters of flatness*

ISO/TS 14253-2, *Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 2: Guide to the estimation of uncertainty in GPS measurement, in calibration of measuring equipment and in product verification*

ISO 25178-2, *Geometrical product specifications (GPS) — Surface texture: Areal — Part 2: Terms, definitions and surface texture parameters*

ISO 25178-601, *Geometrical product specifications (GPS) — Surface texture: Areal — Part 601: Nominal characteristics of contact (stylus) instruments*

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

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 3274, ISO 25178-2, ISO 25178-601 and ISO/IEC Guide 99 apply.

4 General

A material measurement standard can be used for two different purposes:

— calibration of the metrological characteristics, followed by assessment of the measurement uncertainty;

— user adjustment of the instrument (see ISO 25178-601), which establishes correction factors of the measured quantities.

Both of these depend on the metrological characteristics of the measurement standards.

The measurement standards presented below are suitable for both purposes; nevertheless, they have been especially designed for the assessment and for the correction of systematic errors. This is due to the fact that the characteristics of those standards permit the calibration of quantities such as X, Y and Z through the assessment and the verification of adjustment coefficients C_x, C_y and C_z (see ISO 25178-601).

However, these material measurement standards do not permit the assessment of errors due to filtering and computation algorithms. These algorithms can be tested using software measurement standards (see ISO 5436-2 and ISO 25178-7).

Moreover, most of the material measurement standards presented below permit the verification and the correction of the perpendicular deviation between X and Y drive units.

The measurement standards defined in ISO 5436-1 are designed for the calibration of quantities which permit the assessment of profile parameters.

This part of ISO 25178 provides default methods for the assessment of the software measurement standards. Nevertheless, the method and the characteristics of the measurement standard should be supplied by the manufacturer.

5 Measurement standards

5.1 Types of standards

The different types of measurement standards are given in Table 1.

Table 1 — Type of measurement standards

Type	Name
ER1	Measurement standard with two parallel grooves
ER2	Measurement standard with four grooves forming a rectangle
ER3	Measurement standard with a circular groove
ES	Measurement standard with a sphere/plane intersection
CS	Measurement standard with a contour profile
CG	Crossed-grating measurement standard

It is necessary to choose a measurement standard having characteristics in accordance with the metrological characteristics of the instrument under consideration. Therefore, a non-exhaustive list of significant characteristics is supplied below for each measurement standard.

5.2 Description of the measurement standards

5.2.1 Type ER: Groove standard

5.2.1.1 General

The ER standards contain two or more triangular grooves.

These grooves are characterized by:

— the depth, d;

— the angle between the flanks, α;

— the intersection line of their respective flanks.

The parallelism and the perpendicularity of grooves and the distance between grooves are determined from the intersection line of the flanks.

The angle α should be greater than the cone angle of the stylus.

The groove bottom radius r_f should be greater than the tip radius r_{tip} of the stylus.

The depth d of the grooves is defined according to ISO 5436-1:2000, 7.2.

5.2.1.2 Requirements for the ER measurement standard

The design characteristics of the measurement standards shall be compatible with the considered application (e.g. geometry of stylus tips).

The following geometrical characteristics shall not significantly affect the measurement:

— flatness of the real integral surface relative to the reference plane, P, of the standard;

— form deviation of the groove(s);

— groove bottom radius, r_f;

— form deviation of the flanks of the triangles;

— parallelism between grooves;

— perpendicularity between grooves;

— local slope at any point.

Roughness shall be considered not to affect the measurement.

The bisector of the groove(s) or the triangles (line, plane or cylinder) shall be nominally perpendicular to the reference plane of the standard.

For type ER2 measurement standards, an orientation mark with an angle of 45° with respect to the grooves can be added on the standard to identify a preferred measurement direction.

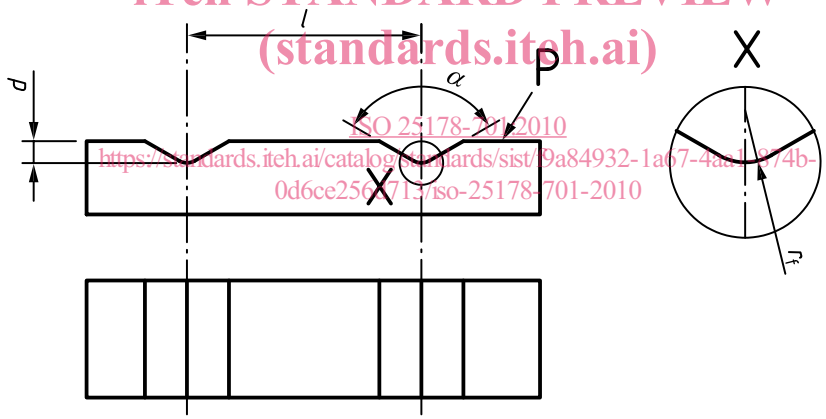
5.2.1.3 Type ER1: Two-parallel-grooves standards

5.2.1.3.1 Purpose

The two-parallel-grooves standards are used for calibrating the vertical and the horizontal amplification coefficients of the measuring instrument.

5.2.1.3.2 Design characteristics

This measurement standard has two parallel grooves (see Figure 1).



Key

d depth of grooves
l distance between grooves
α angle of the groove flanks
P reference plane
r_f groove bottom radius

Figure 1 — Two-parallel-grooves standard, ER1

5.2.1.3.3 Definition of the measurands

The measurands are:

l the groove spacing,

d the depth of the grooves, defined according to ISO 5436-1:2000, 7.2.

5.2.1.4 Type ER2: Rectangular-groove measurement standards

5.2.1.4.1 Purpose

The rectangular-groove standards are used for calibrating:

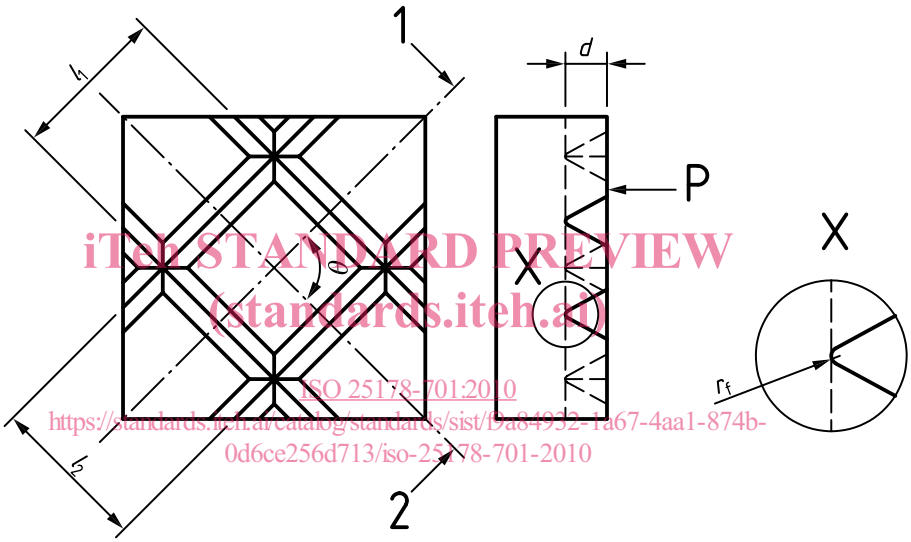
— the vertical amplification α_z;

— the horizontal amplification, α_x, α_y;

— the perpendicularity of both X- and Y-axes of the measuring instrument, Δ_{PER}.

5.2.1.4.2 Design characteristics

This measurement standard is composed of four grooves forming a rectangle (see Figure 2).



Key

1, 2 symmetry lines of parallel grooves
d depth of grooves
l_1, l_2 groove spacing
θ angle between the grooves
P reference plane
r_f groove bottom radius

Figure 2 — Rectangular-groove measurement standard, ER2

5.2.1.4.3 Definition of the measurands

The measurands are:

l_1, l_2 the spacing between the grooves;

d the depth of the grooves, defined according to ISO 5436-1:2000, 7.2;

θ the angle between the grooves, defined as the intersection of the two median lines of the two sets of parallel grooves (see Figure 2).

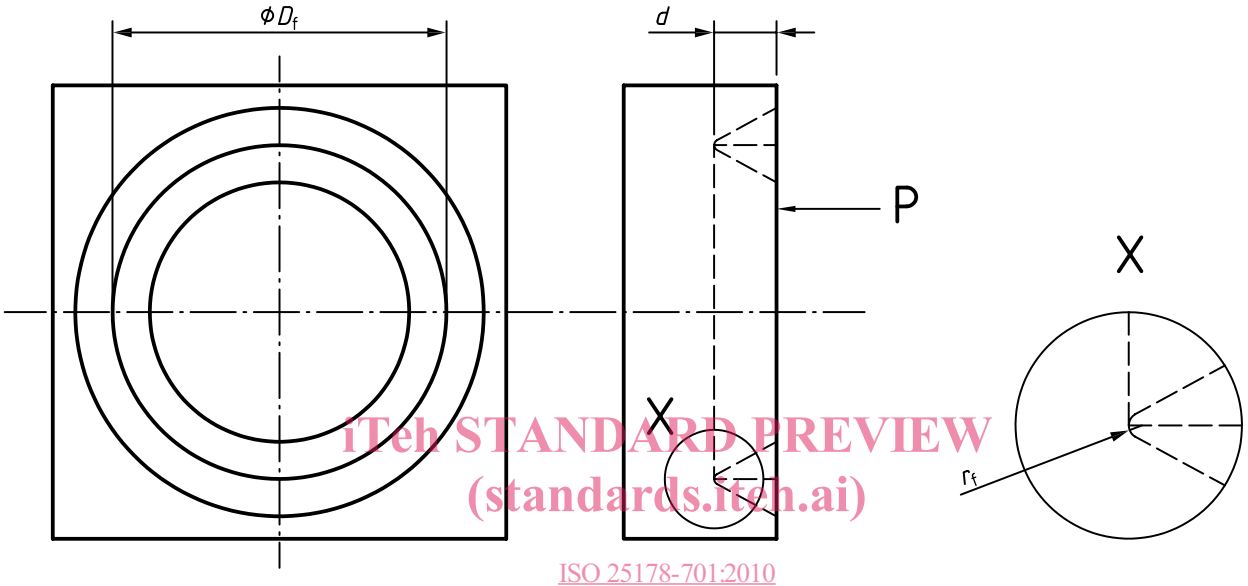
5.2.1.5 Type ER3: Circular-groove standards

5.2.1.5.1 Purpose

The circular-groove standards are used for calibrating the vertical and the horizontal amplification coefficients and the perpendicularity of both X- and Y-axes of the measuring instrument.

5.2.1.5.2 Design characteristics

This measurement standard has a circular groove (see Figure 3).



Key

d depth of grooves
D_f diameter of the groove
P reference plane
r_f groove bottom radius

Figure 3 — Circular-groove standard, ER3

5.2.1.5.3 Definition of the measurands

The measurands are:

D_f the diameter of the groove, defined as the diameter of the intersection circle of the two flanks of the groove;

d the depth of the grooves, defined according to ISO 5436-1:2000, 7.2.

5.2.2 Type ES: Sphere/plane measurement standard

5.2.2.1 Purpose

The sphere/plane standards are used for calibrating:

— the vertical amplification, α_z;

— the horizontal amplification, α_x, α_y;