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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

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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 (see 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 World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

This second edition cancels and replaces the first edition (ISO 25178-2:2012), which has been technically revised.

The main changes compared to the previous edition are described in Annex F.

A list of all parts in the ISO 25178 series can be found on the ISO website.

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 14638). It influences the chain link B of the chains of standards on profile and areal surface texture.

The ISO/GPS matrix model given in ISO 14638 gives an overview of the ISO/GPS system of which this part of ISO 25178 is a part. The fundamental rules of ISO/GPS given in ISO 8015 apply to this part of ISO 25178 and the default decision rules given in ISO 14253-1 apply to the specifications made in accordance with this part of ISO 25178, unless otherwise indicated.

For more detailed information of the relation of this part of ISO 25178 to other standards and the GPS matrix model, see Annex F.

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 defines terms, definitions and parameters for the determination of surface texture by areal methods.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 16610-1:2015, *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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17450-1:2011 and ISO 16610-1:2015, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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

[SOURCE: ISO 17450-1:2011, 3.2.2]

3.1.2
surface texture
<areal> geometrical irregularities contained in a scale-limited surface

Note 1 to entry: Surface texture does not include those geometrical irregularities contributing to the form or shape of the surface.

3.1.3
mechanical surface
boundary of the erosion, by a sphere 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

[SOURCE: ISO 14406:2010, 3.1.1]

3.1.3.1
electromagnetic surface
surface obtained by the electromagnetic interaction with the skin model of a workpiece

[SOURCE: ISO 14406:2010, 3.1.2]

3.1.3.2
auxiliary surface
surface obtained by an arbitrary external source

Note 1 to entry: A software measurement standard is an example for an auxiliary surface. Other physical measurement principles which differ from a mechanical or electromagnetic surface, such as tunnelling microscopy or atomic force microscopy, can also serve as an auxiliary surface. See Figure 1.

3.1.4
specification coordinate system
system of coordinates in which surface texture parameters are specified

Note 1 to entry: If the nominal form of the 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.

3.1.5
primary surface
surface portion obtained when a surface portion is represented as a specified primary mathematical model with specified nesting index

[SOURCE: ISO 16610-1:2015, 3.3]

Note 1 to entry: In this part of ISO 25178, an S-filter is used to derive the primary surface. See Figure 1.

3.1.5.1
primary extracted surface
finite set of data points sampled from the primary surface

[SOURCE: ISO 14406:2010, 3.7]

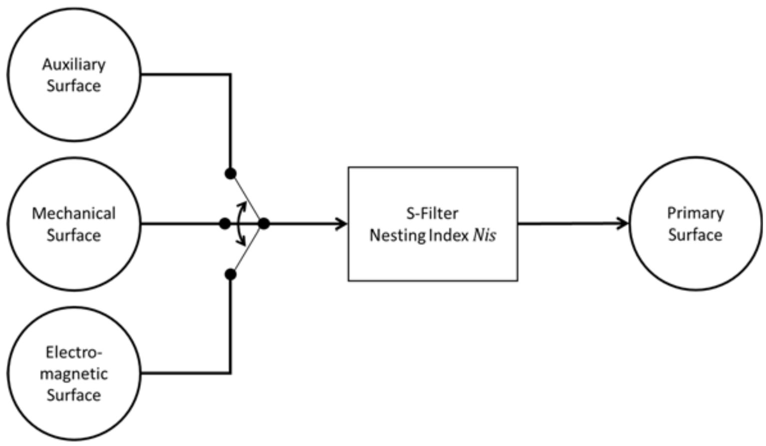


Figure 1 – Definition of primary surface

3.1.6
surface filter
filtration operator applied to a surface

3.1.6.1
S-filter
surface filter which removes small scale lateral components from the surface, resulting in the primary surface

3.1.6.2
L-filter
surface filter which removes large scale lateral components from the primary surface or S-F surface

Note 1 to entry: When the L-Filter is not tolerant to form, it must be applied on an S-F surface; when it is tolerant to form, it can be applied either on the primary surface or on an S-F surface.

3.1.6.3
F-operation
operation which removes form from the primary surface

Note 1 to entry: 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. It is represented in Figure 2 using the same convention as for a filter.

Note 2 to entry: Some L-filters are not tolerant to form and require an F-operation first as a prefilter before being applied.

3.1.6.4
nesting index
Nis, Nic, Nif
number or set of numbers indicating the relative level of nesting for a particular primary mathematical model

[SOURCE: ISO 16610-1:2015, 3.2.1]

3.1.7
S-F surface
surface derived from the primary surface by removing the form using an F-operation

Note 1 to entry: Figure 2 illustrates the relationship between the S-F surface and the S-filter and F-operation.

Note 2 to entry: If filtered with *Nis* nesting index to remove the shortest wavelengths from the surface, the surface is equivalent to a “Primary S-F surface”. In that case, *Nis* is the areal equivalent of the λs cut-off (see f in Figure 2).

Note 3 to entry: If filtered with *Nic* nesting index to separate longer from shorter wavelengths, the surface is equivalent to a “Waviness S-F surface”. In that case, *Nic* is the areal equivalent of the λc cut-off (see g in Figure 2).

Note 4 to entry: The concepts of “roughness” or “waviness” are less important in areal surface texture than in profile surface texture. Some surfaces could exhibit roughness in one direction and waviness in the perpendicular direction. That is why the concepts of S-L surface and S-F surface are preferred in this document.

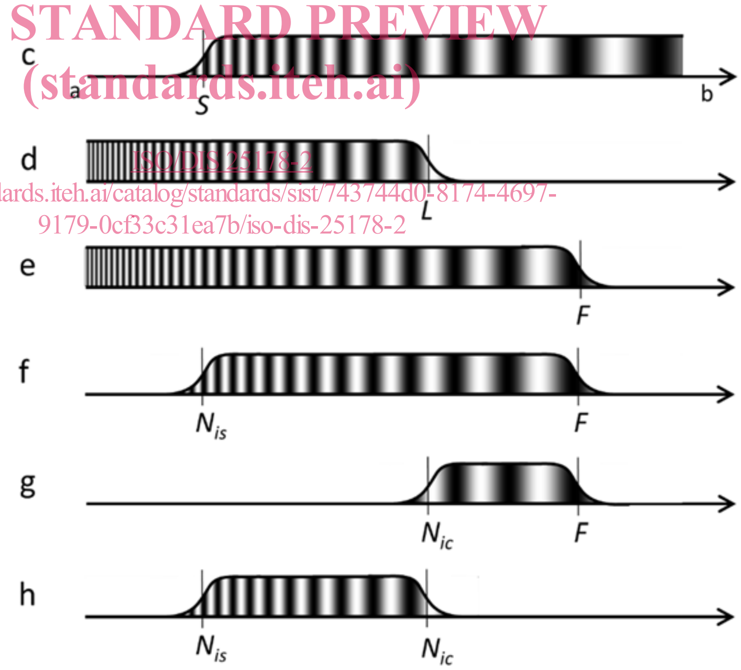
3.1.8
S-L surface

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

Note 1 to entry: Figure 2 illustrates the relationship between the S-L surface and the S-filter and L-filter.

Note 2 to entry: If the S-Filter nesting index *Nis* is chosen to remove the shortest wavelengths from the surface and the L-Filter nesting index *Nic* is chosen in order to separate longer from shorter wavelengths, the surface is equivalent to a “Roughness S-L surface”. See *h* in Figure 2.

Note 3 to entry: A series of S-L surfaces can be generated with narrow bandwidth using a S-Filter and a L-Filter of close nesting indices (or equal), in order to achieve a multi-scale exploration of the surface. See Figure 3.



a Small scale

b Large scale

c S-Filter

d L-Filter

e F-Operation

f S-F surface

g S-F surface (see note 3 of 3.1.7)

h S-L surface (see note 2 of 3.1.8)

Figure 2 — Relationships between the S-filter, L-filter, F-operation and S-F and S-L surfaces

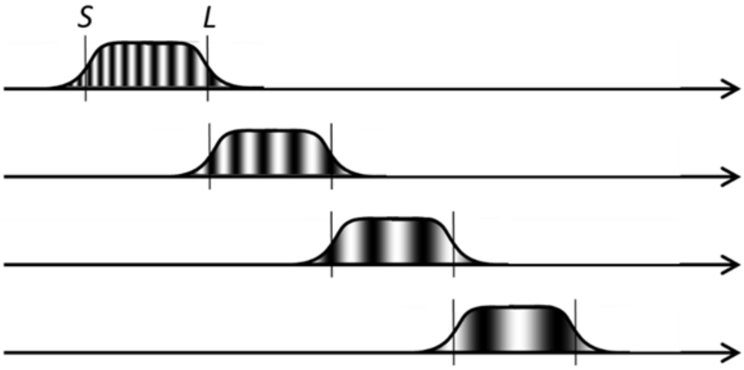


Figure 3 — Example of bandpass filters used to generate a bank of S-L surfaces

3.1.9
scale-limited surface
S-F surface or S-L surface

3.1.10
reference surface
surface associated to the scale-limited surface according to a criterion

Note 1 to entry: This reference surface is used for surface texture parameters.

Note 2 to entry: Examples of reference surfaces include plane, cylinder and sphere.

3.1.11
evaluation area
portion of the scale-limited surface for specifying the area under evaluation

Note 1 to entry: See ISO 25178-3 for more information.

3.1.12
definition area
portion of the evaluation area for defining the parameters characterizing the scale-limited surface

Note1 to entry: Throughout this document, the symbol A is used for the numerical value of the definition area and the symbol $\tilde{A}$ for the domain of integration.

3.2 Geometrical parameter terms

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

Note 1 to entry: 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 1 to entry: Feature parameters are defined in Clause 5.

Note 2 to entry: The parameters Sp, Sv and Sz correspond to the definition of feature parameters but for historical reasons they are considered as field parameters.

3.2.3
V-parameter
material volume or void volume field parameter

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

3.2.5
height
ordinate value
$z(x,y)$
signed normal distance from the reference surface to the scale-limited surface

Note1 to entry: Throughout this document, the term "height" is either used for a distance or for an absolute coordinate. Example: Sz, maximum height, is a distance, and Sp, maximum peak height, is an absolute height.

3.2.5.1
depth
opposite value of height.

3.2.6
local gradient vector
$\left(\frac{\partial z(x,y)}{\partial x}, \frac{\partial z(x,y)}{\partial y}\right)$
first derivative along x and along y of the scale-limited surface at position x,y

Note 1 to entry: See Annex E for implementation details.

3.2.7
local mean curvature
arithmetic mean of the principal curvatures at position x,y

Note 1 to entry: Principal curvatures are two numbers, k_1 and k_2 representing the maximum and minimum curvatures at a point. The local mean curvature is therefore: $\frac{k_1+k_2}{2}$.

Note 2 to entry: See Annex E for implementation details.

3.2.8
material ratio
ratio of the area of the surface portion intersected by a plane at height c, to the evaluation area

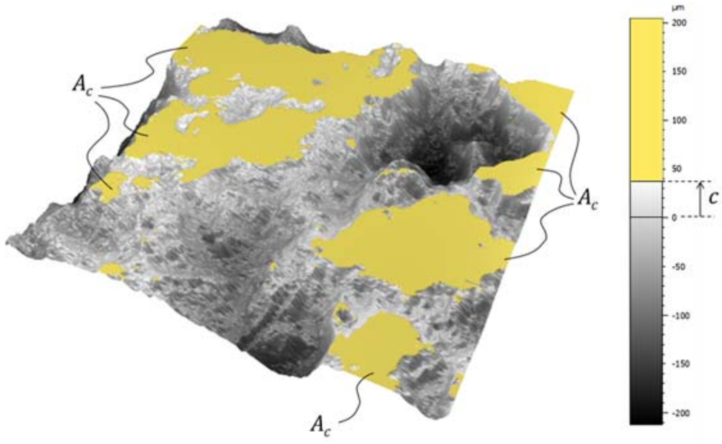
$$M_r(c) = \frac{A_c(c)}{A}$$

Note 1 to entry: The curve representing material ratio as a function of height is also called Abbott Firestone curve.

Note 2 to entry: The material ratio may be given in percentage or value between 0 and 1

Note 3 to entry: See Figure 4.

Note 4 to entry: See Annex E for the determination of the material ratio curve.



Key

c intersecting height *c*

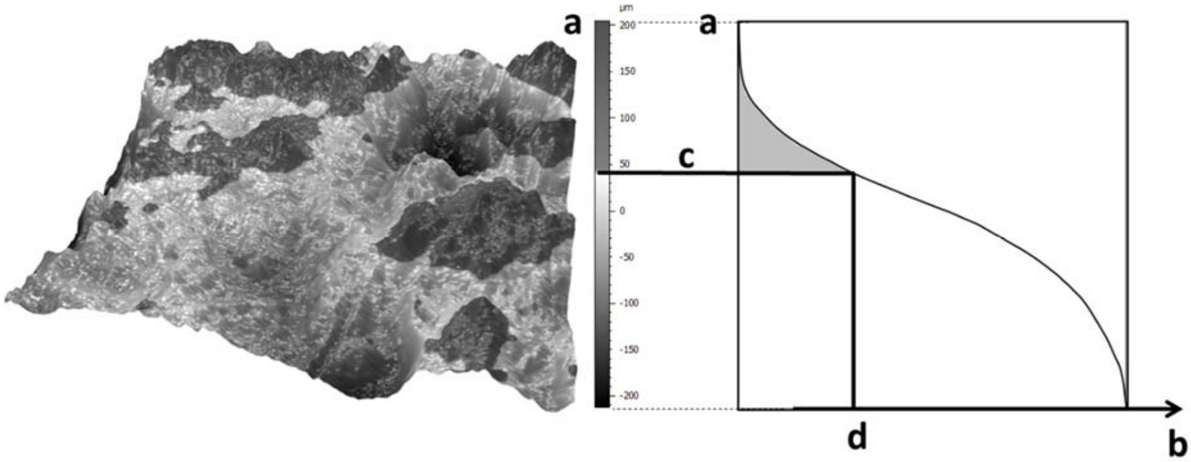
A_c areal portions intersected by plane at level c

Figure 4 — Area of the surface portion intersected by plane at level c

3.2.9
material ratio curve
material ratio function
function representing the areal material ratio of the scale-limited surface as a function of height

Note 1 to entry: This function can be interpreted as the sample cumulative probability function of the ordinates $z(x,y)$ within the evaluation area. See Annex E.

Note 2 to entry: See Figure 5.



Key

a height

b material ratio in percent

c intersection level of height c

d material ratio at height c

Figure 5 — Material ratio curve

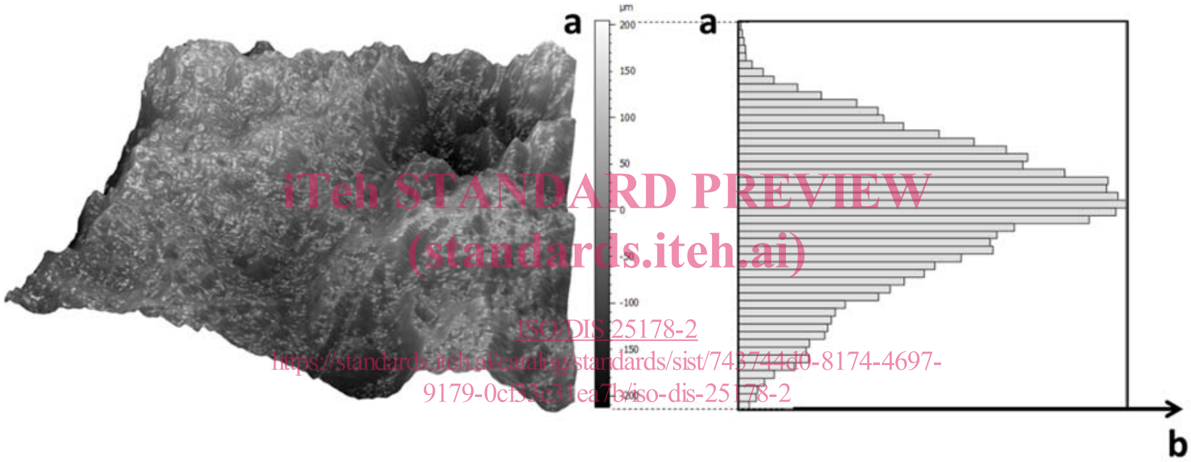
3.2.10
inverse material ratio
$C(m_r)$
height at which a given material ratio m_r in percent is satisfied

$$C(m_r) = M_r^{-1}(m_r)$$

3.2.11
height density curve
height density function
$h(c)$
curve representing the density of the height of the scale-limited profile z in percent

$$h(c) = \frac{dM_r(c)}{dc}$$

Note 1to entry: See Figure 6.



Key
a height
b density in percent

Figure 6 — Height density curve

3.2.12
autocorrelation function
$f_{ACF}(t_x, t_y)$
function which describes the correlation between a surface and the same surface translated by (t_x, t_y)

$$f_{ACF}(t_x, t_y) = \frac{\iint_{\tilde{B}} z(x,y)z(x + t_x, y + t_y)dxdy}{\iint_{\tilde{B}} z^2(x,y)dxdy}$$

B being the intersecting area of the two surfaces at shifts t_x and t_y

3.2.13
Fourier transformation
F(*p*, *q*)
operator which transforms the height ordinate values of the scale-limited surface into Fourier space

$$F(p,q) = \iint_{\tilde{A}} z(x,y)e^{-(ipx+iqy)}dxdy$$

Note 1 to entry: The Fourier transformation defined here is using a limited support *A*, therefore it is an approximation of the mathematical function called Fourier transformation which has an infinite support.

3.2.13.1
angular spectrum
F(*r*, *s*)
Fourier transformation expressed in polar coordinates, with respect to a reference direction θ_{ref} in the plane of the definition area

$$F(r,s) = F\left(r\ \cos\left(s-\theta_{ref}\right), r\ \sin\left(s-\theta_{ref}\right)\right)$$

where *r* is a spatial frequency, *s* the specified direction and *F* is the Fourier transformation function

Note 1 to entry: The positive x-axis is defined as the zero angle.

Note 2 to entry: The angle is positive in an anticlockwise direction from the x-axis.

3.2.13.2
angular amplitude density
angular amplitude distribution

$f_{\mathrm{AAD}}(s)$
integrated amplitude of the angular spectrum for a given direction s

$$f_{AAD}(s) = \int_{R_1}^{R_2} |F(r,s)| r\, dr$$

where *r* is a spatial frequency, R_1 to R_2 ($R_1 < R_2$) is the range of integration of the frequencies in the radial direction and *s* the specified direction and *F* is the Fourier transformation function

Note 1 to entry: the term “density” refers to the value at a given angle, and the term “distribution” refers to the graph representing the values for all angles.

3.2.13.3
angular power density
angular power distribution
$f_{\mathrm{APD}}(s)$
integrated squared amplitude of the angular spectrum for a given direction s

$$f_{APD}(s) = \int_{R_1}^{R_2} |F(r,s)|^2\, r\, dr$$

where *r* is a spatial frequency, R_1 to R_2 ($R_1 < R_2$) is the range of integration of the frequencies in the radial direction and *s* the specified direction and *F* is the Fourier transformation function

Note 1 to entry: the term “density” refers to the value at a given angle, and the term “distribution” refers to the graph representing the values for all angles.