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

Part 70: Material measures

Spécification géométrique des produits (GPS) — État de surface: surfacique —

Partie 70: Mesures matérialisées

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Contents

Page

Foreword .... **iv**

Introduction .... **vi**

1 Scope **1**

2 Normative references **1**

3 Terms and definitions **1**

4 General **2**

5 Requirements for the material measures **2**

6 Types of material measures **3**

7 Profile material measures **4**

7.1 Type PPS: Periodic sinusoidal shape 4

7.2 Type PPT: Periodic triangular shape 5

7.3 Type PPR: Periodic rectangular shape 6

7.4 Type PPA: Periodic arcuate shape 6

7.5 Type PGR: Groove, rectangular 7

7.6 Type PGC: Groove, circular 8

7.7 Type PRO: Irregular profile 9

7.8 Type PCR: Circular irregular profile 10

7.9 Type PRI: Prism 11

7.10 Type PRB: Razor blade 11

7.11 Type PAS: Approximated sinusoidal shape 12

7.12 Type PCS: Contour standard 13

7.13 Type PDG: Double groove 14

8 Areal material measures **15**

8.1 Type AGP: Grooves, perpendicular 15

8.2 Type AGC: Grooves, circular 15

8.3 Type ASP: Hemisphere 16

8.4 Type APS: Plane-sphere 17

8.5 Type ACG: Cross grating 18

8.6 Type ACS: Cross sinusoidal 19

8.7 Type ARS: Radial sinusoidal 19

8.8 Type ASG: Star-shape grooves 20

8.9 Type AIR: Irregular 21

8.10 Type AFL: Flat plane 22

8.11 Type APC: Photochromic pattern 22

9 Material measure certificate **23**

Annex A (normative) **Requirements for measurements** **24**

Annex B (informative) **Equivalence table for material measure names** **25**

Annex C (informative) **Evaluation of a spacing measurand on an areal instrument** **26**

Annex D (informative) **Irregular measurement standards** **28**

Annex E (informative) **Relationship to the GPS matrix model** **31**

Bibliography **33**

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, *Dimensional and geometrical product specifications and verification*.

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

— *Part 1: Areal – Indication of surface texture*

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

— *Part 3: Areal – Specification operators*

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

— *Part 70: Material measures*

— *Part 71: 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 604: Nominal characteristics of non-contact (coherence scanning interferometry) instruments*

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

— *Part 606: Nominal characteristics of non-contact (focus variation) instruments*

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

The following part is under preparation:

— *Part 72: XML file format x3p*

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 the chain link 6 of the chains of standards on areal surface texture, roughness profile, waviness profile and primary profile.

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. The default decision rules given in ISO 14253-1 apply to specifications made in accordance with this document, unless otherwise stated.

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

This part of ISO 25178 introduces material measures that can be used for periodic verification and adjustment of areal surface texture instruments.

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

Part 70: Material measures

1 Scope

This part of ISO 25178 specifies the characteristics of material measures used for the periodic verification and adjustment of areal surface texture measurement instruments.

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 3274:1996, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Nominal characteristics of contact (stylus) instruments*

ISO 10012, *Measurement management systems — Requirements for measurement processes and measuring equipment*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

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

3.1
material measure
<surface texture> dedicated manufactured workpiece intended to reproduce or supply, in a permanent manner during its use quantities of one or more given kinds, each with an assigned quantity value

Note 1 to entry: The indication of a material measure is its assigned quantity value.

Note 2 to entry: A material measure can be a measurement standard.

Note 3 to entry: A material measure is sometimes called calibration sample, calibration specimen, calibration standard, standard artefact, physical measurement standard or physical standard.

[SOURCE: ISO/IEC Guide 99:2007, 3.6, modified — A domain has been added and the definition modified. The examples are not reproduced.]

4 General

A material measure can be used for two different purposes:

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

— user adjustment of the instrument, which establishes corrections of the measured quantities.

Both purposes depend on the metrological characteristics of the material measures (see the ISO 25178-700 series).

The material measures presented in this part of ISO 25178 are suitable for both purposes; nevertheless, they have been especially designed for the assessment and correction of systematic errors. This is due to the fact that the characteristics of those material measures permit the calibration of coordinates such as x, y and z through the assessment and verification of adjustment coefficients C_x, C_y and C_z (see the ISO 25178-600 series).

These material measures are not intended to separate the errors introduced by the instrument from those due to the filtering and computation algorithms. The algorithms can be tested using software measurement standards (see ISO 5436-2, ISO 25178-71 and ISO 25178-72).

Most of the material measures presented below permit the verification and the correction of the squareness between X and Y drive units on areal instruments.

The measurement method and the characteristics of the material measure shall be supplied by the manufacturer of the material measure.

In ISO 25178-2, each term is followed by its parameter (abbreviated term), then its symbol. Whereas abbreviated terms can contain multiple letters, symbols consist only of a single letter with subscripts as needed. For these terms, symbols are used in the equations shown in this document. The reason for this differentiation is to avoid misinterpretation of compound letters as an indication of multiplication between quantities in equations. The parameters (abbreviated terms) are used everywhere else in this document as well as in product documentation, drawings and data sheets.

5 Requirements for the material measures

The design characteristics of material measures shall be compatible with the considered application. See also Annex A.

The material characteristics of the material measure shall not significantly affect the measurement carried out on it.

The real integral surface of a standard shall have a scale limitation specified and features outside this limitation shall be considered not to affect the measurement.

Examples of such features are:

— flatness deviation of the real integral surface of the standard;

— form deviation of the groove(s) (i.e. for PGR, PGC, PDG, AGP, AGC, etc.);

— groove bottom radius (i.e. for PGC, PCS, PDG, AGP, AGC, etc.);

— form deviation of the flanks of the triangles (i.e. for PPT, PCS, PDG, AGP, etc.);

— parallelism errors between grooves (i.e. for PDG, AGP, etc.);

— squareness between grooves (i.e. for AGP, etc.);

— local slope at any point (when using an optical instrument);

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

— reflectivity of the surface (when using an optical instrument);

— hardness of the material (when using a stylus instruments);

— refractive index of the material;

— colour of the material.

The measurement standards should be uniquely identified. Serial number, type and nominal values of the measurands are recommended to be engraved on the standard and/or standard's casing.

6 Types of material measures

The different types of material measures covered by this part of ISO 25178 are given in Table 1 and Table 2.

NOTE 1 The prefix P is used for the profile material measures type.

NOTE 2 The prefix A is used for the areal material measures type.

Annex B gives the equivalence between names defined in other standards (e.g. ISO 5436-1 and ISO 25178-701).

Table 1 — Types of profile material measures

Type	Name
PPS	Periodic sinusoidal shape
PPT	Periodic triangular shape
PPR	Periodic rectangular shape
PPA	Periodic arcuate shape
PGR	Groove, rectangular
PGC	Groove, circular
PRO	Irregular profile
PCR	Circular irregular profile
PRI	Prism
PRB	Razor blade
PAS	Approximated sinusoidal shape
PCS	Contour standard
PDG	Double groove

Table 2 — Types of areal material measures

Type	Name
AGP	Grooves, perpendicular
AGC	Groove, circular
ASP	Hemisphere
APS	Plane – sphere
ACG	Cross grating
ACS	Cross sinusoidal
ARS	Radial, sinusoidal
ASG	Star-shape grooves
AIR	Irregular
AFL	Flat plane
APC	Photochromic pattern

7 Profile material measures

7.1 Type PPS: Periodic sinusoidal shape

7.1.1 Design characteristics

This material measure reproduces a sinusoidal shape along one direction. The shape is defined by the period *p* and the amplitude *d* (see Figure 1).

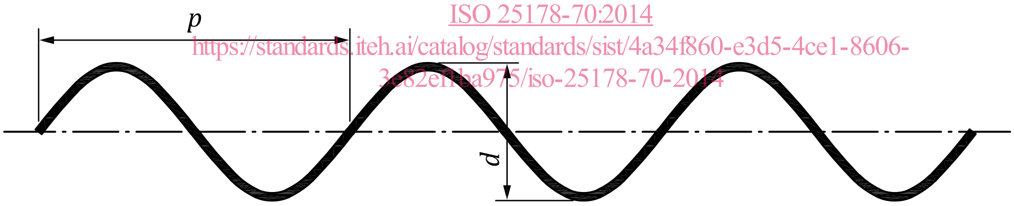

Figure 1 — Sinusoidal shape

NOTE 1 According to ISO 5436-1, this material measure is a type B2 or C1 depending on the period (see Annex B).

NOTE 2 Particular cases of PPS material measures, commonly called chirps, have increasing or decreasing periods. They make possible the assessment of instrument bandwidth or lateral resolution.

7.1.2 Measurands

See Table 3.

Table 3 — Measurand of material measures — Type PPS

	Profile	Areal
Z axis	Ra or Rq	Sa or Sq
X axis (and Y axis)	RSm	averaged PSm

NOTE 1 RSm is equal to the period of the sinusoid.

NOTE 2 Ra and Rq can be calculated using the Formulae (1) and (2), assuming the effect of the λc and λs filters is negligible:

$$R_a = \frac{d}{\pi} \tag{1}$$

and

$$R_q = \frac{d}{2\sqrt{2}} \tag{2}$$

NOTE 3 The maximum slope on this material measure is given by the ratio $\frac{\pi d}{p}$.

NOTE 4 For the definition of “averaged PSm”, see Annex C.

7.2 Type PPT: Periodic triangular shape

7.2.1 Design characteristics

This material measure reproduces a triangular shape along one direction. The shape is defined by the period *p* and the depth *d*, or by the depth *d* and the angle *α* between opposing flanks (see Figure 2).

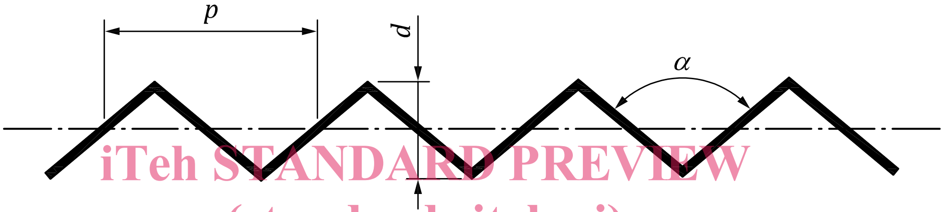

Figure 2 — Triangular shape

NOTE According to ISO 5436-1, Figure 2 illustrates a material measure of type B2 or C2 depending on the period (see Annex B).

7.2.2 Measurands

See Table 4.

Table 4 — Measurand of material measures — Type PPT

	Profile	Areal
Z axis	Ra or Rq	Sa or Sq
X axis (and Y axis)	RSm	averaged PSm

NOTE 1 RSm is equal to the period *p* of the triangular motif.

NOTE 2 Ra and Rq can be calculated using the Formulae (3) and (4) assuming the effect of λc and λs filters is negligible:

$$R_a = \frac{d}{4} \tag{3}$$

and

$$R_q = \frac{d}{2\sqrt{3}} \tag{4}$$

NOTE 3 For the definition of “averaged PSm”, see Annex C.

7.3 Type PPR: Periodic rectangular shape

7.3.1 Design characteristics

This material measure repeats rectangular grooves along one direction. The shape is defined by the groove width w, the shape period p, and the groove depth d (see Figure 3).

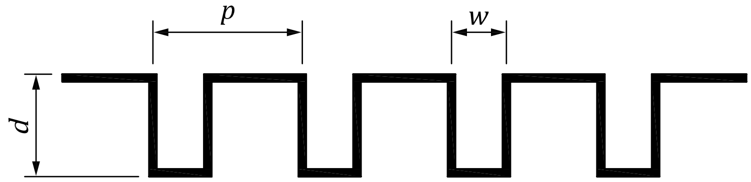

Figure 3 — Rectangular shape

7.3.2 Measurands

See Table 5.

Table 5 — Measurand of material measures — Type PPR

	Profile	Areal
Z axis	Ra or Rq	Sa or Sq
X axis (and Y axis)	RSm	average PSm

NOTE 1 RSm is equal to the period p of the rectangular motif.

NOTE 2 Ra and Rq can be calculated using the Formulae (5) and (6) assuming the effect of λc and λs filters is negligible:

$$R_a = 2 \times \frac{d \times w}{p} \times \left(1 - \frac{w}{p}\right) \tag{5}$$

and

$$R_q = \frac{d \times w}{p} \times \sqrt{\frac{p}{w} - 1} \tag{6}$$

NOTE 3 For the definition of "averaged PSm", see Annex C.

7.4 Type PPA: Periodic arcuate shape

7.4.1 Design characteristics

This material measure reproduces an arcuate shape along one direction. The shape is defined by the period p and the radius r of arcs or by the period p and the depth d (see Figure 4).

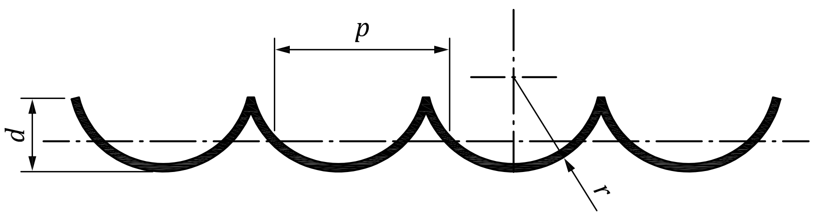

Figure 4 — Arcuate shape

NOTE According to ISO 5436-1, Figure 4 illustrates a material measure of type B2 or C4 depending on the period (see Annex B).

7.4.2 Measurands

See Table 6.

Table 6 — Measurand of material measures – Type PPA

	Profile	Areal
Z axis	Ra or Rq	Sa or Sq
X axis (and Y axis)	RSm	averaged PSm

NOTE 1 RSm is equal to the period p of the arcuate shape.

NOTE 2 For the definition of “averaged PSm”, see Annex C.

7.5 Type PGR: Groove, rectangular

7.5.1 Design characteristics

These material measures have a wide groove with a flat bottom or a number of separated grooves of equal or increasing depth, each groove being wide enough to be insensitive to the lateral resolution limitations of the instrument (for example the stylus tip).

Each groove is characterized by its width w and its depth d (see Figure 5).

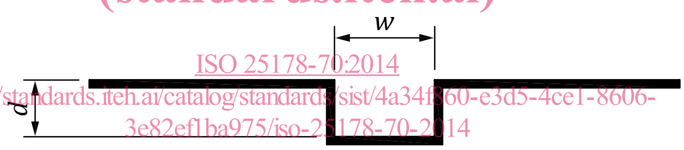

Figure 5 — Rectangular groove

NOTE According to ISO 5436-1, Figure 5 illustrates a material measure of type A1 (see Annex B).

7.5.2 Measurands

The measurand is the depth d.

It can be assessed using the following equation:

$$Z = \alpha X + \beta + h\delta$$

where α, β and h are unknown parameters. It is fitted by the method of least squares to a profile equal in length to three times the width of the groove (see Figure 6). The variable δ takes the value +1 on regions A and B and the value −1 on region C (see Figure 6). The depth of the groove d is twice the estimated value of h.