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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

Reference number
ISO 25178-70:2014(E)

Contents

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).

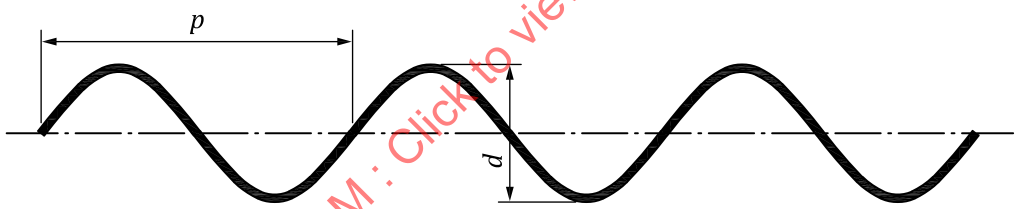


Figure 1 — Sinusoidal shape

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:

$$R_a = \frac{d}{\pi} \qquad (1)$$

and

$$R_q = \frac{d}{2\sqrt{2}} \qquad (2)$$

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).

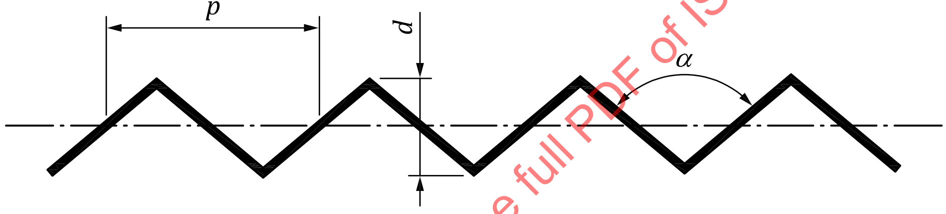


Figure 2 — Triangular shape

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:

$$R_a = \frac{d}{4} \qquad (3)$$

and

$$R_q = \frac{d}{2\sqrt{3}} \qquad (4)$$

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).

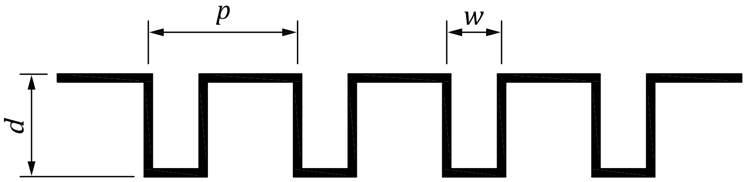


Figure 3 — Rectangular shape

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).

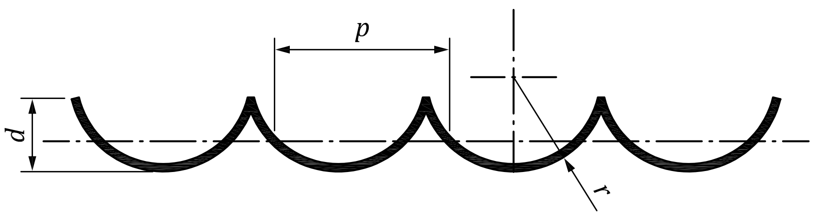


Figure 4 — Arcuate shape

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).

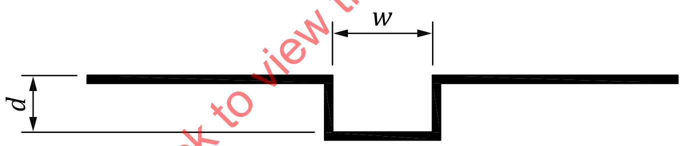


Figure 5 — Rectangular groove

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

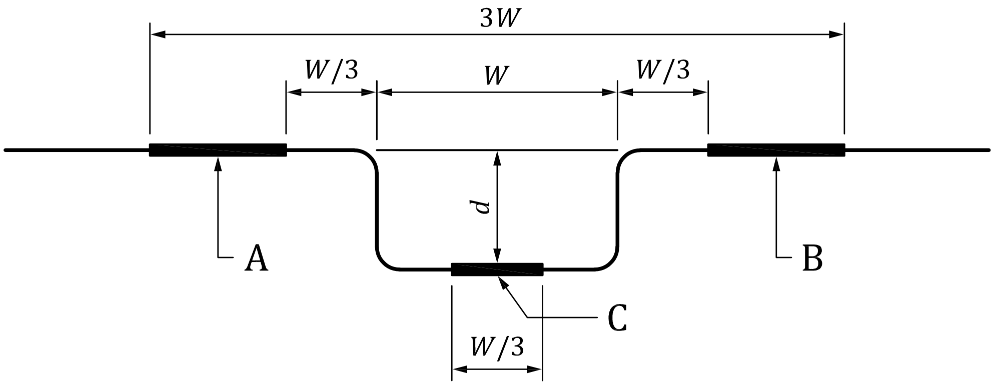
7.5.2 Measurands

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.



Key
A, B, C portions to be used

Figure 6 — Assessment of values for type PGR

To avoid the influence of any rounding of the corners, the upper surface on each side of the groove is to be ignored for a length equal to one-third of the width of the groove. The surface at the bottom of the groove is assessed only over the central third of its width. The portions to be used for assessment purposes are those shown at A, B and C in Figure 6.

7.6 Type PGC: Groove, circular

7.6.1 Design characteristics

These material measures are similar to type PGR, except that the grooves have rounded bottoms of sufficient radius to be insensitive to the lateral resolution limitations of the instrument.

This material measure is characterized by its radius r and its depth d. See Figure 7.

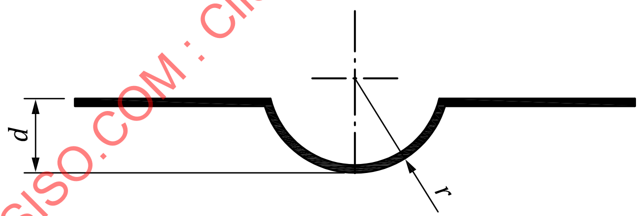
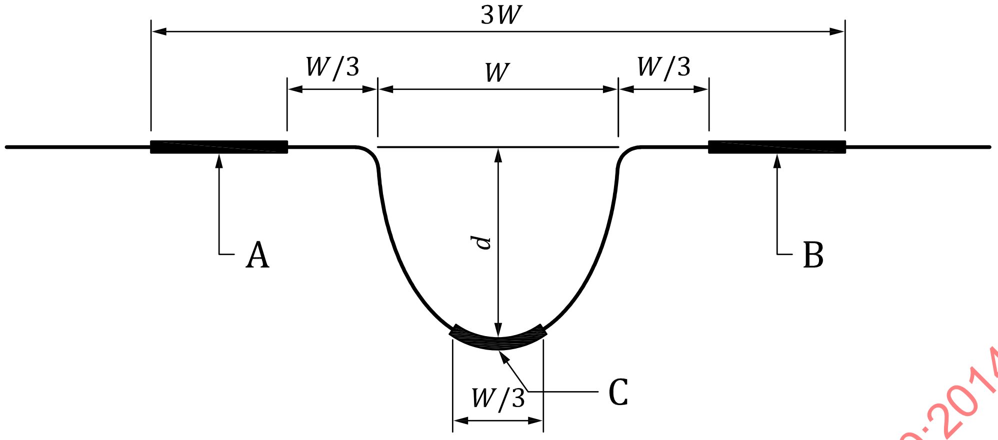


Figure 7 — Circular groove

NOTE According to ISO 5436-1, Figure 7 illustrates a material measure of type A2 (see Annex B).

7.6.2 Measurands

A least squares mean line representing the upper level is drawn over the groove. A least squares circle is fitted through the centre third of the width of the groove. The depth is assessed from the line to the lowest point of the fitted circle (see Figure 8).



Key

A, B, C portions to be used

Figure 8 — Assessment of values for type PGC

7.7 Type PRO: Irregular profile

7.7.1 Design characteristics

These material measures have irregular profiles (for example as obtained by grinding) in the direction of traverse (see Figure 9).

For several types of PRO measurement standards, the irregular profile is repeated every 5λc in the longitudinal direction of the material measure. Normal to the measuring direction of the material measure, the profile form is constant.

The material measures simulate workpieces containing a wide range of crest spacings, but reduce the number of traverses needed to give a good average value. They provide, for reassurance, an overall check on the adjustment of the instrument.

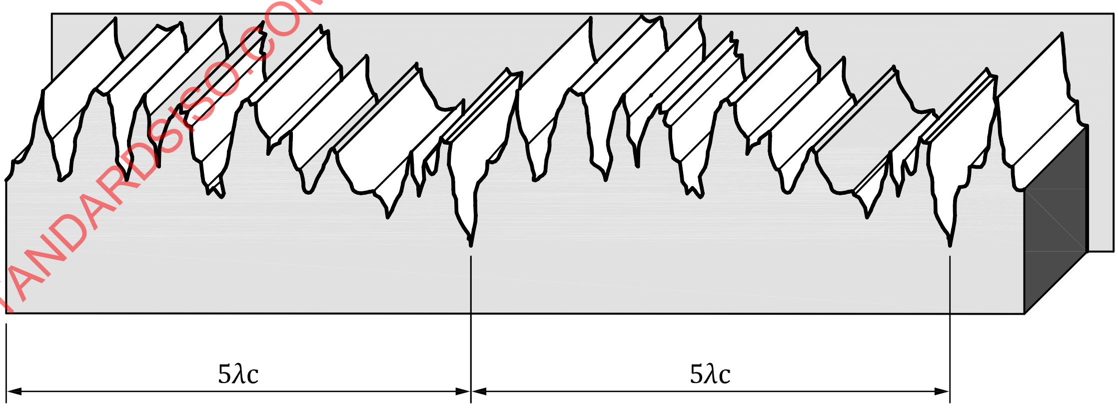


Figure 9 — Irregular profile standard

NOTE According to ISO 5436-1, Figure 9 illustrates a material measure of type D1 (see Annex B).

7.7.2 Measurands

The measurands are Ra and Rz.

7.8 Type PCR: Circular irregular profile

7.8.1 Design characteristics

These circular material measures have irregular profiles in the radial direction, but they have convenience of an approximately constant cross-section along their circumference.

These material measures have irregular profiles which are repeated every 5λc in the radial direction of the material measure. Normal to the measuring direction of the material measure (in the circumferential direction), the profile form is constant (see Figure 10).

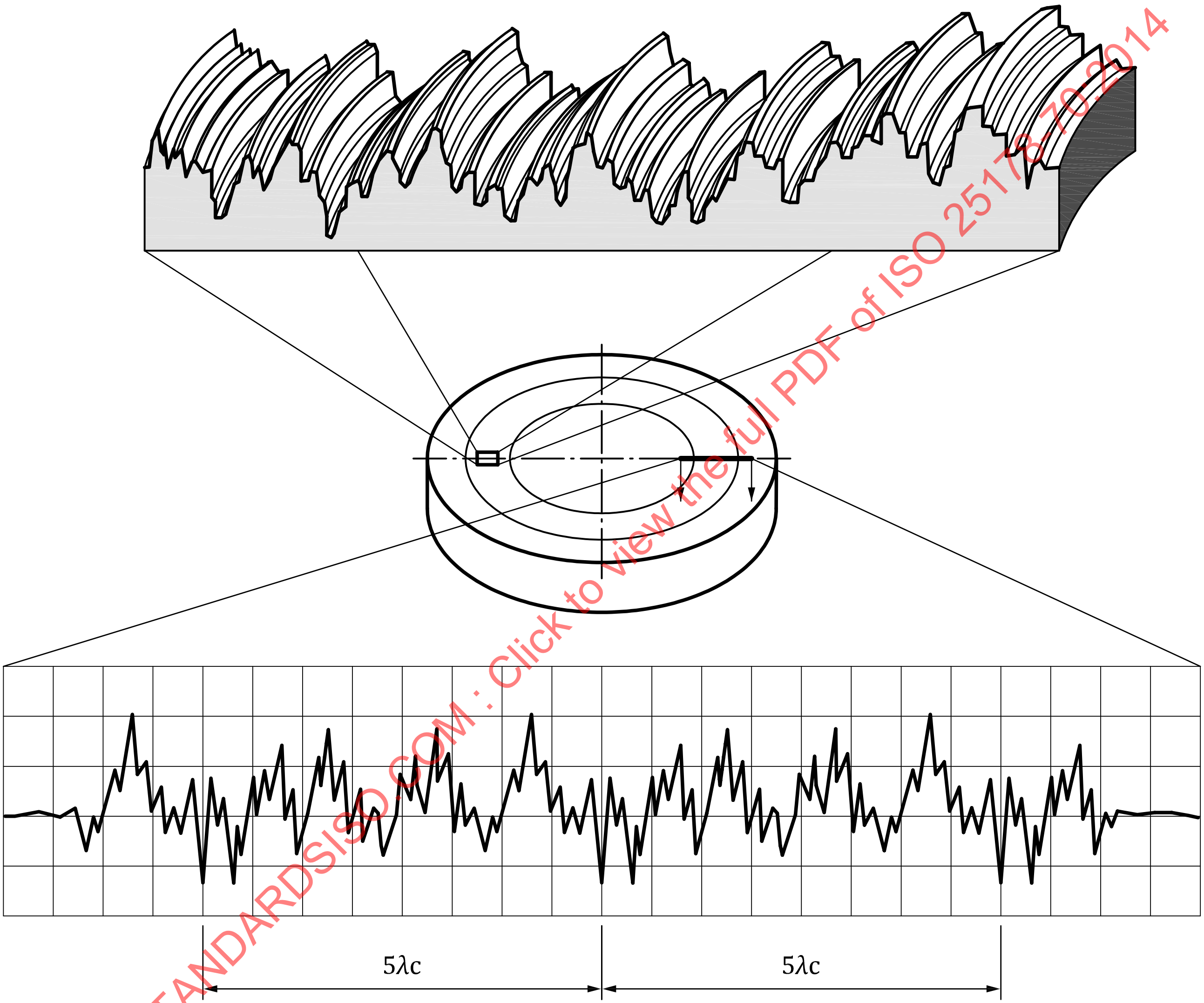


Figure 10 — Circular irregular profile standard

NOTE According to ISO 5436-1, Figure 10 is a material measure of type D2 (see Annex B).

7.8.2 Measurands

The measurands are Ra and Rz.

7.9 Type PRI: Prism

7.9.1 Design characteristics

This material measure consists of a prism with a trapezium cross-section. The base of the trapezium is the longer of the parallel surfaces. The top surface and the two surfaces generated by the sides of the trapezium are the measuring surfaces. The angles of the two side measuring surfaces are designed to cover the range of the probe and to be compatible with the maximum slope that the probe can measure (see Figure 11).

Figure 11 — Precision prism

NOTE According to ISO 5436-1, Figure 11 illustrates a material measure of type E2 (see Annex B).

7.9.2 Measurands

This material measure is characterized by:

— the angles between the faces;

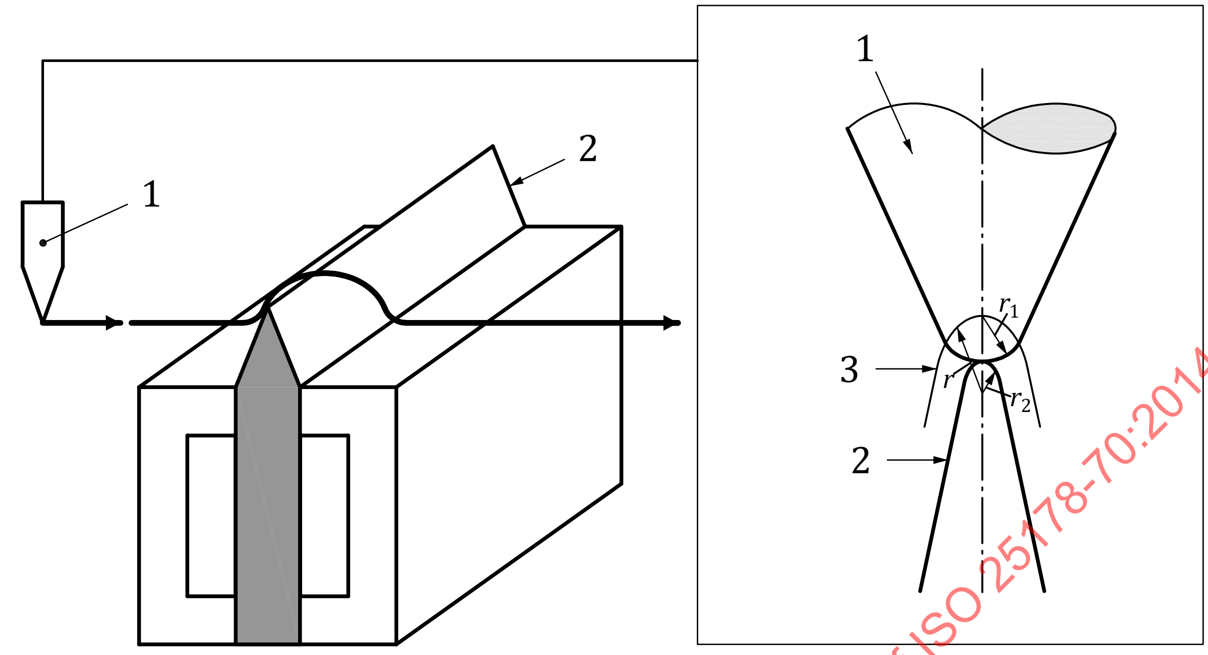
— Pz on each face.

7.10 Type PRB: Razor blade

7.10.1 Design characteristics

This material measure has a fine protruding edge. It is mainly dedicated to evaluate the stylus tip radius of a tactile instrument. Uncoated razor blades, for example, have edge widths of approximately 0,1 µm or less.

NOTE According to ISO 5436-1, Figure 12 illustrates a material measure of type B3 (see Annex B).



Key

1 stylus

2 razor blade

3 recorded profile

NOTE 1 Schematic diagram of razor blade trace for profiling the shape of a stylus tip to determine its radius.

NOTE 2 The output profile essentially represents the stylus tip shape if the radius and apex angle of the razor blade are much finer.

Figure 12 — Use of type PRB material measure

7.10.2 Measurands

The stylus condition may be measured by traversing a sharp protruding edge, such as a razor blade, as shown in Figure 12. If r_1 is the stylus tip radius and r_2 is the radius of the razor blade edge, the recorded profile has a radius $r = r_1 + r_2$. If, in addition, r_2 is much less than r_1, then the recorded radius is approximately equal to the stylus tip radius itself. This method can only be used with direct profile recording instruments with very slow traversing speed capability.

7.11 Type PAS: Approximated sinusoidal shape

7.11.1 Design characteristics

These are simulated sine waves, which include triangular profiles with rounded or truncated peaks and valleys, the total root mean square (r.m.s.) harmonic content of which shall not exceed 10 % of the rms value of the fundamental.

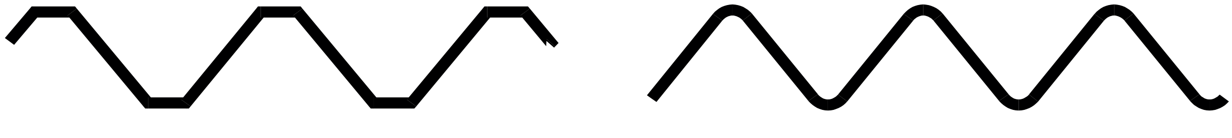


Figure 13 — Type C3 grooves

NOTE According to ISO 5436-1, Figure 13 illustrates a material measure of type C3 (see Annex B).

7.11.2 Measurands

The measurands are RSm and Ra.

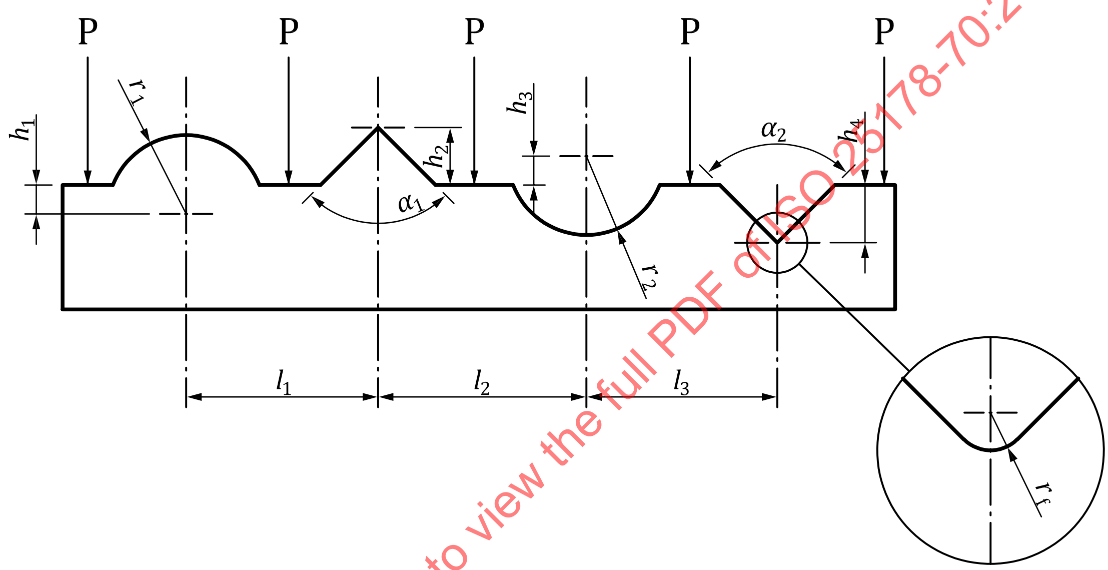
7.12 Type PCS: Contour standard

7.12.1 Design characteristics

This material measure is composed of a profile including different geometrical patterns (see Figure 14):

— at least two arcs of a circle (1 convex, 1 concave);

— at least two wedges/triangles (1 convex, 1 concave).



Key

P reference plane in a common zone with 5 features

r_f groove bottom radius

r_i the radii of the arcs of the circles

α_i the angles between the flanks of the wedges/triangles;

l_i the distances measured in a direction parallel to the plane P between the centres of the circles and/or the intersections of flanks of the triangles with respect to the reference plane;

h_i heights measured in a direction perpendicular to the plane P between the centres of the circles and/or the intersections of the flanks of the triangles

Figure 14 — Contour standard

7.12.2 Measurands

The measurands are:

r_i the radii of the arcs of the circles;

α_i the angles between the flanks of the wedges/triangles;

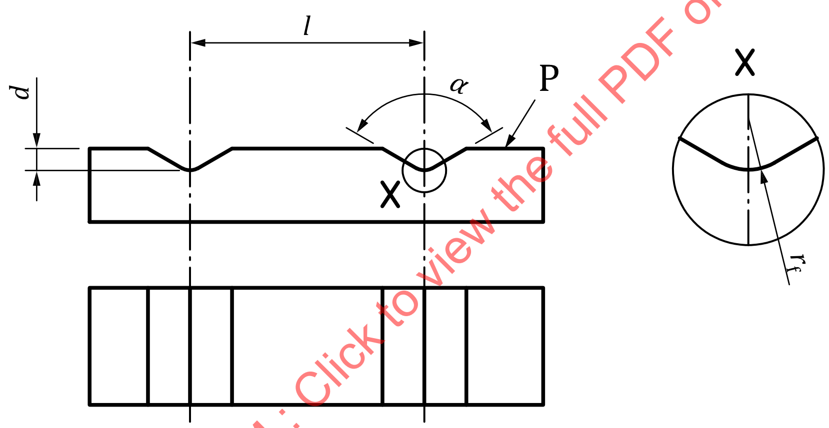
l_i the distances measured in a direction parallel to the plane P between the centres of the circles and/or the intersection of the flanks of the triangles with respect to the reference plane;

h_i heights measured in a direction perpendicular to the plane P between the centres of the circles and/or the intersections of the flanks of the triangles.

7.13 Type PDG: Double groove

7.13.1 Design characteristics

This material measure has two parallel grooves (see Figure 15).



Key

d depth of grooves

l distance between grooves

α angle of the groove flanks

P reference plane

r_f groove bottom radius

Figure 15 — Double groove standard

7.13.2 Measurands

The measurands are:

l the groove spacing;

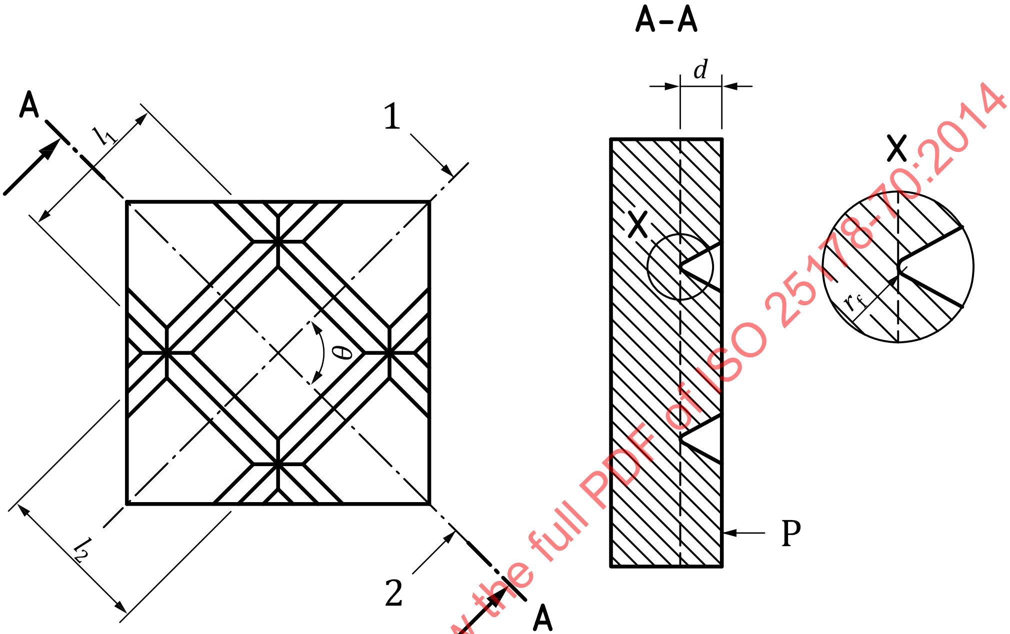
d the depth of the grooves.

8 Areal material measures

8.1 Type AGP: Grooves, perpendicular

8.1.1 Design characteristics

This material measure is composed of four grooves forming a rectangle (see Figure 16).



Key

d depth of grooves

l_1, l_2 groove spacings

1, 2 symmetry lines of parallel grooves

θ angle between the grooves

P reference plane

r_f groove bottom radius

Figure 16 — Areal grooves standard

8.1.2 Measurands

The measurands are:

l_1, l_2 the two spacings between each pair of grooves;

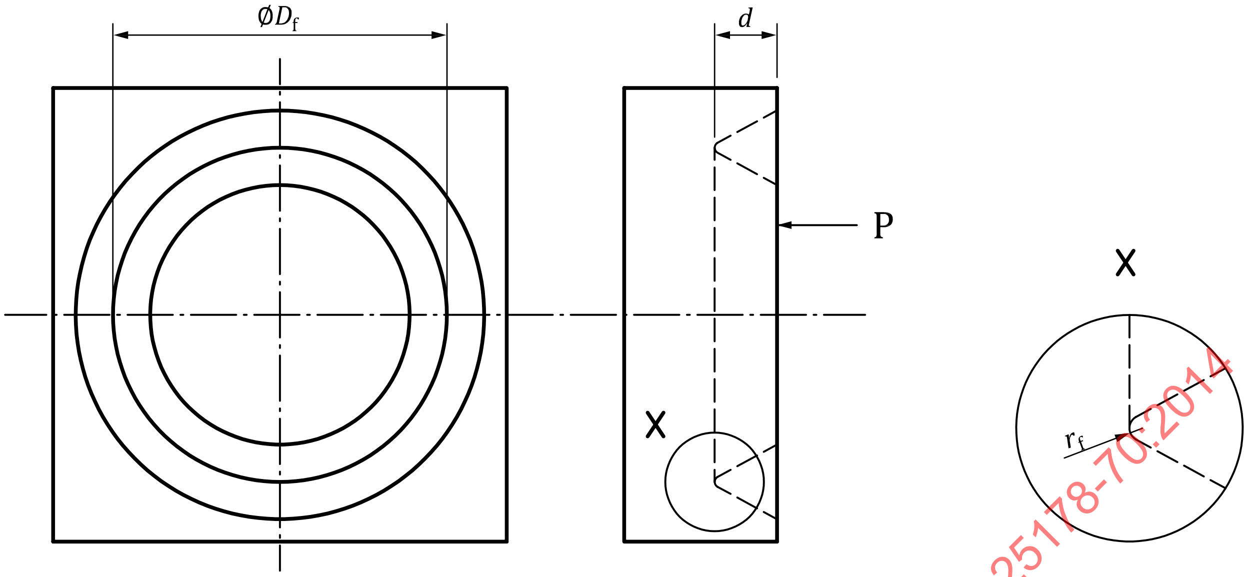
d the depth of the grooves;

θ the angle between the grooves, defined as the angle of intersection of the two median lines of the two sets of parallel grooves (see Figure 16).

8.2 Type AGC: Grooves, circular

8.2.1 Design characteristics

This material measure has a circular groove (see Figure 17).



Key

d depth of the groove

D_f diameter of the groove

P reference plane

r_f groove bottom radius

Figure 17 — Circular groove standard

8.2.2 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 groove.

8.3 Type ASP: Hemisphere

8.3.1 Design characteristics

This material measure consists of a hemisphere.

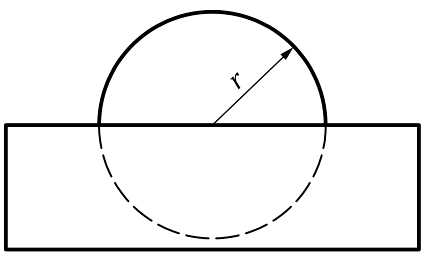


Figure 18 — Hemisphere standard

The radius of the sphere should be sufficient to allow correct measurement with the probe while covering the full measuring range of the probe:

— to allow the spherical portion of a stylus tip to remain in contact (and not any other part of the stylus);

— to allow an optical probe to remain within its operating angle.

NOTE 1 According to ISO 5436-1, Figure 18 illustrates a material measure of type E1 (see Annex B).

NOTE 2 The horizontal plane around the sphere is not part of the material measure.

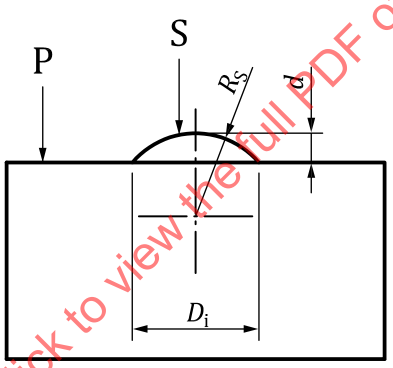
8.3.2 Measurands

The measurand is the radius of the sphere (or hemisphere).

8.4 Type APS: Plane-sphere

8.4.1 Design characteristics

This material measure is composed of a part of a sphere S and a plane P (see Figure 19).



Key

d distance from the top of the sphere to the plane P

S part of a sphere

R_S radius of the sphere

D_i intersection diameter

P reference plane

Figure 19 — Plane-sphere standard

8.4.2 Measurands

The measurands are:

d the largest distance from a point on the sphere to the plane P;

R_S the radius of the sphere;

D_i the diameter of the circle obtained by the intersection between the sphere S and the plane P (see Figure 19), which is a function of the height d and the radius R_S of the sphere, assessed as follows:

$$D_i = 2\sqrt{{R_S}^2 - (R_S - d)^2} \quad (7)$$

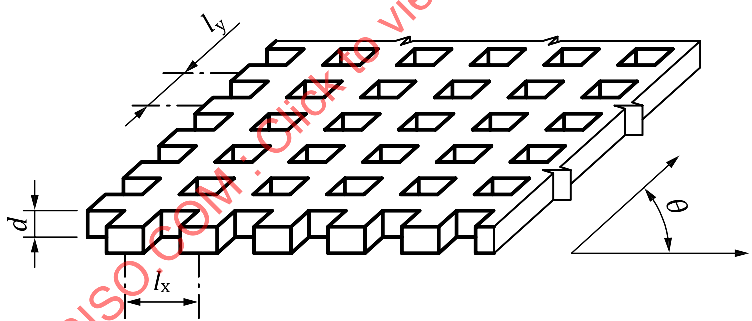
D_x, D_y the diameters along X and along Y, used to calculate amplification coefficients along X and Y.

NOTE The squareness of the X and Y axes can be assessed from the shape of the intersection between the sphere and the plane.

8.5 Type ACG: Cross grating

8.5.1 Design characteristics

The material measure has a two dimensional array pattern that may be made up of raised lines, grooves or dots (see Figure 20). The standard should be marked to identify the X and Y axes. The active area of the standard should be defined, either by reference marks on the standard or in the certificate of calibration of the standard.



Key

1 l_x pitch in the X axis

2 l_y pitch in the Y axis

3 θ, angle between the X and the Y axes

4 d depth of the pits

Figure 20 — Cross grating standard

NOTE Some gratings do not have significant depth and are used only for lateral calibrations, such as spacings and pitches.

8.5.2 Measurands

The measurands are:

- l_x, l_y average pitches in the X and the Y axes over the defined active area of the standard;
- li_x, li_y individual pitches in the X and Y axes, used to calculate linearity deviations;
- θ average angle between the X and the Y axes over the defined active area of the standard;
- D average depth of the flat bottomed pits, over the defined active area of the standard.

8.6 Type ACS: Cross sinusoidal

8.6.1 Design characteristics

This material measure is formed by the addition of a sinusoidal wave along the X axis, defined by its period p_x and its amplitude a_x, and a sinusoidal wave along the Y axis, defined by its period p_y and its amplitude a_y (see Figure 21).

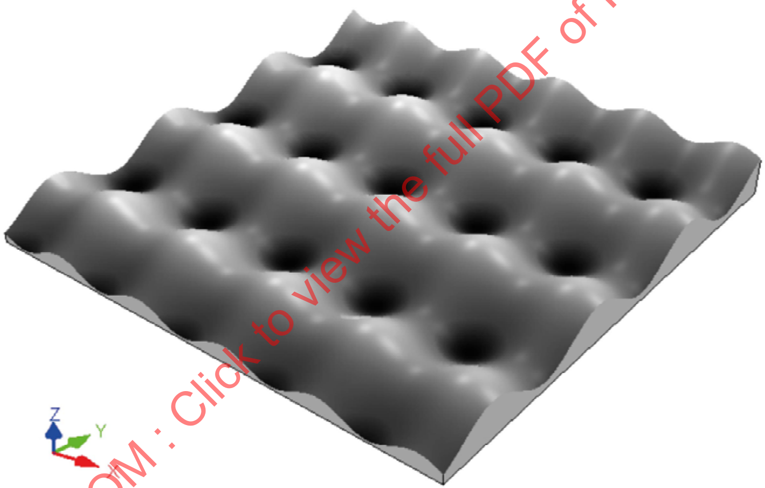


Figure 21 — Cross sinusoidal standard

8.6.2 Measurands

The measurands are:

- Sa arithmetic mean height of the surface;
- Sq root mean square height of the surface.

8.7 Type ARS: Radial sinusoidal

8.7.1 Design characteristics

This material measure is formed by a radial sinusoidal wave (i.e. a cross section in any direction from the centre gives a linear sinusoidal wave), defined by its period p and its amplitude d (see Figure 22).

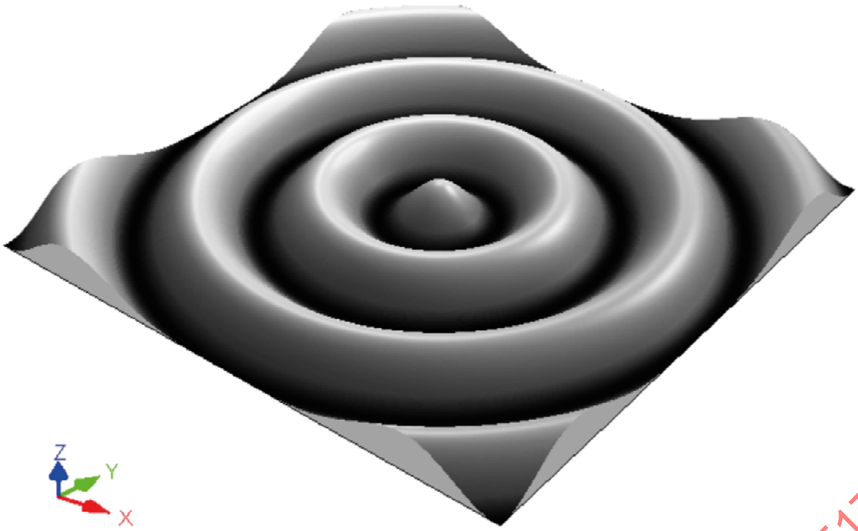


Figure 22 — Radial sinusoidal standard

8.7.2 Measurands

The measurands are:

Sa arithmetic mean height of the surface;

Sq root mean square height of the surface.

8.8 Type ASG: Star-shape grooves

8.8.1 Design characteristics

The standard consists of a number of grooves with triangular cross-section in the X-Y plane with respect to the azimuthal orientation. It is mainly used for verification of the lateral resolution of the instrument.

The grooves radiate from a common centre and become wider as they get further from it (see Figure 23). The grooves have flat bottoms in the X-Y plane and vertical sidewalls orthogonal to the X-Y plane. The angles between two consecutive radial oriented sidewalls are equal.

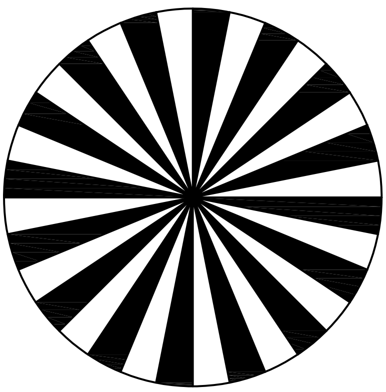


Figure 23 — Star-pattern standard, where dark areas are raised in comparison to light areas

8.8.2 Measurands

The measurand is *d*, depth of profile as function of PSm.

NOTE The measurand is measured on circular profiles that are extracted concentric to apex of the pattern. As the circular profiles are measured closer to the apex, the PSm will change. When the PSm gets close to twice the value of the resolution of the instrument, the depth of the profile will change.

8.9 Type AIR: Irregular

8.9.1 Design characteristics

The surface topography on the material measure consists of a limited range of wavelength components. The surface periodicity or unit sampling area should be defined. The material measure should be marked to identify X and Y axes in order to align them with the coordinate system of the instrument.

The active area should be defined. Sampling areas should contain the same height values regardless of the sampling position (see Figure 24). The surface topography shall be isotropic and its surface texture parameter values such as Sq (or Sa), Sz, Ssk and Sku are to be evaluated.

NOTE Irregular material measures can be realized by using a stochastic maunufacturing process or by controlling the manufacturing process by an autoregressive model (see Annex D).

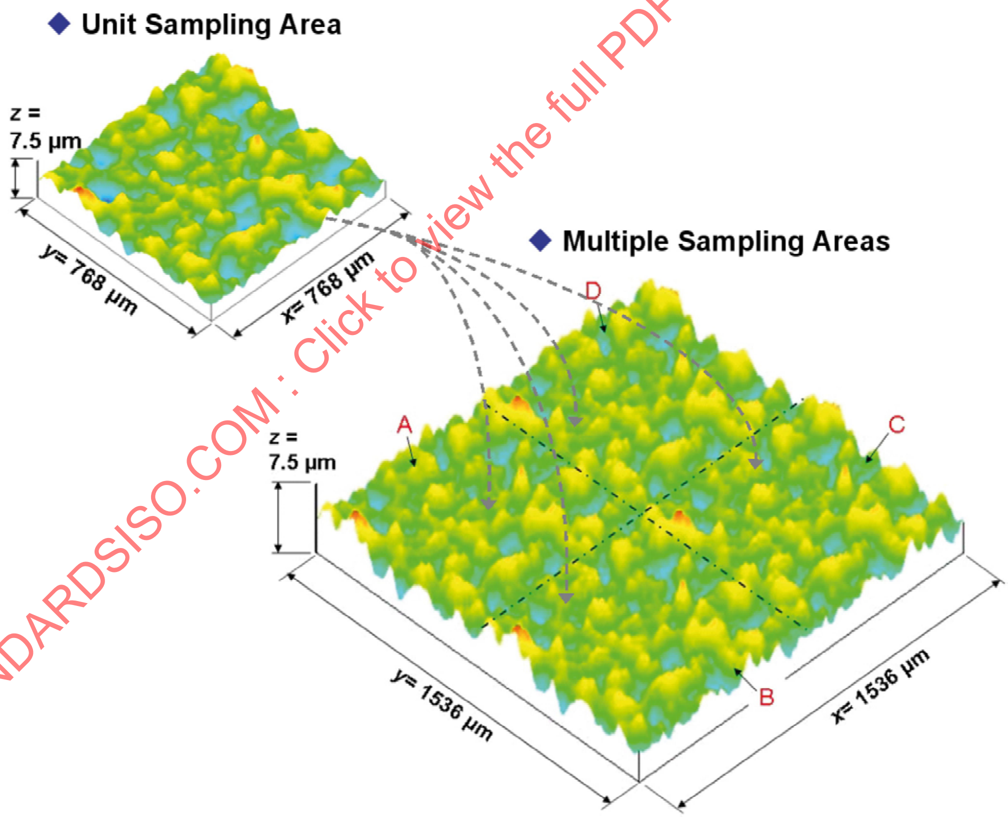


Figure 24 — Areal irregular material measure

8.9.2 Measurands

The measurands are:

Sa arithmetic mean height of the surface;

Sq root mean square height of the surface;

Sz maximum height of the surface;

Ssk skewness of the surface;

Sku kurtosis of the surface.

8.10 Type AFL: Flat plane

8.10.1 Design characteristics

This material measure is a flat plane with negligible form deviation and roughness. It is usually made of polished glass.

8.10.2 Measurands

See Table 7.

Table 7 — Measurand of material measures — Type AFL

	Profile	Areal
Z axis	Pt, Pq, Rq or Rz	Sq or Sz
Z axis	STRt	FLTt

NOTE On a scanning instrument, the flat plane can also be used vertically to assess straightness deviations along X of the Y axis, or straightness deviations along Y of the X axis.

8.11 Type APC: Photochromic pattern

8.11.1 Design characteristics

This type of material measure shall not have height variation but only colour variation. It is aimed at evaluating certain characteristics of optical instruments.

A large variety of patterns can be used and generated. For example, Figure 25 shows a chess board pattern made of back and white (or transparent) squares of size *d*.

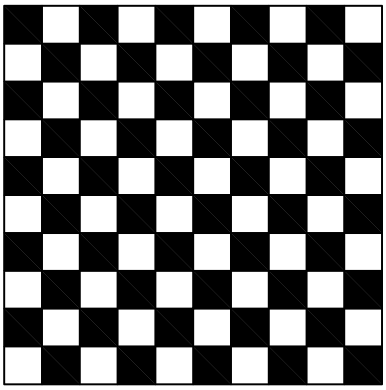


Figure 25 — Chess board pattern

These material measures are intended to be measured using intensity acquisition.

8.11.2 Measurands

The measurands depend on the pattern drawn on the material measure. Users shall refer to the certificate to know which measurand is to be used.

9 Material measure certificate

When a material measure certificate is required, it shall be accompanied by at least the minimum requirements of information for material measures as defined in ISO 10012, ISO/IEC 17025 and, where applicable, the following information:

a) configuration of the calibration equipment ;

b) details of calibration procedure including bases of assessment, the number of measurements taken, position of measurements, filters, etc. ;

c) for each relevant measurand, the mean value with its associated uncertainties (see ISO 14253-2 and ISO/IEC Guide 98-3).

Visible defects that may influence the measurement shall be excluded from measurement.

Annex A
(normative)

Requirements for measurements

A.1 Selection of the area to be measured

The surface of the material measure shall be visually inspected before measurement and a clean area free of defects shall be selected. Local defects or dirt may significantly affect the evaluation of measurands and introduce errors when calibrating or adjusting metrological characteristics.

After the measurement, the profile or surface shall be checked to detect if defects are visible on the measured data although they were not visible with eyes.

A.2 Number of measurements

In order to reduce uncertainty on measured values, it is recommended to proceed to a series of measurements (for example, five measurements) and calculate an averaged value of the measurand. Extreme values that significantly differ from the nominal value shall be investigated to determine the cause and discarded if they are caused by surface imperfections or by other infrequent explainable measurement errors.

Annex B
(informative)

Equivalence table for material measure names

Some of the material measures described in this International standard were also described in existing standards, such as ISO 5436-1 and ISO 25178-701. These are renamed according to Table B.1 which provides equivalences between new names and previous names used in existing standards.

Table B.1 — Naming equivalence

ISO 25178-70:2014	ISO 5436-1:2000	ISO 25178-701:2010
PPS	C1 or B2	–
PPT	B2 or C2	–
PPR		–
PPA	C4 or B2	–
PGR	A1	–
PGC	A2	–
PRO	D1	–
PCR	D2	–
PRI	E2	–
PRB	B3	–
PAS	C3	–
PCS	–	CS
PDG	–	ER1
AGP	–	ER2
AGC	–	ER3
ASP	E1	–
APS	–	ES
ACG	–	CG2
ACS	–	–
ARS	–	–
ASG	–	–
AIR	–	–
AFL	–	–
APC	–	–

Annex C
(informative)

Evaluation of a spacing measurand on an areal instrument

C.1 Introduction

Profile material measures require the evaluation of the spacing between grooves in order to verify or calibrate the lateral amplification coefficient. When measuring these material measures with an areal instrument that produces a surface topography image directly without scanning profiles (such as imaging confocal microscopes), the evaluation of the spacing measurand shall be carried out using one of the methods described below.

C.2 Averaged PSm

From the primary surface:

a) extract a profile from each surface topography;

b) calculate one *PSm* parameter value over the full length of each profile;

c) average determination of all values.

C.3 Dominant wavelength

The Fourier spectrum of the surface measured on a periodic structure will show peaks at a wavelength corresponding to the spacing between these structures (see Figure C.1).

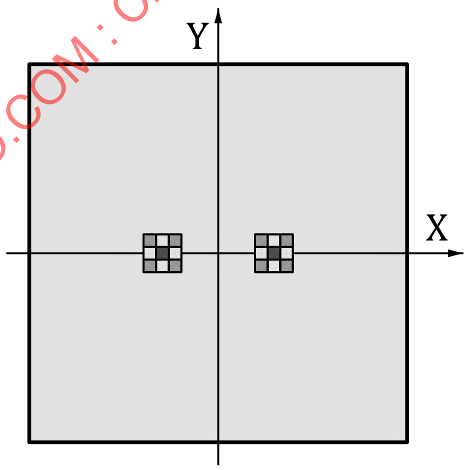


Figure C.1 — Spectrum of a PPS material measure

Where wavelengths are calculated from the X- and Y-positions on the spectrum:

$$\lambda_x = \frac{N_x \Delta_x}{x} \text{ and } \lambda_y = \frac{N_y \Delta_y}{y} \qquad \text{(C.1)}$$

where

N_x and N_y are the number of points of the spectrum;

Δ_x and Δ_y are the spacing values on the measured surface in the same unit as λ_x and λ_y;

x and y are the indices of the wavelength in the spectrum.

When the alignment is not perfect, the peak is spread over a small area around the maximum point. Therefore, it is recommended to calculate a precise position (λ_x, λ_y) using a barycenter calculation of the 3×3 or 5×5 neighbourhood around the maximum peak.

The mean spacing is then calculated by:

$$\lambda_{xy} = \frac{1}{\sqrt{\frac{1}{\lambda_x^2} + \frac{1}{\lambda_y^2}}} \qquad \text{(C.2)}$$

C.4 Spacing between extracted features

A possible evaluation method is detecting line features (see Figure C.2), for example at the crest of each periodic shape, and calculating their mean spacing in the perpendicular direction.

The lines can be detected by finding the maximum point (with an interpolation or not) or using a segmentation method, such as described in ISO 25178-2.

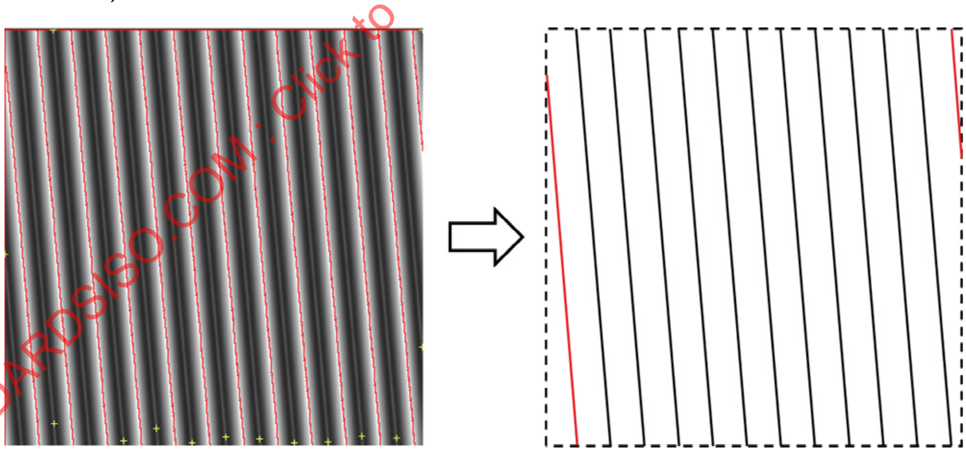


Figure C.2 — Extraction of line features (left) and calculation of their spacing (right)

C.5 Checking alignment

This method is sensitive to the alignment of the material measure.

The material measure shall be aligned so that periodic shapes are perpendicular to the X- or Y-axes of the instrument coordinate system.

A verification of that alignment can be carried out by calculating Std parameter as defined in ISO 25178-2.