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

Part 2: Terms, definitions and surface texture parameters

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

Partie 2: Termes, définitions et paramètres d'états de surface

Reference number
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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.

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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 25178-2 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 70: Physical measurement standards*
- *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 604: Nominal characteristics of non-contact (coherence scanning interferometry) instruments*
- *Part 605: Nominal characteristics of non-contact (point autofocus probe) instruments*
- *Part 701: Calibration and measurement standards for contact (stylus) instruments*

The following parts are under preparation:

- *Part 1: Indication of surface texture*
- *Part 603: Nominal characteristics of non-contact (phase-shifting interferometric microscopy) instruments*

Introduction

This part of ISO 25178 is a geometrical product specification (GPS) standard and is to be regarded as a general GPS standard (see ISO/TR 14638). It influences chain link 2 of the chains of standards on areal surface texture.

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.

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

This part of ISO 25178 develops the terminology, concepts and parameters for areal surface texture.

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

Part 2:
Terms, definitions and surface texture parameters

1 Scope

This part of ISO 25178 specifies terms, definitions and parameters for the determination of surface texture by areal methods.

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/TS 16610-1:2006, *Geometrical product specifications (GPS) — Filtration — Part 1: Overview and basic concepts*

ISO 17450-1:2011, *Geometrical product specifications (GPS) — General concepts — Part 1: Model for geometrical specification and verification*

ISO 25178-3:—[1], *Geometrical product specifications (GPS) — Surface texture: Areal — Part 3: Specification operators*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17450-1 and ISO/TS 16610-1, and the following apply.

3.1 General terms

3.1.1
non-ideal surface model
skin model
<of a workpiece> model of the physical interface of the workpiece with its environment

[ISO 17450-1:2011, 3.2.2]

1) To be published.

3.1.1.1
mechanical surface
boundary of the erosion, by a spherical ball of radius r, of the locus of the centre of an ideal tactile sphere, also with radius r, rolled over the skin model of a workpiece

[ISO 14406:2010, 3.1.1]

3.1.1.2
electromagnetic surface
surface obtained by the electromagnetic interaction with the skin model of a workpiece

[ISO 14406:2010, 3.1.2]

3.1.2
specification coordinate system
system of coordinates in which surface texture parameters are specified

NOTE If the nominal surface is a plane (or portion of a plane), it is common (practice) to use a rectangular coordinate system in which the axes form a right-handed Cartesian set, the X-axis and the Y-axis also lying on the nominal surface, and the Z-axis being in an outward direction (from the material to the surrounding medium). This convention is adopted throughout the rest of this part of ISO 25178.

3.1.3
primary surface
surface portion obtained when a surface portion is represented as a specified primary mathematical model with specified nesting index

[ISO/TS 16610-1:2006, 3.3]

NOTE In this part of ISO 25178, an S-filter is used to derive the primary surface.

3.1.3.1
primary extracted surface
finite set of data points sampled from the primary surface

[ISO 14406:2010, 3.7]

3.1.4
surface filter
filtration operator applied to a surface

NOTE In practice, the filter operator will apply to a primary extracted surface.

3.1.4.1
S-filter
surface filter which removes small scale lateral components from the surface resulting in the primary surface

3.1.4.2
L-filter
surface filter which removes large scale lateral components from the primary surface or S-F surface

3.1.4.3
F-operation
operation which removes form from the primary surface

NOTE 1 Some F-operations (such as association operations) have a very different action to that of filtration. Though their action can limit the larger lateral scales of a surface this action is very fuzzy hence the fuzzy line for the action of the F-operation in Figure 1.

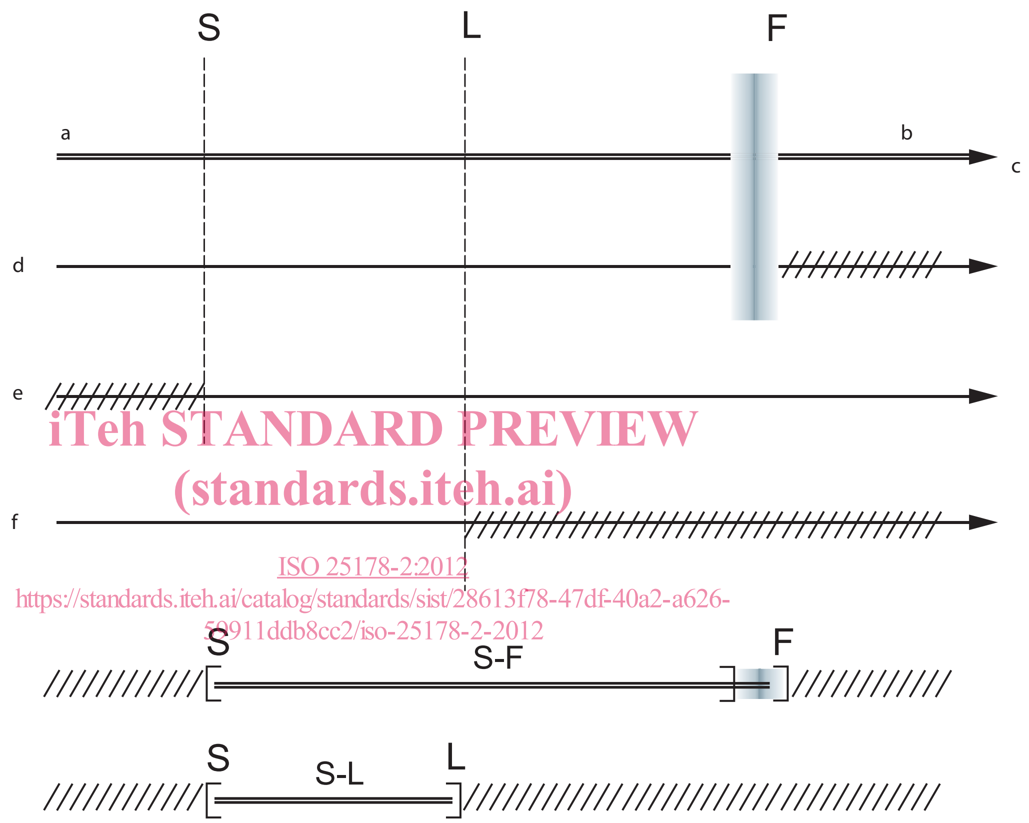
NOTE 2 Many L-filters are sensitive to form and require an F-operation first as a prefilter before being applied.

3.1.5
S-F surface
surface derived from the primary surface by removing the form using an F-operation

NOTE Figure 1 illustrates the relationship between the S-F surface and the S-filter and F-operation.

3.1.6
S-L surface
surface derived from the S-F surface by removing the large scale components using an L-filter

NOTE Figure 1 illustrates the relationship between the S-L surface and the S-filter and L-filter.



a Small scale.
b Large scale.
c Scale axis.
d F-operation.
e S-filter.
f L-filter.

Figure 1 — Relationships between the S-filter, L-filter, F-operation and S-F and S-L surfaces

3.1.7
scale-limited surface
S-F surface or a S-L surface

3.1.8
reference surface
surface associated to the scale-limited surface according to a criterion

NOTE 1 The result is used as a reference surface for surface texture parameters.

NOTE 2 Examples of reference surfaces include plane, cylinder and sphere.

3.1.9
evaluation area
portion of the scale-limited surface for specifying the area under evaluation

NOTE See ISO 25178-3 for more information.

3.1.10
definition area
portion of the evaluation area for defining the parameters characterizing the scale-limited surface

3.2 Geometrical parameter terms

3.2.1
field parameter
parameter defined from all the points on a scale-limited surface

NOTE Field parameters are defined in Clause 4.

3.2.2
feature parameter
parameter defined from a subset of predefined topographic features from the scale-limited surface

NOTE Feature parameters are defined in Clause 5.

3.2.3
V-parameter
material volume or void volume field or feature parameter

3.2.4
S-parameter
field or feature parameter that is not a V-parameter

3.2.5
height
signed normal distance from the reference surface to the scale-limited surface

NOTE 1 The distance is defined normal to the reference surface.

NOTE 2 The height is negative, if from the reference surface the point lies in the direction of the material.

3.2.6
ordinate value
$z(x,y)$
height of the scale-limited surface at position x,y

NOTE The coordinate system is based on the reference surface.

3.2.7
local gradient vector
$\left(\frac{\partial z}{\partial x}, \frac{\partial z}{\partial y}\right)$
gradient of the scale-limited surface at position x,y

NOTE For specific implementation, see ISO 25178-3.

3.2.8
autocorrelation function
$f_{\text{ACF}}(t_x,t_y)$
function which describes the correlation between a surface and the same surface translated by (t_x,t_y)

$$f_{\mathrm{ACF}}\left(t_x,t_y\right)=\frac{\iint\limits_A z(x,y)z(x-t_x,y-t_y)\mathrm{d}x\mathrm{d}y}{\iint\limits_A z(x,y)z(x,y)\mathrm{d}x\mathrm{d}y}$$

with A being the definition area

3.2.9
Fourier transformation
$F(p,q)$
operator which transforms the scale-limited surface into Fourier space

$$F(p,q)=\iint\limits_A z(x,y)\mathrm{e}^{-(ipx+iqy)}\mathrm{d}x\mathrm{d}y$$

with A being the definition area

3.2.9.1
angular spectrum
$f_{\mathrm{APS}}(s)$
power spectrum for a given direction, with respect to a specified direction θ in the plane of the definition area

$$f_{\mathrm{APS}}(s)=\int\limits_{R_2}^{R_1} r\left|F\left[r\sin(s-\theta),r\cos(s-\theta)\right]\right|^2\mathrm{d}r$$

where R_1 to R_2 is the range of integration in the radial direction and s the specified direction

NOTE 1 The positive x-axis is defined as the zero angle.

NOTE 2 The angle is positive in an anticlockwise direction from the x-axis.

3.3 Geometrical feature terms

3.3.1
peak
point on the surface which is higher than all other points within a neighbourhood of that point

NOTE 1 For discrete data, a triangulization of the surface is necessary.

NOTE 2 There is a theoretical possibility of a plateau. In practice, this can be avoided by the use of an infinitesimal tilt.

NOTE 3 For specific implementation, see ISO 25178-3.

3.3.1.1
hill
region around a peak such that all maximal upward paths end at the peak

3.3.1.2
course line
curve separating adjacent hills

3.3.2
pit
point on the surface which is lower than all other points within a neighbourhood of that point

NOTE 1 For discrete data, a triangulization of the surface is necessary.

NOTE 2 There is a theoretical possibility of a plateau. In practice, this can be avoided by the use of an infinitesimal tilt.

NOTE 3 For specific implementation, see ISO 25178-3.

3.3.2.1
dale
region around a pit such that all maximal downward paths end at the pit

NOTE An areal motif is a dale; see ISO 12085.

3.3.2.2
ridge line
curve separating adjacent dales

3.3.3
saddle
set of points on the scale-limited surface where ridge lines and course lines cross

3.3.3.1
saddle point
saddle consisting of one point

3.3.4
topographic feature
areal, line or point feature on a scale-limited surface

3.3.4.1
areal feature
hill or dale

3.3.4.2
line feature
course line or ridge line

3.3.4.3
point feature
peak, pit or saddle point

3.3.5
contour line
line on the surface consisting of points of equal height

3.3.6
segmentation
method which partitions a scale-limited surface into distinct regions

3.3.6.1
segmentation function
function which splits a set of "events" into two distinct sets called the significant events and the insignificant events and which satisfies the three segmentation properties

NOTE 1 Examples of events are: ordinate values, point features, etc.

NOTE 2 A full mathematical description of the segmentation function and the three segmentation properties can be found in Scott (2004) (see Reference [16]).

NOTE 3 The mathematical treatment of the segmentation function and segmentation properties will be transferred to a future ISO 16610 series document on segmentation.

3.3.6.2
first segmentation property
P1
property where each event is allocated to the set of significant events or the set of insignificant events but not both

$$\text{P1}: \forall A \subseteq E, \ \Psi(A) \cup \Phi(A) = A \ \wedge \ \Psi(A) \cap \Phi(A) = \varnothing$$

where

E is the set of all events;

$\Psi(.)$ maps events onto the set of significant events;

$\Phi(.)$ maps events onto the set of insignificant events

3.3.6.3
second segmentation property
P2
property where if a significant event is removed from the set of events then the remaining significant events are contained in the new set of significant events

$$\text{P2}: \forall A \subseteq B \subseteq E, \quad \Phi(A) \subseteq \Phi(B)$$

where

E is the set of all events;

$\Phi(.)$ maps events onto the set of insignificant events

3.3.6.4
third segmentation property
P3
property where if an insignificant event is removed from the set of events then the same set of significant events is obtained

$$\text{P3}: \forall A \subseteq B \subseteq E, \quad \Psi(B) \subseteq A \Rightarrow \Psi(A) = \Psi(B)$$

where

E is the set of all events;

$\Psi(.)$ maps events onto the set of significant events

3.3.7
change tree
graph where each contour line is plotted as a point against height in such a way that adjacent contour lines are adjacent points on the graph

NOTE Peaks and pits are represented on a change tree by the end of lines. Saddle points are represented on a change tree by joining lines. See Annex A for more details concerning change trees.

3.3.7.1
pruning
method to simplify a change tree in which lines from peaks (or pits) to their nearest connected saddle points are removed

3.3.7.2
local peak height
difference between the height of a peak and the height of the nearest connected saddle on the change tree

3.3.7.3
local pit height
difference between the height of the nearest connected saddle on the change tree and the height of a pit

3.3.7.4
Wolf pruning
pruning where lines are removed in order from the peak/pit with the smallest local peak/pit height up to the peak/pit with a specified local peak/pit height

NOTE The local peak/pit heights will change during Wolf pruning as removing lines from a change tree will also remove the associated saddle point.

3.3.8
Wolf peak height
minimum threshold at which a peak is pruned using Wolf pruning

3.3.9
Wolf pit height
minimum threshold at which a pit is pruned using Wolf pruning

3.3.10
peak height
height of the peak

3.3.11
pit height
height of the pit

3.3.12
height discrimination
minimum Wolf peak height or Wolf pit height of the scale-limited surface which should be taken into account

NOTE The height discrimination is usually specified as a percentage of Sz (4.1.6).

4 Field parameter definitions

In the terminological entries below, 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. 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 in product documentation, drawings and data sheets.

4.1 Height parameters

All height parameters are defined over the definition area.

4.1.1
root mean square height of the scale-limited surface
Sq
S_{q}
root mean square value of the ordinate values within a definition area (A)

$$S_q = \sqrt{\frac{1}{A}\iint_A z^2(x,y)\mathrm{d}x\mathrm{d}y}$$

4.1.2
skewness of the scale-limited surface
Ssk
S_{sk}
quotient of the mean cube value of the ordinate values and the cube of Sq within a definition area (A)

$$S_{sk} = \frac{1}{S_q^3}\left[\frac{1}{A}\iint_A z^3(x,y)\mathrm{d}x\mathrm{d}y\right]$$

4.1.3
kurtosis of the scale-limited surface
Sku
S_{ku}
quotient of the mean quartic value of the ordinate values and the fourth power of Sq within a definition area (A)

$$S_{ku} = \frac{1}{S_q^4}\left[\frac{1}{A}\iint_A z^4(x,y)\mathrm{d}x\mathrm{d}y\right]$$

4.1.4
maximum peak height of the scale limited surface
Sp
S_p
largest peak height value within a definition area

4.1.5
maximum pit height of the scale limited surface
Sv
S_v
minus the smallest pit height value within a definition area

4.1.6
maximum height of the scale-limited surface
Sz
S_z
sum of the maximum peak height value and the maximum pit height value within a definition area

4.1.7
arithmetical mean height of the scale limited surface
Sa
S_a
arithmetic mean of the absolute of the ordinate values within a definition area (A)

$$S_a = \frac{1}{A}\iint_A |z(x,y)|\ \mathrm{d}x\mathrm{d}y$$

4.2 Spatial parameters

All spatial parameters are defined over the definition area.

