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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.

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 of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 290, *Dimensional and geometrical product specification and verification,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 25178-2:2012), which has been technically revised. The main changes to the previous edition are described in Annex E.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document 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 areal surface texture.

The ISO/GPS matrix model given in ISO 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 the specifications made in accordance with this document, unless otherwise indicated.

For more detailed information of the relation of this document to other standards and the GPS matrix model, see Annex I. An overview of standards on profiles and areal surface texture is given in Annex H.

This document develops the terminology, concepts and parameters for areal surface texture.

Throughout this document, parameters are written as abbreviations with lower-case suffixes (as in Sq or Vmp) when used in a sentence and are written as symbols with subscripts (as in S_q or V_{mp}) when used in formulae, to avoid misinterpretations of compound letters as an indication of multiplication between quantities in formulae. The parameters in lower case are used in product documentation, drawings and data sheets.

Parameters are calculated from coordinates defined in the specification coordinate system, or from derived quantities (e.g. gradient, curvature).

Parameters are defined for the continuous case, but in verification they are calculated on discrete surfaces such as the primary extracted surface.

A short history of the work done on areal surface texture can be found in Annex C.

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

Part 2: Terms, definitions and surface texture parameters

1 Scope

This document specifies 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 16610-1:2015 and ISO 17450-1:2011 and the following apply.

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

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

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

3.1 General terms

3.1.1
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* (3.1.9)

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

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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* (3.1.1) of a workpiece

[SOURCE: ISO 14406:2010, 3.1.1, modified — Notes to entry removed.]

3.1.3.1
electromagnetic surface
surface obtained by the electromagnetic interaction with the *skin model* (3.1.1) of a workpiece

[SOURCE: ISO 14406:2010, 3.1.2, modified — Notes to entry removed.]

3.1.3.2
auxiliary surface
surface, other than mechanical or electromagnetic, obtained by an interaction with the *skin model* (3.1.1) of a workpiece

Note 1 to entry: A mathematical surface (softgauge) is an example of an auxiliary surface.

Note 2 to entry: Other physical measurement principles, such as tunnelling microscopy or atomic force microscopy, can also serve as an auxiliary surface. See Figure 1 and Annex G.

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 document.

3.1.5
primary surface
surface portion obtained when a surface portion is represented as a specified primary mathematical model with specified *nesting index* (3.1.6.4)

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

[SOURCE: ISO 16610-1:2015, 3.3, modified — Note 1 to entry added.]

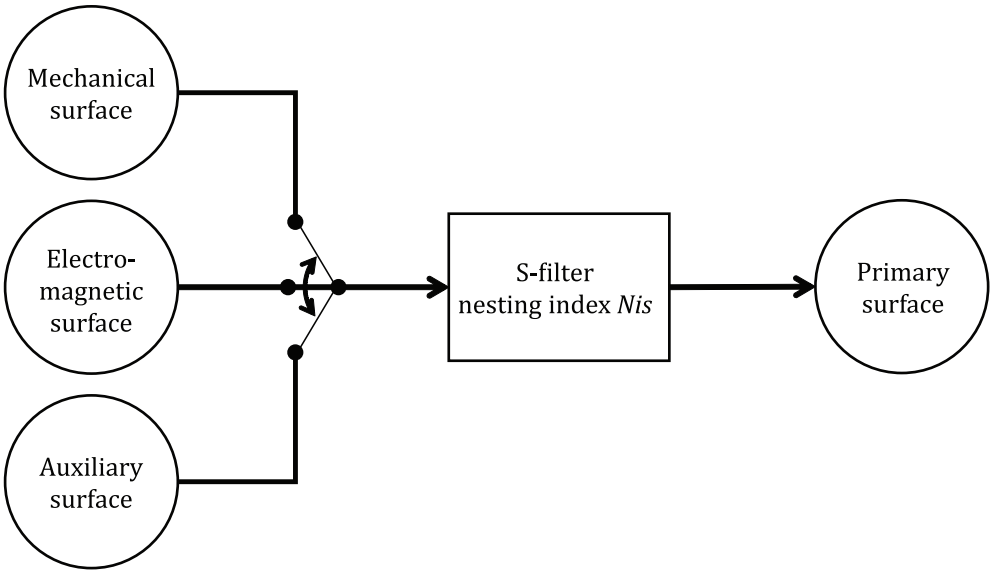

Figure 1 — Definition of primary surface

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3.1.5.1
primary extracted surface
finite set of data points sampled from the *primary surface* (3.1.5)

[SOURCE: ISO 14406:2010, 3.7, modified — Notes to entry removed.]

3.1.6
surface filter
filtration operator applied to a surface

3.1.6.1
S-filter
surface filter (3.1.6) which removes small-scale lateral components from the surface, resulting in the *primary surface* (3.1.5)

3.1.6.2
L-filter
surface filter (3.1.6) which removes large-scale lateral components from the *primary surface* (3.1.5) or *S-F surface* (3.1.7)

Note 1 to entry: When the L-filter is not tolerant to form, it needs to 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* (3.1.5)

Note 1 to entry: Some F-operations (such as association) 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.

Note 3 to entry: An F-operation can be a filtration operation such as a robust Gaussian filter.

3.1.6.4
nesting index
N_{is}, N_{ic}, N_{if}
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, modified — definition revised and notes to entry removed.]

3.1.7
S-F surface
surface derived from the *primary surface* (3.1.5) by removing the form using an *F-operation* (3.1.6.3)

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 N_{is} nesting index to remove the shortest wavelengths from the surface, the surface is equivalent to a "primary surface". In this case, N_{is} is the areal equivalent of the λs cut-off. See key reference 4 in Figure 2 and Annex G.

Note 3 to entry: If filtered with N_{ic} nesting index to separate longer from shorter wavelengths, the surface is equivalent to a "waviness surface". In this case, N_{ic} is the areal equivalent of the λc cut-off. See key reference 5 in Figure 2 and Annex G.

Note 4 to entry: The concepts of "roughness" or "waviness" are less important in areal surface texture than in profile surface texture. Some surfaces can 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.

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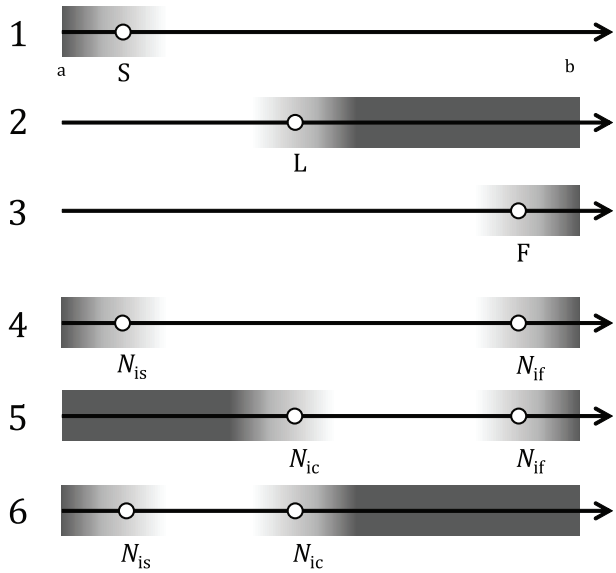
3.1.8
S-L surface
surface derived from the *S-F surface* (3.1.7) by removing the large-scale components using an *L-filter* (3.1.6.2)

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 N_{is} is chosen to remove the shortest wavelengths from the surface and the L-filter nesting index N_{ic} is chosen in order to separate longer from shorter wavelengths, the surface is equivalent to a "roughness surface". See key reference 6 in Figure 2 and Annex G.

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



Key

1 S-filter
2 L-filter
3 F-operation
4 S-F surface
5 S-F surface
6 S-L surface
A small scale
B large scale

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

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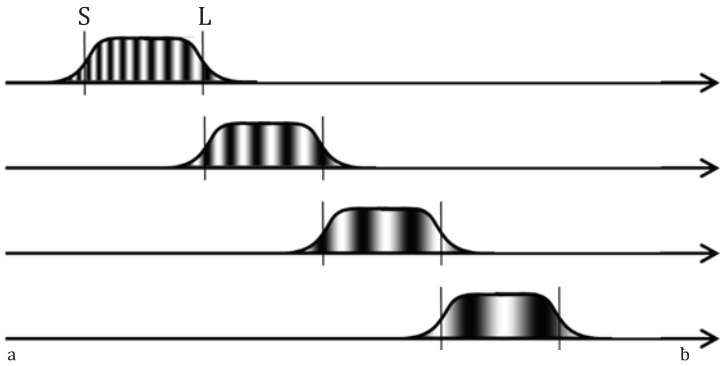

Key

S S-filter

L L-filter

A small scale

B large scale

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

3.1.9
scale-limited surface
S-F surface (3.1.7) or *S-L surface* (3.1.8)

3.1.10
reference surface
<surface texture> surface associated to the *scale-limited surface* (3.1.9) according to a criterion

Note 1 to entry: This reference surface is used as the origin of heights for surface texture parameters.

EXAMPLE Plane, cylinder and sphere.

3.1.11
evaluation area
A
$\tilde{A}$
portion of the *scale-limited surface* (3.1.9) for specifying the area under evaluation

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

Note 2 to entry: Throughout this document, the symbol A is used for the numerical value of the evaluation area and the symbol $\tilde{A}$ for the domain (of integration or definition).

3.2 Geometrical parameter terms

3.2.1
field parameter
parameter defined from all the points on a *scale-limited surface* (3.1.9)

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* (3.1.9)

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

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3.2.3
V-parameter
material volume or void volume *field parameter* (3.2.1)

3.2.4
S-parameter
field parameter (3.2.1) or *feature parameter* (3.2.2) that is not a *V-parameter* (3.2.3)

3.2.5
height
ordinate value
$z(x,y)$
signed normal distance from the *reference surface* (3.1.10) to the *scale-limited surface* (3.1.9)

Note 1 to entry: Throughout this document, the term "height" is either used for a distance or for an absolute coordinate. For 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* (3.2.5)

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 y of the *scale-limited surface* (3.1.9) at position (x, y)

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

3.2.8
material ratio
$M_r(c)$
ratio of the area A_c of the surface portion intersected by a plane at level c, to the *evaluation area* (3.1.11), A

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

Note 2 to entry: The level c is usually defined as a height taken with respect to a reference c_0. By default, the reference is at the highest point of the surface. In the first edition of this document, the reference height was set to the *reference surface* (3.1.10).

Note 3 to entry: The material ratio may be given as a percentage or a value between 0 and 1.

Note 4 to entry: See Figure 4 and Formula (1).

Note 5 to entry: See Annex D for the determination of the material ratio curve.

$$M_r(c) = \frac{A_c(c)}{A} . 100\ \% \tag{1}$$

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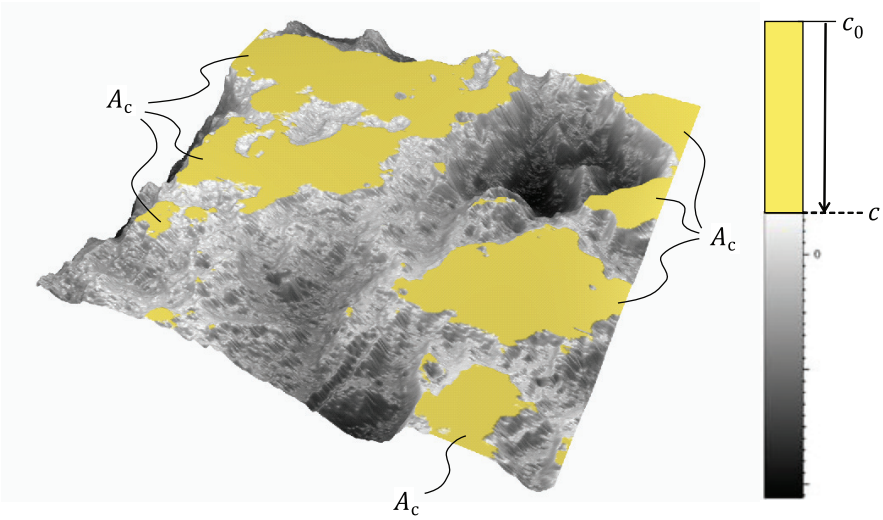


Key

c intersecting level

c_0 reference height

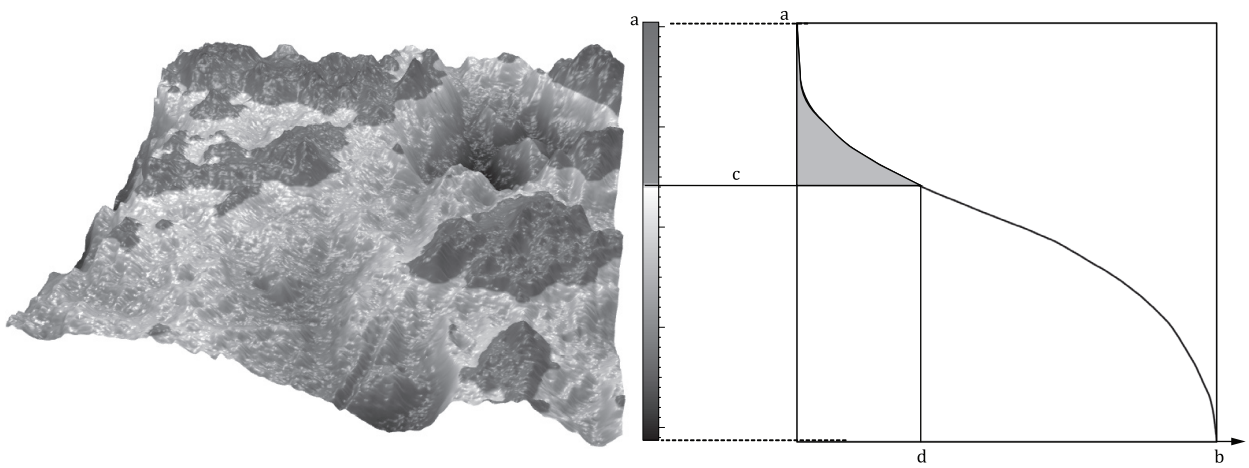
A_c areal portions intersected by plane at height c

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

3.2.9
areal material ratio curve
material ratio function
function representing the areal *material ratio* (3.2.8) of the *scale-limited surface* (3.1.9) as a function of a level *c*

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

Note 2 to entry: See Figure 5.



Key

A height

B areal material ratio

C intersection level *c*

D material ratio at level *c*

Figure 5 — Material ratio curve

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3.2.10
inverse material ratio
$C(p)$
intersecting level at which a given areal *material ratio* (3.2.8) p is satisfied

Note 1 to entry: See Formula (2).

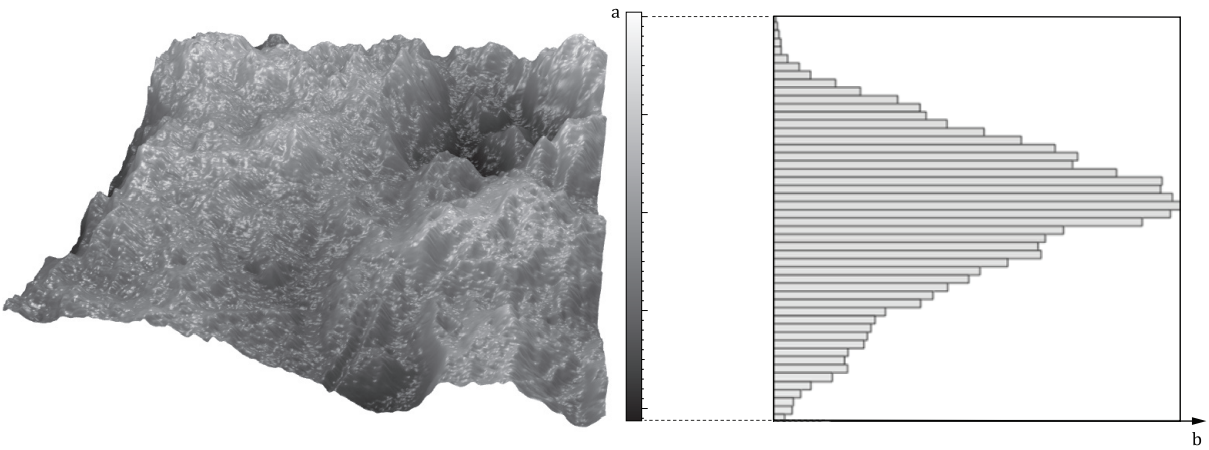
$$C(p) = M_r^{-1}(p) \tag{2}$$

3.2.11
height density curve
height density function
$h(c)$
curve representing the density of points laying at level c on the *scale-limited surface* (3.1.9)

Note 1 to entry: When represented as a histogram with bins, the percentage per bin depends on their width.

Note 2 to entry: See Figure 6 and Formula (3).

$$h(c) = -\frac{dM_r(c)}{dc} \tag{3}$$



Key

A height

B density

Figure 6 — Height density curve

3.2.12
core surface
scale-limited surface (3.1.9) excluding core-protruding hills and dales

Note 1 to entry: The terms hills and dales in this definition refer to 3.3.1.2 and 3.3.2.2 but are defined by graphical construction. See Figure 14 and Annex B.3.

3.2.13
areal material probability curve
representation of the *areal material ratio curve* (3.2.9) in which the areal material area ratio is expressed as a Gaussian probability in standard deviation values, plotted linearly on the horizontal axis

Note 1 to entry: This scale is expressed linearly in standard deviations according to the Gaussian distribution. In this scale, the areal material ratio curve of a Gaussian distribution becomes a straight line. For stratified surfaces composed of two Gaussian distributions, the areal material probability curve will exhibit two linear regions (see E and F in Figure 7).

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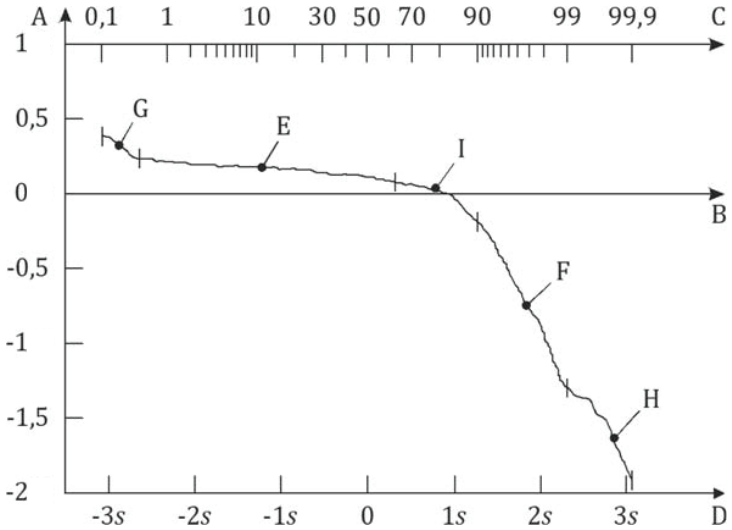

Key

A amplitude

B reference line

C material ratio expressed as a Gaussian probability in per cent

D material ratio expressed as a Gaussian probability in standard deviation

E plateau region

F dale region

G outlying hills (possibly including debris or dirt particles)

H outlying dales (possibly deep scratches)

I unstable region (curvature) introduced at the plateau-to-dale transition point based on the combination of two distributions horizontal axis *s* is the standard deviation

Figure 7 — Areal material probability curve

3.2.14
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)

Note 1 to entry: The autocorrelation used here is normalized between −1 and 1. The maximum value is always met but the minimum may not always be at −1, it depends on the surface (it may be −0,76).

Note 2 to entry: See Formula (4).

$$f_{\mathrm{ACF}}\left(t_{\mathrm{x}}, t_{\mathrm{y}}\right)=\frac{\frac{1}{B}\iint_{\tilde{B}} z(x,y)z\left(x+t_x, y+t_y\right)dxdy}{\frac{1}{A}\iint_{\tilde{A}} z^2(x,y)dxdy} \tag{4}$$

where $\tilde{B}$ is the intersecting area of the two surfaces at shifts t_x and t_y.

3.2.15
Fourier transformation
$F(p, q)$
operator which transforms *ordinate values* (3.2.5) of the *scale-limited surface* (3.1.9) into Fourier space

Note 1 to entry: The Fourier transformation defined here is using a limited support $\tilde{A}$, therefore it approximates the mathematical function called Fourier transformation which has an infinite support.

Note 2 to entry: See Formula (5).

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$$F(p,q)=\iint_{\tilde{A}} z(x,y)e^{-2i\pi(px+qy)}dxdy \tag{5}$$

where

p and q are spatial frequencies in x and y direction, respectively;

i is the imaginary unit.

3.2.15.1
angular spectrum
$F_{AS}(r, \theta)$
Fourier transformation (3.2.15) expressed in polar coordinates, with respect to a reference direction θ_{ref} in the plane of the *evaluation area* (3.1.11)

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.

Note 3 to entry: See Formula (6).

$$F_{AS}(r,\theta)=F(r\ \cos(\theta-\theta_{ref}),\ r\ \sin(\theta-\theta_{ref})) \tag{6}$$

where

r is a spatial frequency;

θ is the specified direction;

F is the Fourier transformation.

3.2.15.2
angular amplitude density
angular amplitude distribution
$f_{AAD}(\theta)$
integrated amplitude of the *angular spectrum* (3.2.15.1) for a given direction θ

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.

Note 2 to entry: See Formula (7).

$$f_{AAD}(\theta)=\int_{R_1}^{R_2}|F_{AS}(r,\ \theta)|rdr \tag{7}$$

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;

θ is the specified direction;

F_{AS} is the angular spectrum function.

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3.2.15.3
angular power density
angular power distribution
$f_{\mathrm{APD}}(\theta)$
integrated squared amplitude of the *angular spectrum* (3.2.15.1) for a given direction θ

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.

Note 2 to entry: See Formula (8).

$$f_{\mathrm{APD}}(\theta) = \int_{R_1}^{R_2} F_{\mathrm{AS}}{}^2(r,\theta) r \, dr \tag{8}$$

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;
θ	is the specified direction;
F_{AS}	is the angular spectrum function.

3.2.16
areal power spectral density
f_{APSD}
squared magnitude of the *Fourier transformation* (3.2.15) using an appropriate weighting function

Note 1 to entry: The areal power spectral density describes surface texture in a spatial frequency context allowing the waviness or ripples in the surface to be described and controlled.

Note 2 to entry: See Formula (9).

Note 3 to entry: The areal power spectral density can also be calculated from a polar spectrum. It is usually the case when exploring optics surfaces (see ISO 10110-8).

$$f_{\mathrm{APSD}}(p,q) = \frac{1}{A}|F(p,q)|^2 \tag{9}$$

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

Note 2 to entry: See Figure 8.

3.3.1.1
hill
<watershed segmentation> region around a *peak* (3.3.1) such that all maximal upward paths end at the peak

Note 1 to entry: This definition is used for feature parameters.

Note 2 to entry: See Figure 8.

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3.3.1.2
hill
<reference plane> outwardly directed (from material to surrounding medium) contiguous portion of the *scale-limited surface* (3.1.9) above the *reference surface* (3.1.10)

Note 1 to entry: This definition is used for field parameters.

Note 2 to entry: The reference surface is usually the mean plane of the scale-limited surface.

3.3.1.3
course line
curve separating adjacent *hills* (3.3.1.1)

Note 1 to entry: See Figure 8.

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

Note 1 to entry: There is a theoretical possibility of a plateau. In practice, this can be avoided by the use of an infinitesimal tilt.

Note 2 to entry: See Figure 9.

3.3.2.1
dale
<watershed segmentation> region around a *pit* (3.3.2) such that all maximal downward paths end at the pit

Note 1 to entry: This definition is used for feature parameters.

Note 2 to entry: See Figure 9.

3.3.2.2
dale
<reference plane> inwardly directed (from surrounding medium to material) contiguous portion of the *scale-limited surface* (3.1.9) below the *reference surface* (3.1.10)

Note 1 to entry: This definition is used for field parameters.

Note 2 to entry: The reference surface is usually the mean plane of the scale-limited surface.

3.3.2.3
ridge line
curve separating adjacent *dales* (3.3.2.1)

Note 1 to entry: See Figure 9.

3.3.3
saddle
point or set of points on the *scale-limited surface* (3.1.9) where *ridge lines* (3.3.2.3) and *course lines* (3.3.1.3) cross

3.3.3.1
saddle point
saddle (3.3.3) consisting of one point

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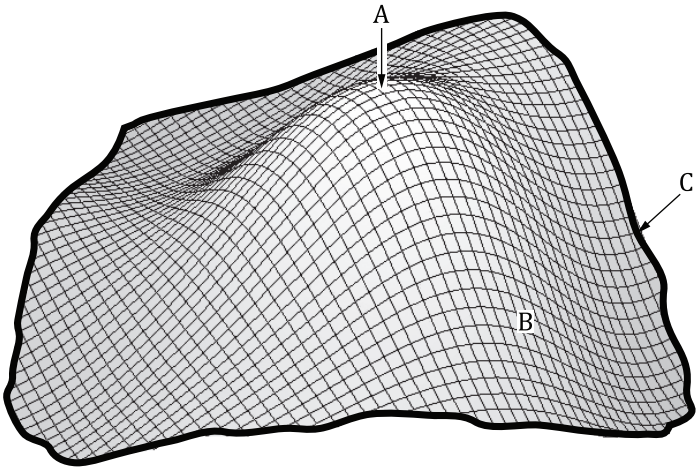


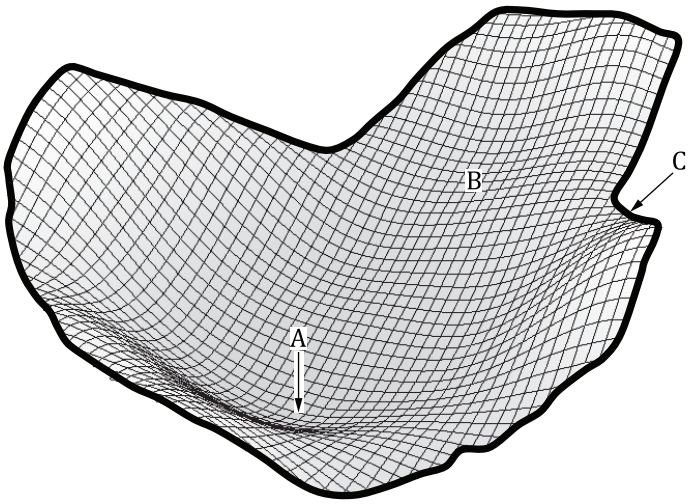
Key

A peak

B hill

C course line

Figure 8 — Representation of a hill in the context of watershed segmentation with the peak and the course line



Key

A pit

B dale

C ridge line

Figure 9 — Representation of a dale in the context of watershed segmentation with the pit and the ridge line

3.3.4
motif
hill (3.3.1.1) or *dale* (3.3.2.1) defined with watershed segmentation

Note 1 to entry: The term motif is used to designate an areal feature obtained by segmentation.

Note 2 to entry: The term motif as defined on a profile in ISO 12085 is a cross-section of a dale.

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3.3.5
topographic feature
areal feature, line feature or point feature on a *scale-limited surface* (3.1.9)

3.3.5.1
areal feature
hill (3.3.1.1) or *dale* (3.3.2.1)

3.3.5.2
line feature
course line (3.3.1.3) or *ridge line* (3.3.2.3)

3.3.5.3
point feature
peak (3.3.1), *pit* (3.3.2) or *saddle point* (3.3.3.1)

3.3.6
contour line
line on the surface consisting of adjacent points of equal height

3.3.7
segmentation
method which partitions a *scale-limited surface* (3.1.9) into distinct features

3.3.7.1
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 to entry: Examples of events include ordinate values and point features.

Note 2 to entry: A full mathematical description of the segmentation function and the three segmentation properties can be found in Reference [26] and ISO 16610-85.

3.3.8
change tree
graph where each *contour line* (3.3.6) is plotted as a point against height in such a way that adjacent contour lines are adjacent points on the graph

Note 1 to entry: 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 ISO 16610-85 and Annex A for more details concerning change trees.

3.3.8.1
pruning
method to simplify a *change tree* (3.3.8) in which lines from *peaks* (3.3.1) [or *pits* (3.3.2)] to their nearest connected *saddle points* (3.3.3.1) are removed

3.3.8.2
hill local height
difference between the height of a *peak* (3.3.1) and the height of the nearest connected *saddle point* (3.3.3.1) on the *change tree* (3.3.8)

3.3.8.3
dale local depth
difference between the height of the nearest connected *saddle point* (3.3.3.1) on the *change tree* (3.3.8) and the height of a *pit* (3.3.2)

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3.3.8.4
Wolf pruning
pruning where lines in the *change tree* (3.3.8) are removed, starting from the *peak* (3.3.1) [*pit* (3.3.2)] with the smallest *hill local height* (3.3.8.2) [*dale local depth* (3.3.8.3)] up to the peak (pit) with a specified hill *local height* (3.3.8.2) [*dale local depth* (3.3.8.3)]

Note 1 to entry: The peak local heights and pit local depths change during Wolf pruning as removing lines from a change tree also removes the associated saddle point.

3.3.9
height discrimination
minimum *hill local height* (3.3.8.2) or *dale local depth* (3.3.8.3) of the *scale-limited surface* (3.1.9) which should be considered during *Wolf pruning* (3.3.8.4)

Note 1 to entry: The height discrimination is specified by default as a percentage of Sz (4.2.7).

4 Field parameters

4.1 General

The symbol $\tilde{A}$ represents the domain (of integration or of definition of the parameters), and the symbol A represents the value of the evaluation area, in micrometres squared (µm^2) or millimetres squared (mm^2).

A summary of all S-parameters and V-parameters is given in Annex F.

4.2 Height parameters

4.2.1 General

All height parameters are defined over the evaluation area $\tilde{A}$.

4.2.2 Root mean square height

Sq

The root mean square height parameter is the square root of the mean square of the ordinate values of the scale-limited surface. It is sometimes referred to as the RMS height. It is calculated according to Formula (10).

$$S_{\mathrm{q}} = \sqrt{\frac{1}{A}\iint_{\tilde{A}} z^2(x,y)\,dxdy} \tag{10}$$

4.2.3 Skewness

Ssk

The skewness parameter is the quotient of the mean cube value of the ordinate values of the scale-limited surface and the cube of Sq. It is calculated according to Formula (11).

$$S_{\mathrm{sk}} = \frac{1}{AS_{\mathrm{q}}^3}\iint_{\tilde{A}} z^3(x,y)\,dxdy \tag{11}$$

4.2.4 Kurtosis

Sku

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The kurtosis parameter is the quotient of the mean quartic value of the ordinate values of the scale-limited surface and the fourth power of Sq. It is calculated according to Formula (12).

$$S_{\mathrm{ku}} = \frac{1}{AS_{\mathrm{q}}^{4}} \iint_{\tilde{A}} z^{4}(x,y)\,dxdy \tag{12}$$

4.2.5 Maximum peak height

Sp

The maximum peak height parameter is the largest peak height value of the scale-limited surface.

4.2.6 Maximum pit depth

Sv

The maximum pit depth parameter is the largest pit depth value of the scale-limited surface. Sv is always a positive quantity, as the reference surface is always higher to the deepest pit.

4.2.7 Maximum height

Sz

The maximum height parameter is the sum of the maximum peak height value and the maximum pit depth value of the scale-limited surface.

4.2.8 Arithmetic mean height

Sa

The arithmetic mean height parameter is the mean of the absolute of the ordinate values of the scale-limited surface. It is calculated according to Formula (13).

$$S_{\mathrm{a}} = \frac{1}{A} \iint_{\tilde{A}} |z(x,y)|\,dxdy \tag{13}$$

4.3 Spatial parameters

4.3.1 General

All spatial parameters are defined over the evaluation area $\tilde{A}$.

4.3.2 Autocorrelation length

Sal

The autocorrelation length parameter is the horizontal distance of the $f_{\mathrm{ACF}}(t_x,t_y)$ which has the fastest decay to a specified value s, with $0 \le s < 1$. It is calculated according to Formula (14) or (15).

$$S_{\mathrm{al}} = \min_{t_{\mathrm{x}},t_{\mathrm{y}} \in R} \sqrt{t_{\mathrm{x}}^{2} + t_{\mathrm{y}}^{2}} \tag{14}$$

where

$$R = \left\{ \left(t_{\mathrm{x}}, t_{\mathrm{y}}\right) : f_{ACF}\left(t_{\mathrm{x}}, t_{\mathrm{y}}\right) \le s \right\}$$

NOTE 1 If not otherwise specified, the default value of s is found in ISO 25178-3.

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