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

Part 1: Indication of surface texture

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

Partie 1: Indication des états de surface

Reference number
ISO 25178-1:2016(E)

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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. www.iso.org/directives

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This document 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 1: Indication of surface texture*

— *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 72: XML file format x3p*

— *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 parts are planned:

— *Part 4: Comparison rules*

— *Part 5: Verification operators*

— *Part 600: Metrological characteristics for areal-topography measuring methods* [1)]

— *Part 607: Nominal characteristics of non-contact (confocal microscopy) instruments*

— *Part 700: Calibration and verification of metrological characteristics of areal-topography measuring instruments*

1) Part 600 is intended to contain provisions that are in common with the other 600-level parts of ISO 25178. Once Part 600 has been submitted as a Final Draft International Standard, provisions of the other 600-level parts that are then redundant with provisions of Part 600 will be removed from them.

Introduction

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

The ISO GPS Masterplan 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. 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 F.

This part of ISO 25178 covers the indication of areal surface texture

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

Part 1: Indication of surface texture

1 Scope

This part of ISO 25178 specifies the rules for indication of areal surface texture in technical product documentation (e.g. drawings, specifications, contracts, reports) by means of graphical symbols.

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 1101:2012, *Geometrical product specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

ISO 1302:2002, *Geometrical Product Specifications (GPS) — Indication of surface texture in technical product documentation*

ISO 3098-2, *Technical product documentation — Lettering — Part 2: Latin alphabet, numerals and marks*

ISO 14406, *Geometrical product specifications (GPS) — Extraction*

ISO 16792, *Technical product documentation — Digital product definition data practices*

ISO 25178-2:2012, *Geometrical product specifications (GPS) — Surface texture: Areal — Part 2: Terms, definitions and surface texture parameters*

ISO 25178-3:2012, *Geometrical product specifications (GPS) — Surface texture: Areal — Part 3: Specification operators*

ISO 81714-1, *Design of graphical symbols for use in the technical documentation of products — Part 1: Basic rules*

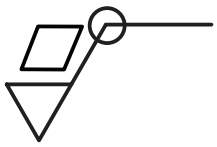
3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 1101, ISO 1302, ISO 14406, ISO 16792, ISO 25178-2 and ISO 25178-3 apply.

4 Graphical symbols for the indication of areal surface texture

Requirements for areal surface texture are indicated on technical product documentation by graphical symbols, each having its own significant meaning. The symbols used are similar to the ones defined in ISO 1302:2002, Clause 4. To identify that the requirement is an areal surface texture, a rhomb is added to the symbol, see Table 1.

Table 1 — Graphical symbols for the indication of areal surface texture

No.	Description	Symbol
1	Basic graphical symbol for areal surface texture	
2	Expanded graphical symbol indicating removal of material required	
3	Expanded graphical symbol indicating removal of material not permitted	
4	Complete graphical symbol. Any manufacturing process permitted	
5	Complete graphical symbol Material shall be removed	
6	Complete graphical symbol Material shall not be removed	
7	Complete graphical symbol With “all around” modifier	

When the same surface texture is required on all surfaces around a workpiece outline (integral features), represented on the drawing by a closed outline of the workpiece, a circle shall be added to the complete graphical symbol as illustrated in Table 1 and shown in Figure 1.

Surfaces shall be indicated independently if any ambiguity may arise from the all-around indication.

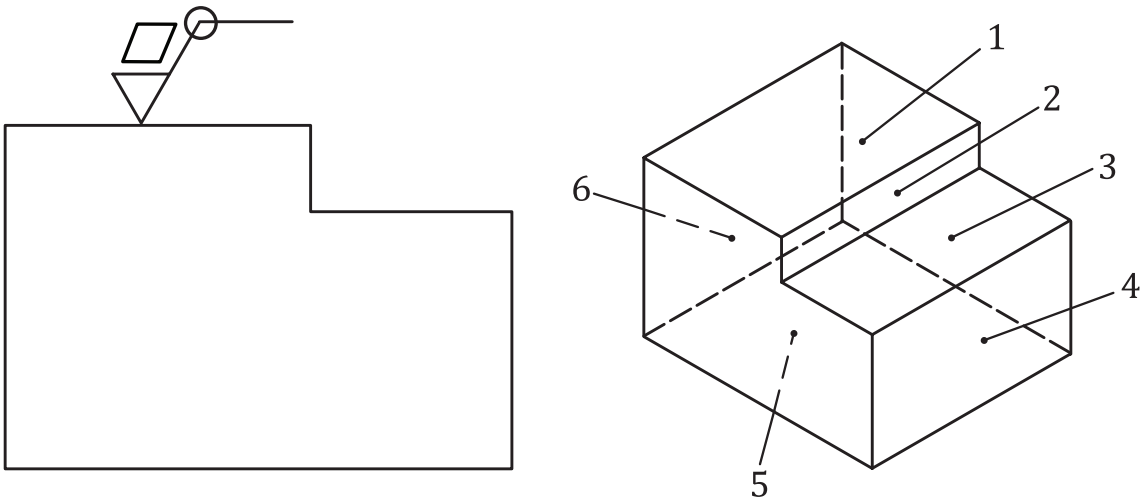


Figure 1 — Areal surface requirement for all six surfaces represented by outline on workpiece

The outline on the drawing in Figure 1 represents the six surfaces shown on the 3 D-representation of the workpiece (the front and rear surfaces not included).

NOTE In 3-D annotation, it might be helpful to add an intersection plane indicator to make the annotation drawing plane independent. For further instructions, see Annex D.

5 Composition of complete graphical symbol for areal surface texture

5.1 General

In order to ensure that an areal surface texture requirement is unambiguous, it is necessary, in addition to the indication of both a surface texture parameter and its numerical value, to specify additional requirements (e.g. type of scale limitation, transmission band, type of filters, manufacturing process, surface lay and possible machining allowances). It may also be necessary to set up requirements for several different surface texture parameters in order that the surface texture requirements ensure the functional properties of the surface. (Examples of indications of areal surface texture requirements are given in Annex C.)

5.2 Positions of surface texture requirements

The mandatory positions of the various surface texture requirements in the complete graphical symbol are shown in Figure 2.

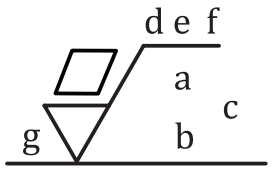


Figure 2 — Positions of surface texture requirements in the complete graphical symbol

The complementary surface texture requirements in the form of

— surface texture parameters

— numerical values, and

— a transmission band

shall be located at the specific positions in the complete graphical symbol in accordance with the following.

a) Position a – Single surface texture requirement

Indicate the type of specification limit, the type of scale limited surface and its nesting indices, the areal surface texture parameter designation with its limit value and other non-defaults in this order.

Generally, the different parts of the indication are separated by a single space but to avoid misinterpretation, a double space (double blank) shall be inserted between the parameter designation and the limit value. Oblique strokes (/) are used to separate the specification sections, see Annex B.

For more information on the contents of position “a”, consult Annex B. Also see ISO 1302:2002, Clause 6.

EXAMPLE S-L 0,025-0,8/Sz 6,8 (minimum content example with mandatory indication of type of scale-limited surface and its nesting indices)

b) Position a and b – Two or more surface texture requirements

Indicate the first surface texture requirement at position “a” as in a).

Indicate the second surface texture requirement at position “b”.

If a third requirement or more is to be indicated, the graphical symbol is to be enlarged accordingly in the vertical direction, to make room for more lines. The positions “a” and “b” are to be moved upwards when the symbol is enlarged. See also ISO 1302:2002, Clause 6.

The orientation of the evaluation area and the orientation of the lay are determined by the position of the graphical symbol on the drawing.

NOTE 1 To make the annotation drawing plane independent, it might be helpful to add an intersection plane indicator, for further instruction see Annex D

c) Position c – Intersection plane for indication of orientation of the evaluation area

If helpful, indicate intersection plane for orientation of the evaluation area, see Annex D.

NOTE 2 If the orientation of the lay is the same as the orientation of the evaluation area, this intersection plane indicator covers both.

d) Position d– Manufacturing requirements

Indicate the manufacturing method, treatment, coatings or other requirements for the manufacturing process to produce the surface, for example, turned, ground, plated. See also ISO 1302:2002, Clause 7.

e) Position e– Surface lay

Indicate the required surface lay symbol in position e, for example, “=”, “X”, “M”. See Table 2. Like the orientation of the evaluation area, the orientation of the lay is determined by the position of the graphical symbol on the drawing.

NOTE 3 If another orientation of the lay is required, it can be indicated in position f by an intersection plane indicator, see Annex D.

f) Position f - Intersection plane indicator for indication of orientation of the surface lay

If the orientation of the surface lay differs from the orientation of the surface texture symbol, it can be indicated here by an intersection plane indicator. See Annex D.

g) Position g – Machining allowance

Indicate the required machining allowance, if any, as a numerical value given in millimetres. See also ISO 1302:2002, Clause 9.

6 Indication of areal surface parameters

6.1 Definition of the tolerance

In the normal case, two conditions are given:

— the type of tolerance, upper or lower limit, designations U or L;

— the type of scale-limited surface, S-F or S-L, as defined in ISO 25178-2:2012, 3.1.5 and 3.1.6.

In the normal case, the upper limit is specified. The designation “U” is then an implicit default and can be left out. For some parameters where there is no normal case, i.e. material ratio parameters and feature parameters, it is recommended always to use the designations U or L. See also ISO 1302:2002, 6.6.

If not otherwise specified, the parameter value indicated is the largest or smallest value allowed.

For bilateral tolerances, see 5.2 b).

6.2 Definition of the parameter

The chosen surface texture areal parameter value shall be supplemented with the information necessary for a correct and unambiguous specification.

In the normal case, three types of information are given:

— filters and nesting indexes;

— parameter and parameter value;

— non-defaults.

For examples, see Annex B.

Defaults according to ISO 25178-2 and -3 are normally not explicitly specified.

Every areal surface texture parameter has its own default control elements and information requirements for specification of non-default elements as given in ISO 25178-3.

The order of the information items follows in principle the order found in ISO 1302 for profile parameters.

For filter designations, see Annex E.

6.3 Indication of manufacturing method or related information

The surface texture parameter value of an actual surface is strongly influenced by the detailed form of the surface texture. A parameter designation, parameter value and transmission band — indicated solely as a surface texture requirement — do not therefore necessarily result in an unambiguous function of the surface.

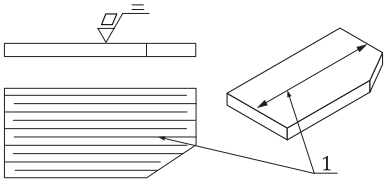
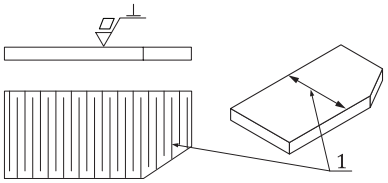
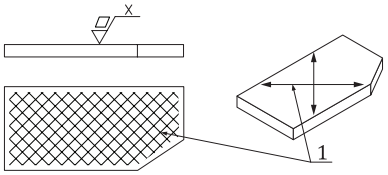
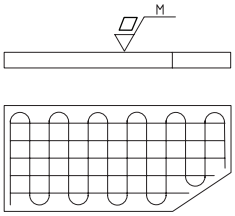
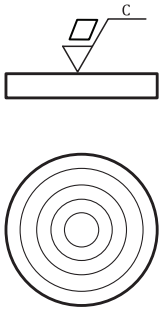
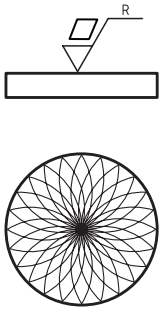
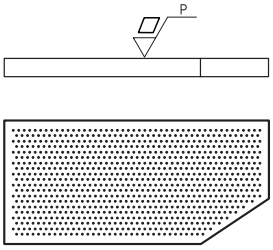
It is consequently sometimes necessary to complement the specification with a statement of the manufacturing process.

For examples, see ISO 1302:2002, Clause 7.

6.4 Indication of surface lay

Standard lay symbols and their indication are shown in Table 2.

Table 2 — Indication of surface lay

Graphical symbol	Interpretation	Examples
=	Parallel to plane of projection of view in which symbol is used	
⊥	Perpendicular to plane of projection of view in which symbol is used	
X	Crossed in two oblique directions relative to plane of projection of view in which symbol is used	
M	Multi-directional	
C	Approximately circular relative to centre of surface to which symbol applies	
R	Approximately radial relative to centre of surface to which symbol applies	
P	Lay is particulate, non-directional or protuberant	
1 Direction of lay		

If it is necessary to specify a surface pattern which is not clearly defined by the symbols in Table 2, this shall be achieved by the addition of a suitable note to the drawing.

6.5 Indication of machining allowance

See ISO 1302:2002, Clause 9.

6.6 Position on drawings and other technical product documentation

See ISO 1302:2002, Clause 11.

6.7 Proportions and dimensions of graphical symbols

See Annex A.

6.8 Orientation of the evaluation area

The position and orientation of the symbol, as exemplified in ISO 1302:2002, Clause 11, determine the orientation of the evaluation area. See also ISO 25178-3:2012, 4.2.1.1.

NOTE 1 This is a difference from the procedure for profile evaluation where it is stipulated that the measurement direction is chosen as the one expected to give the largest value for the assessed parameter, normally found perpendicular to any dominant surface lay. See also ISO 4288.

NOTE 2 In 3-D annotation, it might be helpful to add an intersection plane indicator to make the annotation drawing plane independent, for further instruction see Annex D.

7 Coordinate system

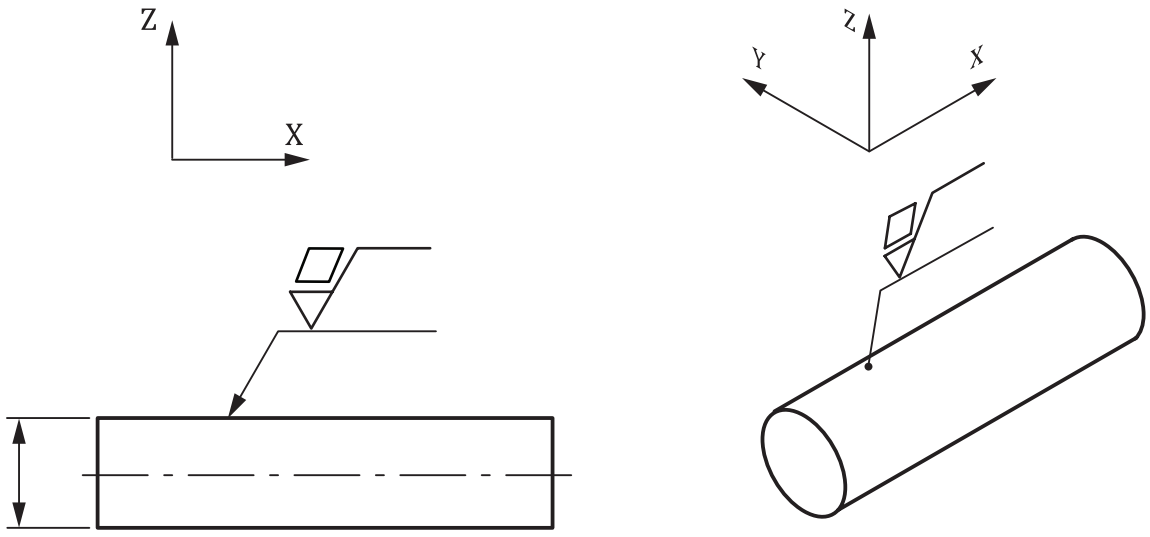
The usual coordinate system in which areal surface texture parameters are defined is a rectangular coordinate system in which the axes form a right-handed Cartesian set, the x-axis being the direction of tracing as indicated by the position of the graphical symbol on the drawing and nominally lying on the real surface, the y-axis also nominally lying on the real surface and the z-axis being in the outward direction (from the material to the surrounding medium). See Figure 3.

By convention when areal surface texture requirements are the same in both the x- and y-directions, the x-axis requirements are shown; see Annex B for further details.

This local coordinate system is not to be confused with the coordinate system used for the complete drawing, which may be different.

Defining the exact orientation of the evaluation area (on which the surface texture parameter is defined) is only necessary when the requirements are different in the x- and y-directions.

NOTE Normally, the information on the drawing is enough for the orientation of the evaluation area and the lay orientation. If not one or two intersection plane indicators can be used, see Annex D.



a) 2-D drawing **b) 3-D drawing**

Figure 3 — Example of local coordinate system directions in a 2-D and a 3-D drawing

8 Digital product definition data

All advice given in ISO 16792 is also, when applicable, valid for specifications made according to this International Standard.

When specifications are made on 3-D drawings, it is sometimes useful to clarify the orientation of a requirement. For that purpose, the concept of an "intersection plane" has been created. The intersection plane is a substitute for a 2-D drawing plane. For further information, see ISO 1101.

When specifying areal surface texture on 3-D drawings, the indication of an intersection plane can be used to clarify the orientation of the evaluation area. See Annex D for more information and examples.

Intersection planes can also be used for indication of the orientation, if any, of the surface lay.

In the normal case, the intersection planes for the surface lay orientation and the orientation of the evaluation area coincide into one plane, where the 2-D drawing plane in 3-D is replaced with the intersection plane. An areal surface texture specification, however, might contain a need for indicating two separate intersection planes. In Annex D, information and an example are given on how this can be made.

Annex A
(normative)

Proportions and dimensions of graphical symbols

A.1 General requirements

In order to harmonize the size of the symbols specified in this part of ISO 25178 with those of other inscriptions on technical drawings (dimensions, geometrical tolerances, etc.), the rules given in ISO 81714-1 are applicable.

A.2 Proportions

The basic graphical symbol and its complements (see Clauses 4 and 5) shall be drawn in accordance with Figures A.1 to A.3. The shape of the symbols in Figure A.2 c) to g), is the same as that of the corresponding capital letter in ISO 3098-2:2000 (lettering B, vertical). For dimensions, see A.3. The length of the horizontal stroke of the symbol in Figure A.1 b) depends on the indication to be placed above and beneath it

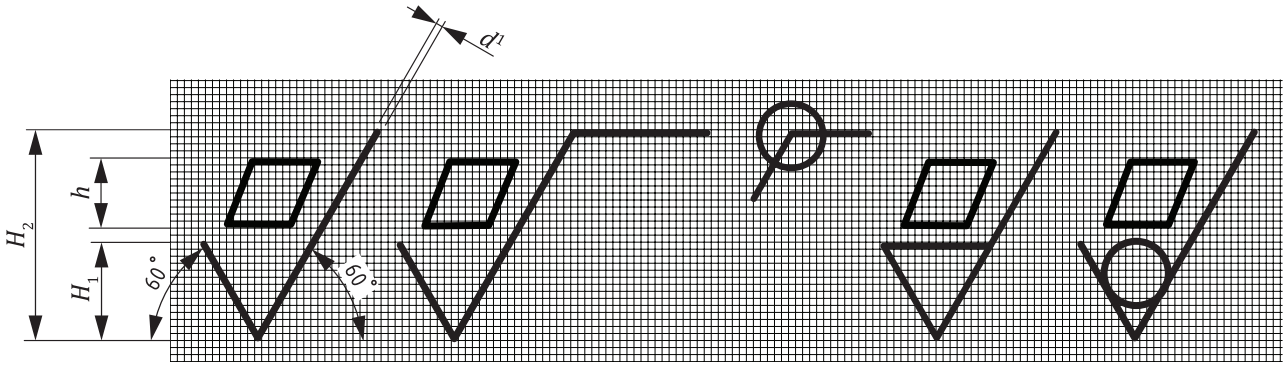


Figure A.1

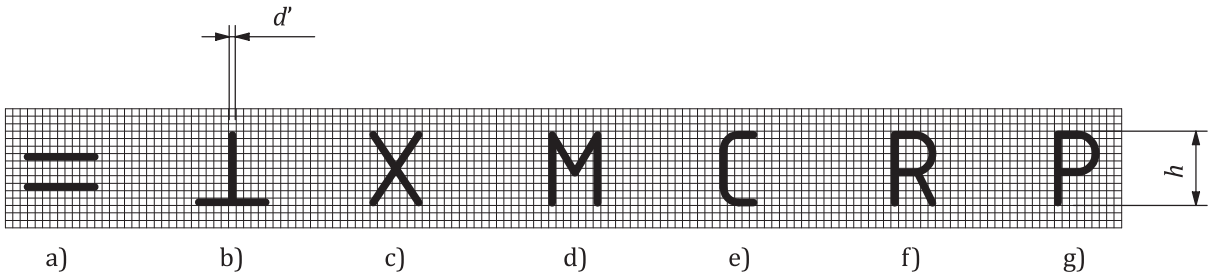


Figure A.2

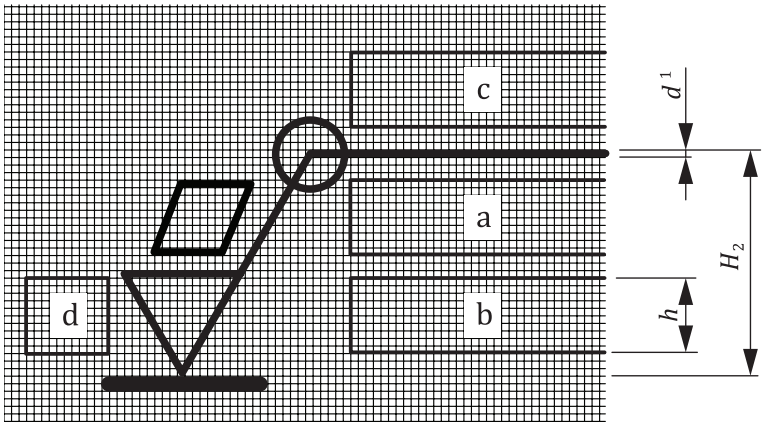


Figure A.3

The height of all lettering in areas “a”, “b”, “c” and “d” in Figure A.3 shall be equal to h. As the letterings in areas a, b and c of Figure A.3 may comprise capital or lower case letters or both, the height of these areas may be greater than h to allow for tails of lower case letters.

A.3 Dimensions

The dimensions of the graphical symbols and additional indications shall be as specified in Table A.1.

Table A.1 — Dimensions

Dimensions in millimetres

Height of numerals and letters, h (see ISO 3098-2)	2,5	3,5	5	7	10	14	20
Line width for symbols, d'	0,25	0,35	0,5	0,7	1	1,4	2
Line width for lettering, ($h/10$)							
Height, H_1	3,5	5	7	10	14	20	28
Height, H_2 (minimum) [a]	7,5	10,5	15	21	30	42	60
[a] H_2 depends on the number of lines of indication.							

Annex B
(normative)

Indications for unambiguous surface texture specifications

B.1 General

An areal surface texture specification is built from several different control elements, which can be part of the indication on the drawing or given in other documents. The elements are as given in B.2, B.3 and B 4 below.

Control elements are placed in place holders in specification sections separated by oblique strokes (/).

The three specification sections are:

a) the tolerance limit type, filter and association information, reference level information;

b) the parameter and value;

c) the options.

[ ] square brackets mean that the placeholder is controlled by defaults or giving options.

< > angular brackets mean that the placeholder shall be specified.

B.2 Control elements in indication of S-L surface texture on engineering drawings

[limit] S-L < S filter > – < L filter > [F operator] / < parameter > < value > [unit] / [ES] [OR(*n*)]

where

[limit]	Either U (upper) or L (lower) specification limits (The default, U, need not be indicated.) See also ISO 1302:2002, 6.6.
S-L	The specification is for an S-L surface. See also ISO 25178-2:2012, 3.1.6.
< S filter >	Type of filter (see Table E.1) and nesting index of the S filter (see Table E.2). For example, **S 0,025** means Spline filter with a cut-off of 0,025 mm. (The default Gaussian filter, G, need not be indicated). See also ISO 25178-3:2012, 4.2.3. Default unit mm need not be indicated.
< L filter >	Type of filter (see Table E.1) and nesting index of the L filter (see Table E.2). For example, **RG 0,8** means Robust Gaussian filter with a cut-off of 0,8 mm. (The default Gaussian filter, G, need not be indicated). See also ISO 25178-3:2012, 4.4.3. The evaluation area is determined by the L filter nesting index value.
[F operator]	Type of association operator, (see Table E.3). A filter can also be used as an F operator (see Table E.1). For example, **RS 8** means Robust Spline filter with a cut-off of 8 mm. The default association operator, G, need not be indicated. See also ISO 25178-3:2012, 4.4.
<parameter >	Name of the areal parameter. See also ISO 25178-2:2012, 3.2. The parameter "Smr(*c*)" is assessed from a reference plane, the position of which, if non-default, shall be indicated, see B.4 and the example in C.2 for more information.
< value >	Specified limit value of the parameter

[unit]	Unit of the parameter value when not the default unit (The default unit, µm, need not be indicated.)
[ES]	Symbol for option *Electro-magnetic Surface.*
	Relationships between S-filter nesting index value, sampling distance and lateral period limit are to be chosen according to ISO 25178-3:2012, Table 3.
	The default, Mechanical Surface, need not be indicated.
	In ISO 25178-3:2012, "*Electro-magnetic Surface*" is named "*Optical Surface*", this nomenclature is to be changed in the next revision of ISO 25178-3..
[OR(*n*)]	Symbol for option *Other Requirements.*
	Added requirements are put in this place.
	If the symbol "OR(*n*)" is put here, it indicates that information of added requirements is to be found in free text in another place on the drawing.
	n=1, 2, 3 etc., if there is more than one indication on the drawing.
	EXAMPLE:
	OR(7):Rectangular evaluation area; 2,5 mm in the x-direction x 1,0 mm in the y-direction

B.3 Control elements in indication of S-F surface texture on engineering drawings

[limit] S-F < S filter > - < F operator > / < parameter > < value > [unit] / [ES] [OR(*n*)]

where

[limit]	Either U (upper) or L (lower) specification limits (The default, U, need not be indicated.) See also ISO 1302:2002, 6.6.
S-F	The specification is for an S-F surface. See also ISO 25178-2:2012, 3.1.5.
< S filter >	Type of filter (see Table E.1) and nesting index of the S filter (see Table E.2). For example, **S 0,002 5** means Spline filter with a cut-off of 2,5 µm. (The default Gaussian filter, G,need not be indicated.) See also ISO 25178-3:2012, 4.2.3.
	The default unit, mm, need not be indicated.
< F operator >	Type of association operator and nesting index. (See Table E.3.)
	Side of (square) evaluation area in mm when the F operator is not a filter.
	If a non-filter F-operator is specified, it is mandatory to also specify the size of the evaluation area by indicating a nesting index substitute. See the example below and ISO 25178-3:2012, 4.2.1.
	The default association operator, G, need not be indicated. However, since G is not a filter, a nesting index substitute value specifying the size of the evaluation area shall be indicated, typically 5x the coarsest structure of interest.
	A filter can also be used as an F operator (see Table E.1). For example, **RS 8** means Robust Spline filter with a cut-off of 8 mm. See also Note 2 and ISO 25178-3:2012, 4.4.
< parameter >	Name of the areal parameter. See also ISO 25178-2:2012, 3.2.
	The parameter "Smr(*c*)" is assessed from a reference plane, the position of which shall be indicated. The reference plane Smr(*c*) = 0 % need not be indicated. See B.4 and the example in C.2 for more information.
< value >	Specified limit value of the parameter

[unit]	Unit of the parameter value when not the default unit
	Default unit, µm, need not be indicated.
[ES]	Symbol for option Electro-magnetic Surface
	Relationships between an S-filter nesting index value, sampling distance and lateral period limit to be chosen according to ISO 25178-3:2012, Table 3.
	Default, Mechanical Surface, need not be indicated.
	In ISO 25178-3:2012, "Electro-magnetic Surface" is named "Optical Surface"; this is to be changed in the next revision of ISO 25178-3..
[OR(*n*)]	Symbol for option "Other Requirements".
	Added requirements are put in this place.
	If the symbol "OR" is put here, it indicates that information on added requirements is to be found in free text in another place on the drawing.
	n =1, 2, 3 etc., if there is more than one indication on the drawing.
	Example: OR3: Rectangular evaluation area; 2,5 mm in the x-direction x 1,0 mm in the y-direction.

Example of an S-F surface texture specification with a default F-operator, G, (not indicated) and a nesting index substitute (side of (square) evaluation area equals 8 mm).

S-F 0,008-8 / Sa 0,5

Example of an S-F surface texture specification with a non-default filter F-operator

S-F 0,008-RG2,5 / Sa 0,5

B.4 Control elements for indication of material ratio parameter value Smr on engineering drawings

This indication is valid both for S-L and S-F surface textures.

Smr([reference c-value] < signed c-value >) < value > [unit]

where

Smr	Material ratio requirement parameter
[reference c-value]	Specification of the reference level in percentage on the material ratio curve, see ISO 25178-2:2012, 4.4.3. The default reference is the highest point, 0 %, of the material ratio curve and need not be indicated.
< signed c-value >	Specified height distance in relation to the reference c-value in µm, see ISO 25178-2:2012, 4.4.2
	The c-value is negative if it is below the reference c-value, and is positive if it is above the reference c-value.
< value >	Specified limit value of the parameter
[unit]	Default unit, %, always to be indicated

Normally, the Smr value is specified as a minimum limit value; this is indicated by using the designation L as shown in the examples below.

EXAMPLE 1 Example of an S-L surface texture specification with reference level 0% (need not be indicated):

L S-L 0,008-2,5/Smr(- 0,4) 70%

EXAMPLE 2 Example of an S-F surface texture specification with a non-zero reference level (needs to be indicated):

L S-F 0,008-RG2,5/Smr(5%,- 0,2) 60%

See also Example C.2.

EXAMPLE 3 Example of an S-F surface texture specification with a non-zero reference level = 65 % (needs to be indicated):

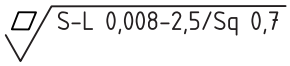
L S-F 0,008-RG2,5/Smr(65%,+0,2) 25%

NOTE Example 3 is exemplified in ISO 25178-2:2012, Figure 3.

Annex C
(informative)

Examples of indications of areal surface texture requirements

C.1 Example: Indication of a field parameter using all the defaults in ISO 25178-3



Interpretation: Surface with no manufacturing requirements, S - L surface, S-filter nesting index = 0,008 mm, L-filter nesting index = 2,5 mm, chosen S-parameter is root mean square height of the scale limited surface; Sq with a maximum limit value 0,7 µm.

Implied defaults (not shown in the indication):

Upper limit tolerance "U".

The evaluation area is equal to the definition area and is a square with a side length of 2,5 mm, the same as the value of the L-filter nesting index. See also Note 1.

With an S-filter nesting index of 0,008 mm, the maximum sampling distance is 0,001 5 mm and the maximum sphere radius is 0,005 mm. These figures are given in ISO 25178-3:2012, Table 2 and determined independently of the size of the chosen L-filter nesting index. See also ISO 25178-3:2012, Table 1 and Note 3.

The F-operator is the total least square removal of form on S-L evaluation area.

The default unit "µm" for the Sq parameter is not indicated.

NOTE 1 With the use of a suitable end-correction algorithm, the actual total area that is to be measured in verification can be very close to the specified evaluation area.

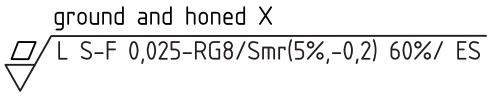
NOTE 2 The main differences with areal specification compared with profile specification are:

The orientation of the evaluation area is determined by the drawing. See also 6.8 and ISO 25178-3:2012, 4.2.1.1.

In areal surface texture specification, there is no equivalent to the "16 %"-rule. See also 6.1.

NOTE 3 In this case, the bandwidth ratio according to Table 1 becomes 300:1 which has been judged sufficient by the designer for the desired correlation ambiguity between the function and the surface texture requirement. The choice of a larger S-filter nesting index allows larger values of the maximum sampling distance and maximum ball radius to be used according to ISO 25178-3:2012, Table 1, possibly allowing a cheaper and faster verification. It is to be noted, however, that the numerical result of the measurement of such a choice might differ from one made with a smaller S-filter.

C.2 Example: Indication of a field parameter with two non-default requirements



Interpretation: Surface with a manufacturing requirement (ground and honed) and a surface lay requirement, lower limit tolerance, S-F surface, S-filter nesting index = 0,025 mm, the non-default F-operator is a Robust Gaussian filter with nesting index of 8 mm, chosen S-parameter is areal material ratio of the scale limited surface, Smr minimum limit value at c-level 0,2 µm = 60 % and measured downwards into the surface from the reference plane given by Smr = 5 %. The non-default specification of extracted surface is an electro-magnetic surface.

Implied defaults (not shown in the indication):

The evaluation area is equal to the definition area and is a square with a side length of 8 mm.

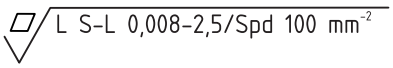
The S-filter is an areal Gaussian filter.

With S-filter value 0,025 mm, the maximum sampling distance is 0,008 mm and the maximum lateral period limit is 0,025 mm. These figures are given in ISO 25178-3:2012, Table 3.

NOTE The lateral period limit for an electro-magnetic surface is the equivalent of the ball radius for the mechanical surface.

Material ratio parameters are often used to secure a high material content in the upper part of the surface for good load bearing and wear properties without loss of lubrication. Such surfaces are typically manufactured in many steps with a skewed material distribution as a result. As using the standard Gaussian L-filter on such surfaces might distort the material ratio curve, it is recommended to instead specify a robust filter such as the Robust Gaussian filter, in this example, ISO 16610-71, see Table E.1.

C.3 Example: Indication of a named feature parameter using all the defaults in ISO 25178-3



Interpretation: Surface with no manufacturing requirements, lower limit tolerance, S-L surface, S-filter nesting index = 0,008 mm, L-filter nesting index = 2,5 mm, chosen S-parameter is Spd (density of peaks) with minimum limit value 100 mm^{-2} (100 peaks per square mm).

Implied defaults (not shown in the indication):

The evaluation area is a square with a side length of 2,5 mm, the same as the value of the L-filter nesting index.

With an S-filter nesting index of 0,008 mm, the maximum sampling distance is =0,001 5 mm and the maximum sphere radius is 0,005 mm. These figures are given in ISO 25178-3:2012, Table 1 and are determined independently of the size of the chosen L-filter nesting index.

S and L-filters are areal Gaussian.

The F-operator is the total least square removal of form on the S-L evaluation area

Feature parameter (FC) attributes:

The texture feature class is Area.

The type of scale limited feature is Hill (H).

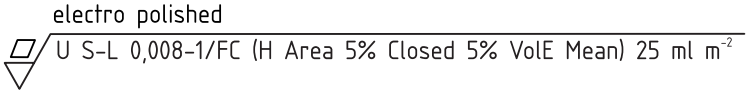
The segmentation criterion is Wolfprune with a nesting index 5 % of Sz.

The method of determining significant features is Areal, line, point (All).

The feature attribute takes a value of one (Count).

The attribute statistic is the sum of all the attribute values divided by the definition area (Density).

C.4 Example: Indication of an unnamed feature parameter



Interpretation: Surface with a manufacturing requirement (electro-polished), upper limit tolerance, S-L surface, unnamed feature parameter (FC) with given characteristics within brackets and with a maximum limit value of 25 ml per meter square. For definitions of the elements of feature characterization, see ISO 25178-2:2012, Clause 6.

Implied defaults (not shown in the indication):

The evaluation area is a square with a side length of 1 mm, the same as the value of the nesting index.

With S-filter value 0,008 mm, the maximum sampling distance is 0,001 5 mm and the maximum sphere radius is 0,005 mm. These figures are given in ISO 25178-3:2012, Table 1 and are determined independently of the size of the chosen L-filter nesting index.

All filters used are areal Gaussian filters.

The F-operator is the total least square removal of form on S-L evaluation area.

Annex D
(informative)

Recommended procedures for indication of intersection planes

D.1 General

In ISO 1101:2012, different types of planes are introduced to make annotations drawing-plane independent.

This concept is, in a simplified way, now introduced for areal surface texture annotations where one of these planes, the "intersection plane" with its symbol the "intersection plane indicator", is applied for our purposes as explained in this annex.

For definitions and general information on intersection and other planes, see ISO 1101:2012.

NOTE It is expected that the intersection plane indicator will be introduced in the ongoing revision of the profile surface texture standards package.

In the normal case, the intersection planes for the surface lay orientation and the orientation of the evaluation area coincide into one plane, where the 2-D drawing plane in 3-D is replaced with the intersection plane when this is necessary for the correct interpretation of the drawing requirement. An areal surface texture specification, however, might contain a need for a reference to two separate intersection planes. In this annex, information and an example are given on how this can be made.

D.2 Case 1

Case 1 is a surface texture indication without a surface lay symbol but with an intersection plane indicator. In this case, the intersection plane orients the evaluation area, an example is shown in Figure D.1.

The evaluation area is parallel with intersection plane A. This is the normal specification situation.

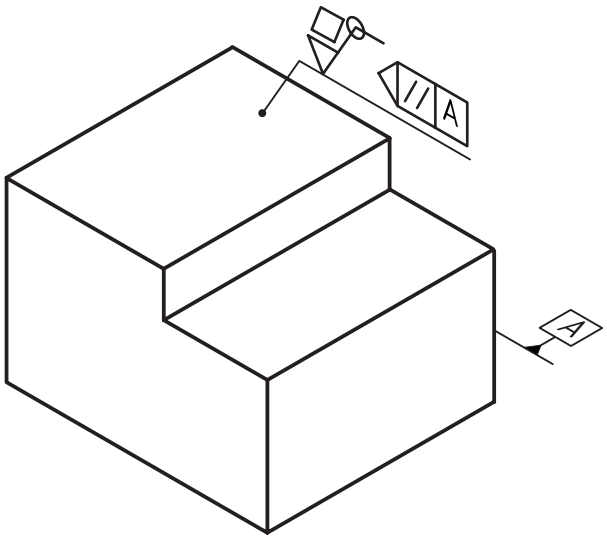


Figure D.1 — Example of an evaluation area oriented with the help of an intersection plane indicator

D.3 Case 2

Case 2 is a surface texture indication with a surface lay symbol and with an intersection plane indicator. In this case, the intersection plane orients both the evaluation area and the surface lay. As in 2-D drawings, the choice of the surface-lay graphical symbol determines the orientation of the lay in relation to the intersection plane. An example is shown in Figure D.2

NOTE 1 In Figure D.2, the evaluation area is parallel with intersection plane A. The surface lay is oriented perpendicular to the intersection plane A.

NOTE 2 The toolmarks in Figure D.2 are shown as an illustration and are not part of the specification indication.

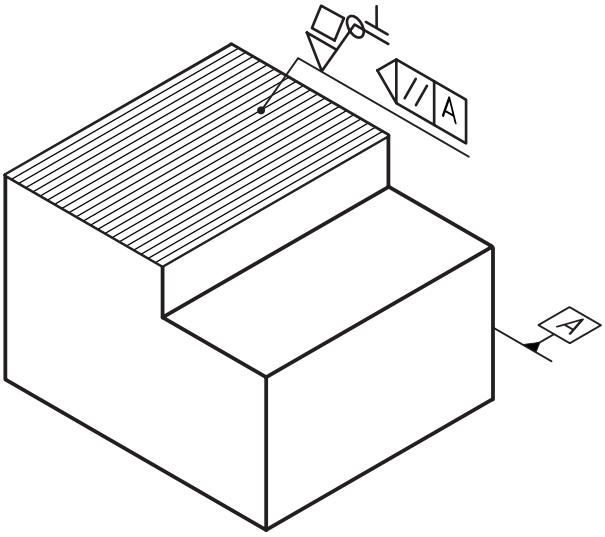


Figure D.2 — Example of evaluation area and surface lay oriented with the help of an intersection plane indicator

D.4 Case 3

Case 3 is a surface texture indication with a surface lay symbol and with two intersection plane indicators. In this case, the upper intersection plane indicator orients the surface lay and the lower intersection plane orients the evaluation area. As in 2-D drawings, the choice of surface lay graphical symbol determines the orientation in relation to the intersection plane. An example is shown in Figure D.3.

NOTE 1 The toolmarks in Figure D.3 are shown as an illustration and are not part of the specification indication.

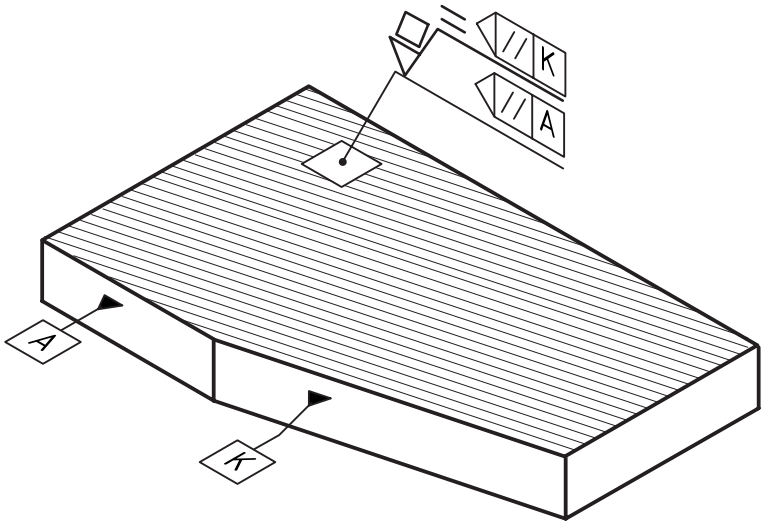


Figure D.3 — Example of evaluation area and surface lay oriented with the help of two intersection plane indicators

Observe in Figure D.3 that:

— the evaluation area is parallel with intersection plane A; and

— the surface lay is oriented parallel to the intersection plane K.

Datums A and K are separate independent datums.

Annex E
(informative)

ISO special specification elements for areal surface texture

E.1 Filter symbols

Table E.1 — Filter symbols

Symbol	Name	ISO 16610 Designation(s)	ISO Document(s)
G	Gaussian	**FALG**, **FPLG**	**ISO 16610-61**, **-21**
S	Spline	FALS, **FPLS**	ISO 16610-62, **-22**
SW	Spline Wavelet	**FALPSW, FPLPSW**	**ISO 16610**-69**, -29**
CW	Complex Wavelet	**FALPCW, FPLPCW**	**ISO 16610**-69**, -29**
RG	Robust Gaussian	**FARG, FPRG**	**ISO 16610-71, -31**
RS	Robust Spline	FARS, **FPRS**	ISO 16610-72, **-32**
OB	Opening Ball	FAMOB	ISO 16610-81,
OD	Opening Disc	**FPMOD**	**ISO 16610-41**
OH	Opening Horizontal segment	FAMOH, **FPMOH**	ISO 16610-81, **-41**
CB	Closing Ball	FAMCB	ISO 16610-81
CD	Closing Disc	**FPMCD**	**ISO 16610-41**
CH	Closing Horizontal segment	FAMCH, **FPMCH**	ISO 16610-81, **-41**
AB	Alternating series Ball	FAMAB	ISO 16610-89
AD	Alternating series Disc	**FPMAD**	**ISO 16610-49**
AH	Alternating series Horizontal segment	FAMAH,**FPMAH**	ISO 16610**-49**
SW	Segmentation	**FAMSW**	**ISO 16610-85**
H	Harmonic (single wavelength)		N/A
Areal filter designations and standards published or under development are marked in bold.			

EXAMPLE Example of a key for a filter designation:

A Gaussian filter with symbol “G” for surface texture areal is designated FALG where “F” stands for “filter”, “A” stands for “areal”, “L” stands for “linear” and “G” stands for “Gaussian”.

E.2 Nesting indices

Table E.2 — Nesting indices

Symbol	Name	Nesting index
G	Gaussian	Cutoff length Cutoff UPR
S	Spline	Cutoff length Cutoff UPR
W	Wavelet	Cutoff length Cutoff UPR
RG	Robust Gaussian	Cutoff length Cutoff UPR
RS	Robust Spline	Cutoff length Cutoff UPR
OB	Opening Ball	Ball radius
OH	Opening Horizontal segment	Segment length
OD	Opening Disc	Disc radius
CB	Closing Ball	Ball radius
CH	Closing Horizontal segment	Segment length
CD	Closing Disc	Disc radius
AB	Alternating Ball	Ball radius
AH	Alternating Horizontal segment	Segment length
AD	Alternating Disc	Disc radius
H	Harmonic	Wavelength UPR number
UPR stands for Undulations Per Revolution.		

E.3 Non-filter association symbols

Table E.3 — Non-filter association symbols

Symbol	Association
G	Total Least Squares
P2	Second order polynomial
P32	Third order polynomial in the x-direction Second order polynomial in the y-direction

Annex F
(informative)

Relation to the GPS matrix model

F.1 General

The ISO GPS matrix model given in ISO 14638 gives an overview of the ISO GPS system of which this standard is a part.

F.2 Information of this part of ISO 25178 and its use

This part of ISO 25178 contains basic information for the tolerancing of areal surface texture of workpieces. It represents the initial basis and describes the fundamentals for indication of areal surface texture.

F.3 Position in the GPS matrix model

This part of ISO 25178 is a general ISO GPS standard. The rules and principles given in this standard apply to all segments of the ISO GPS matrix as illustrated in Table F.1 which are indicated with a filled dot (•).

Table F.1 — Position in the GPS matrix model

	Chain links						
	A	B	C	D	E	F	G
	Symbols and indications	Feature requirements	Feature properties	Conformance and non-conformance	Measurement	Measurement equipment	Calibrations
Size							
Distance							
Radius							
Angle							
Form							
Orientation							
Location							
Run-out							
Profile surface texture							
Areal surface texture	•						
Surface imperfections							
Edges							

F.4 Related international standards

The related international standards are those of the chains of standards indicated in Table F.1.

Bibliography

[1] ISO 128 (all parts), *Technical product documentation (TPD) – General principles of presentation -*

[2] ISO 129 (all parts), *Technical product documentation – Indication of dimensions and tolerances*

[3] ISO 3098-5, *Technical product documentation — Lettering — Part 5: CAD lettering of the Latin alphabet, numerals and marks*

[4] ISO 8015, *Geometrical product specifications (GPS) — Fundamentals — Concepts, principles and rules*

[5] ISO 4288, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Rules and procedures for the assessment of surface texture*

[6] ISO 14253-1, *Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for proving conformity or nonconformity with specifications*

[7] ISO 14638:2015, *Geometrical product specifications (GPS) — Matrix model*

[8] ISO/IEC Guide 99, *International vocabulary of metrology — Basic and general concepts and associated terms (VIM)*

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