
**Geometrical product specifications
(GPS) — Surface texture: Profile —**

**Part 3:
Specification operators**

*Spécification géométrique des produits (GPS) — État de surface:
Méthode du profil —*

Partie 3: Opérateurs de spécification



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Contents

	Page
Foreword.....	iv
Introduction.....	v
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	1
4 Complete specification operator.....	2
4.1 Introduction.....	2
4.2 General.....	2
4.3 General default settings.....	2
4.4 Default settings based on the specification.....	3
4.4.1 General rules.....	3
4.4.2 Default settings based on N_{ic} or Scn	4
4.4.3 Default settings for R_a , R_q , R_z , R_p , R_v , R_{zx} and R_t based on the upper tolerance limit.....	5
4.4.4 Default settings for R_a , R_q , R_z , R_p , R_v , R_{zx} and R_t based on bilateral tolerance limits.....	6
4.4.5 Default settings for R_a , R_q , R_z , R_p , R_v , R_{zx} and R_t based on the lower tolerance limit.....	7
4.4.6 Default settings for P_t	7
5 Default attribute values for parameters from ISO 21920-2.....	8
5.1 General.....	8
5.2 Default attribute values for height parameters and spatial parameters.....	8
5.3 Default attribute values for material ratio functions and related parameters.....	8
5.4 Default attribute values for volume parameters.....	9
5.5 Default attribute values for feature parameters.....	9
6 Default units for parameters from ISO 21920-2.....	9
6.1 General.....	9
6.2 Height parameters.....	10
6.3 Spatial parameters.....	10
6.4 Hybrid parameters.....	10
6.5 Material ratio functions and related parameters.....	10
6.6 Volume parameters.....	11
6.7 Feature parameters.....	11
Annex A (informative) How to determine specification operators.....	13
Annex B (informative) Examples of the determination of default settings.....	15
Annex C (informative) Major changes from ISO 4288.....	23
Annex D (informative) Settings for profile surface texture evaluation in the absence of a specification.....	24
Annex E (informative) Overview of profile and areal standards in the GPS matrix model.....	27
Annex F (informative) Relation with the GPS matrix.....	28
Bibliography.....	29

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 first edition of ISO 21920-3 cancels and replaces ISO 4288:1996, which has been technically revised. It also incorporates the Technical Corrigendum ISO 4288:1996/Cor. 1:1998.

The main changes to ISO 4288:1996 are as follows:

- no distinction between periodic and non-periodic profiles;
- the basis for defaults is the drawing indication;
- the maximum tolerance acceptance rule is the default tolerance acceptance rule;
- for the determination of the profile position, surface defects are considered as part of the specified surface in the default case.

A list of all parts in the ISO 21920 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.

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 chain link C of the chains of standards on profile 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 F](#).

This document specifies the specification operators according to ISO 17450-2.

Throughout this document, parameters are written as abbreviated terms with lower-case suffixes (as in Rq) which are used in product documentation, drawings and data sheets.

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

Part 3: Specification operators

1 Scope

This document specifies the complete specification operator for surface texture by profile 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 21920-1, *Geometrical product specifications (GPS) — Surface texture: Profile — Part 1: Indication of surface texture*

ISO 21920-2, *Geometrical product specifications (GPS) — Surface texture: Profile — Part 2: Terms, definitions and surface texture parameters*

ISO 16610-21, *Geometrical product specifications (GPS) — Filtration — Part 21: Linear profile filters: Gaussian filters*

ISO 16610-31, *Geometrical product specifications (GPS) — Filtration — Part 31: Robust profile filters: Gaussian regression filters*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21920-1 and ISO 21920-2 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 setting class

Scn

identifier to label default settings

Note 1 to entry: Specific setting classes are Sc1, Sc2, Sc3, Sc4 and Sc5.

Note 2 to entry: The setting class specifies the relevant column of [Tables 2](#) to [6](#).

4 Complete specification operator

4.1 Introduction

For non-explicitly specified specification elements (see ISO 21920-1) and often-used specification operators, default settings are used. Default settings should not be expected to ensure correlation with any particular workpiece function.

The advantage of the default specification operators given in [4.3](#) and [4.4](#) is to simplify the drawing indications.

4.2 General

The complete specification operator (see ISO 17450-2) consists of all the operators required for an unambiguous specification. It consists of an ordered full set of unambiguous specification operations in an unambiguous order. For profile surface texture, the complete specification operator defines all setting elements.

The basis for the default settings is the drawing indication according to ISO 21920-1. For R-parameters either the setting class or the profile L-filter nesting index shall be specified. For W-parameters either the setting class or the profile S-filter nesting index shall be specified.

For the R-parameters R_a , R_q , R_z , R_p , R_v , R_{zx} and R_t , and for P_t , all default settings can be specified by the specification of the tolerance limit, see [4.4.3](#) to [4.4.6](#).

A flowchart illustrating the general way to determine the specification operators is given in [Annex A](#). Examples for the determination of default settings are given in [Annex B](#). [Annex C](#) provides an overview of the most important changes in the determination of the default settings according to this document in relation to ISO 4288. A recommendation for the selection of settings in the absence of a specification is given in [Annex D](#). [Annex E](#) provides an overview of the profile and areal standards in the GPS matrix model.

NOTE 1 There is no distinction between periodic and non-periodic profiles.

NOTE 2 This document describes specification operators. For the verification, the following applies: “the verification operator is the physical implementation of the specification operator. It may have exactly the same operations in the same order, in which case the method uncertainty is zero, or it may have different operations or perform the operations in a different order, in which case the method uncertainty is not zero.” [SOURCE: ISO 8015:2011, 5.10.1]

NOTE 3 There are no defaults for electromagnetic profiles.

4.3 General default settings

When specifying surface texture by the profile method, the surface is the tolerated feature. Therefore, the profile direction and the profile position are an integral part of the specification. Surface imperfections and surface defects are part of the specified surface and shall be taken into account when determining profile locations, if not otherwise stated.

The general default settings given in [Table 1](#), independent of the specified parameter type, shall be implemented.

NOTE Considering surface imperfections and surface defects as part of the specified surface is a change from ISO 4288.

Table 1 — General default settings

Criterion	Default setting
Procedure of profile extraction	Mechanical profile
Profile direction	The direction yielding the maximum values of roughness height parameters (perpendicular to the dominant lay direction)
Profile position	The profile position depends on the tolerance acceptance rule according to ISO 21920-1. For the maximum tolerance acceptance rule: location on that part of the surface on which critical values can be expected. If this location cannot be clearly identified separate traces shall be distributed equally over this part of the surface. For the 16 % tolerance acceptance rule and for the median tolerance acceptance rule: uniformly distributed traces shall be taken to represent the entire surface, see NOTE 1.
Tolerance type	Upper tolerance limit
Tolerance acceptance rule	The maximum tolerance acceptance rule according to ISO 21920-1
Profile S-filter type	Gaussian filter according to ISO 16610-21
Profile L-filter type (for R-parameters) Profile S-filter type (for W-parameters)	Gaussian filter according to ISO 16610-21 Exception: The default L-filter for R_k , R_{pk} , R_{vk} , R_{pkx} , R_{vix} , R_{mrk1} , R_{mrk2} , R_{ak1} , R_{ak2} , R_{pq} , R_{mq} and R_{vq} is the robust Gaussian filter, second order according to ISO 16610-31, see NOTE 2.
Profile F-operator association method and element	Association and removal of the specified form element with total least square, see NOTES 3 and 4.
NOTE 1 For the verification, this part of the surface can be identified, for example, by visual inspection.	
NOTE 2 The change of the default filter type for R_k , R_{pk} , R_{vk} , R_{pkx} , R_{vix} , R_{mrk1} , R_{mrk2} , R_{ak1} , R_{ak2} , R_{pq} , R_{mq} and R_{vq} leads to a better elimination of large-scale components and can generate slightly differing values of these parameters from the values obtained on the basis of ISO 13565-1.	
NOTE 3 For the definition of "Association" see ISO 17450-1.	
NOTE 4 For a circle, the radius shall also be included in the least square optimization and not held fixed to the nominal value. The F-operator is applied to the evaluation length.	

4.4 Default settings based on the specification

4.4.1 General rules

This subclause defines rules for the default settings based on the specification in addition to the general default settings.

If several parameters are specified within one graphical symbol, the parameter in the first line shall be used to select the default settings.

If more than one specification element is specified, the topmost specification element shall be used to define the column for all non-explicitly specified default settings in [Tables 2 to 6](#).

If a nesting index N_{ic} not listed in [Tables 2 to 6](#) is specified, a second specification element shall be specified, for example the setting class Scn , to define the column for all other non-explicitly specified settings.

If a nesting index N_{is} not listed in [Tables 2 to 6](#) is specified, the maximum sampling distance d_x shall be $N_{is}/5$, for example if $N_{is} = 5 \mu m$ then the maximum sampling distance $d_x = 1 \mu m$.

If there is a contradiction between the default profile direction and the default measuring length, the profile direction shall be respected first.

NOTE See examples in [B.1](#) to [B.8](#).

4.4.2 Default settings based on N_{ic} or Scn

For all R-parameters, except for R_a , R_q , R_z , R_p , R_v , R_{zx} and R_t , one of the following specifications shall be given in the drawing indication:

- the profile L-filter nesting index N_{ic} ; or
- the setting class Scn .

For all W-parameters one of the following specifications shall be given in the drawing indication:

- the profile S-filter nesting index N_{is} ; or
- the setting class Scn .

For all P-parameters, except for P_t , one of the following specifications shall be given in the drawing indication:

- the profile S-filter nesting index N_{is} ; or
- the setting class Scn .

This defines the default settings according to the corresponding column in [Table 2](#), which defines the non-explicitly specified settings.

Table 2 — Default settings based on N_{ic} or Scn

	Setting class				
	Sc1	Sc2	Sc3	Sc4	Sc5
Profile L-filter nesting index N_{ic} (cut-off λ_c for R-parameters) or profile S-filter nesting index N_{ic} (cut-off λ_c for W-parameters) mm	0,08	0,25	0,8	2,5	8
Evaluation length l_e mm	0,4	1,25	4	12,5	40
Exception: the default evaluation length l_e for P-parameters is the length of the specified feature					
Profile S-filter nesting index N_{is} (cut-off λ_s) μm	2,5	2,5	2,5	8	25
Maximum sampling distance d_x μm	0,5	0,5	0,5	1,5	5
Maximum nominal tip radius r_{tip} μm	2	2	2	5	10
Only for section length parameters					
Section length l_{sc} mm	0,08	0,25	0,8	2,5	8
Exception: the default section length l_{sc} for section length P-parameters is $l_e/5$					
Number of sections n_{sc}	5	5	5	5	5
NOTE For P-parameters, there is no difference between Sc1, Sc2 and Sc3 but these columns are retained to keep the same structure as in Tables 2 to 6.					

4.4.3 Default settings for R_a , R_q , R_z , R_p , R_v , R_{zx} and R_t based on the upper tolerance limit

The default settings for R_a , R_q , R_z , R_p , R_v , R_{zx} and R_t based on the specified upper tolerance limit U or the specified setting class, Scn , are given in Table 3.

If the setting class is specified, it defines the default settings for all non-specified specification elements even if other specification elements are specified.

Table 3 — Default settings for R_a , R_q , R_z , R_p , R_v , R_{zx} and R_t based on the upper tolerance limit

	Setting class				
	Sc1	Sc2	Sc3	Sc4	Sc5
Specified parameter	Upper tolerance limit (U) of the specified parameter				
R_z, μm	$U \leq 0,16$	$0,16 < U \leq 0,8$	$0,8 < U \leq 16$	$16 < U \leq 80$	$U > 80$
R_a, μm	$U \leq 0,02$	$0,02 < U \leq 0,1$	$0,1 < U \leq 2$	$2 < U \leq 10$	$U > 10$
R_p, μm	$U \leq 0,06$	$0,06 < U \leq 0,3$	$0,3 < U \leq 6$	$6 < U \leq 30$	$U > 30$
R_v, μm	$U \leq 0,10$	$0,10 < U \leq 0,5$	$0,5 < U \leq 10$	$10 < U \leq 50$	$U > 50$
R_q, μm	$U \leq 0,032$	$0,032 < U \leq 0,16$	$0,16 < U \leq 3,2$	$3,2 < U \leq 16$	$U > 16$
R_{zx}, μm	$U \leq 0,23$	$0,23 < U \leq 1,15$	$1,15 < U \leq 23$	$23 < U \leq 115$	$U > 115$
R_t, μm	$U \leq 0,26$	$0,26 < U \leq 1,3$	$1,3 < U \leq 26$	$26 < U \leq 130$	$U > 130$
Profile L-filter nesting index N_{ic} (cut-off λ_c) mm	0,08	0,25	0,8	2,5	8

Table 3 (continued)

	Setting class				
	Sc1	Sc2	Sc3	Sc4	Sc5
Evaluation length l_e , mm	0,4	1,25	4	12,5	40
Profile S-filter nesting index N_{is} (cut-off λ_s) μm	2,5	2,5	2,5	8	25
Maximum sampling distance d_x μm	0,5	0,5	0,5	1,5	5
Maximum nominal tip radius r_{tip} μm	2	2	2	5	10
Only for section length parameters, for example Rz, Rp, Rv					
Section length l_{sc} mm	0,08	0,25	0,8	2,5	8
Number of sections n_{sc}	5	5	5	5	5

4.4.4 Default settings for Ra, Rq, Rz, Rp, Rv, Rzx and Rt based on bilateral tolerance limits

The default settings for Ra, Rq, Rz, Rp, Rv, Rzx and Rt based on the specified bilateral tolerance limits or the specified setting class, Scn, are given in Table 4.

NOTE Tolerance centre: $C = (U + L)/2$

Table 4 — Default settings for Ra, Rq, Rz, Rp, Rv, Rzx and Rt based on bilateral tolerance limits

	Setting class				
	Sc1	Sc2	Sc3	Sc4	Sc5
Specified parameter	Tolerance centre (C) of the bilateral tolerance of the specified parameter				
Rz , μm	$C \leq 0,128$	$0,128 < C \leq 0,64$	$0,64 < C \leq 12,8$	$12,8 < C \leq 64$	$C > 64$
Ra , μm	$C \leq 0,016$	$0,016 < C \leq 0,08$	$0,08 < C \leq 1,6$	$1,6 < C \leq 8$	$C > 8$
Rp , μm	$C \leq 0,048$	$0,048 < C \leq 0,24$	$0,24 < C \leq 4,8$	$4,8 < C \leq 24$	$C > 24$
Rv , μm	$C \leq 0,08$	$0,08 < C \leq 0,4$	$0,4 < C \leq 8$	$8 < C \leq 40$	$C > 40$
Rq , μm	$C \leq 0,026$	$0,026 < C \leq 0,13$	$0,13 < C \leq 2,6$	$2,6 < C \leq 13$	$C > 13$
Rzx , μm	$C \leq 0,184$	$0,184 < C \leq 0,92$	$0,92 < C \leq 18,4$	$18,4 < C \leq 92$	$C > 92$
Rt , μm	$C \leq 0,208$	$0,208 < C \leq 1,04$	$1,04 < C \leq 20,8$	$20,8 < C \leq 104$	$C > 104$
Profile L-filter nesting index N_{ic} (cut-off λ_c) mm	0,08	0,25	0,8	2,5	8
Evaluation length l_e mm	0,4	1,25	4	12,5	40
Profile S-filter nesting index N_{is} (cut-off λ_s) μm	2,5	2,5	2,5	8	25
Maximum sampling distance d_x μm	0,5	0,5	0,5	1,5	5
Maximum nominal tip radius r_{tip} μm	2	2	2	5	10

Table 4 (continued)

	Setting class				
	Sc1	Sc2	Sc3	Sc4	Sc5
Only for section length parameters, for example Rz, Rp, Rv					
Section length l_{sc} mm	0,08	0,25	0,8	2,5	8
Number of sections n_{sc}	5	5	5	5	5

4.4.5 Default settings for Ra, Rq, Rz, Rp, Rv, Rzx and Rt based on the lower tolerance limit

The default settings for Ra, Rq, Rz, Rp, Rv, Rzx and Rt based on the lower tolerance limit L or the specified setting class, Scn, are given in [Table 5](#).

Table 5 — Default settings for Ra, Rq, Rz, Rp, Rv, Rzx and Rt based on the lower tolerance limit

	Setting class				
	Sc1	Sc2	Sc3	Sc4	Sc5
Specified parameter	Lower tolerance limit (L) of the specified parameter				
Rz , μm	$L \leq 0,08$	$0,08 < L \leq 0,4$	$0,4 < L \leq 8$	$8 < L \leq 40$	$L > 40$
Ra , μm	$L \leq 0,01$	$0,01 < L \leq 0,05$	$0,05 < L \leq 1$	$1 < L \leq 5$	$L > 5$
Rp , μm	$L \leq 0,03$	$0,03 < L \leq 0,15$	$0,15 < L \leq 3$	$3 < L \leq 15$	$L > 15$
Rv , μm	$L \leq 0,05$	$0,05 < L \leq 0,25$	$0,25 < L \leq 5$	$5 < L \leq 25$	$L > 25$
Rq , μm	$L \leq 0,016$	$0,016 < L \leq 0,08$	$0,08 < L \leq 1,6$	$1,6 < L \leq 8$	$L > 8$
Rzx , μm	$L \leq 0,115$	$0,115 < L \leq 0,57$	$0,57 < L \leq 11,5$	$11,5 < L \leq 57$	$L > 57$
Rt , μm	$L \leq 0,13$	$0,13 < L \leq 0,65$	$0,65 < L \leq 13$	$13 < L \leq 65$	$L > 65$
Profile L-filter nesting index N_{lc} (cut-off λ_c) mm	0,08	0,25	0,8	2,5	8
Evaluation length l_e mm	0,4	1,25	4	12,5	40
Profile S-filter nesting index N_{ls} (cut-off λ_s) μm	2,5	2,5	2,5	8	25
Maximum sampling distance d_x μm	0,5	0,5	0,5	1,5	5
Maximum nominal tip radius r_{tip} μm	2	2	2	5	10
Only for section length parameters, for example Rz, Rp, Rv					
Section length l_{sc} mm	0,08	0,25	0,8	2,5	8
Number of sections n_{sc}	5	5	5	5	5

4.4.6 Default settings for Pt

The default settings for Pt based on the specified tolerance limit and tolerance type are given in [Table 6](#).

Table 6 — Default settings for Pt based on the tolerance limit

	Setting class				
	Sc1	Sc2	Sc3	Sc4	Sc5
Specified parameter Pt, μm	Upper tolerance limit (U)				
	$U \leq 0,27$	$0,27 < U \leq 1,35$	$1,35 < U \leq 27$	$27 < U \leq 135$	$U > 135$
	Centre (C) of the bilateral tolerance limits				
	$C \leq 0,216$	$0,216 < C \leq 1,08$	$1,08 < C \leq 21,6$	$21,6 < C \leq 108$	$C > 108$
	Lower tolerance limit (L)				
	$L \leq 0,135$	$0,135 < L \leq 0,68$	$0,68 < L \leq 13,5$	$13,5 < L \leq 68$	$L > 68$
Evaluation length l_e	Length of the specified feature				
Profile S-filter nesting index N_{is} (cut-off λ_s) μm	2,5	2,5	2,5	8	25
Maximum sampling distance d_x μm	0,5	0,5	0,5	1,5	5
Maximum nominal tip radius r_{tip} μm	2	2	2	5	10
NOTE In this table, there is no difference between Sc1, Sc2 and Sc3 but these columns are retained to keep the same structure as in Tables 2 to 6 .					

5 Default attribute values for parameters from ISO 21920-2

5.1 General

Attribute values are necessary for the calculation of some parameters. The default attribute values are given in [5.2](#) to [5.5](#).

For parameters with necessary attribute values not listed in [5.2](#) to [5.5](#), the attribute values shall be given in the specification.

NOTE Attributes are given in parenthesis following the parameter name.

5.2 Default attribute values for height parameters and spatial parameters

The default attribute values for height parameters and spatial parameters are given in [Table 7](#).

Table 7 — Default attribute values for height parameters and spatial parameters

Parameter	Subclause in ISO 21920-2	Attribute	Default value
Pzx, Wzx, Rzx	4.2.7	Length l of the moving section	$l = l_{sc}$, see Table 2
Pal, Wal, Ral	4.3.2	Fastest decay to a specified value s , with $0 \leq s < 1$	$s = 0,2$

5.3 Default attribute values for material ratio functions and related parameters

There are no defaults for the material ratio functions and related parameters according to ISO 21920-2:2021, 4.5.

5.4 Default attribute values for volume parameters

The default attribute values for volume parameters are given in [Table 8](#).

Table 8 — Default attribute values for volume parameters

Parameter	Subclause in ISO 21920-2	Attribute	Default value
Pvmp, Wvmp, Rvmp	4.5.5.2	Material ratio p	$p = 10 \%$
Pvmc, Wvmc, Rvmc	4.5.5.3	Material ratios p and q	$p = 10 \%$ $q = 80 \%$
Pvvc, Wvvc, Rvvc	4.5.5.4	Material ratios p and q	$p = 10 \%$ $q = 80 \%$
Pvvv, Wvvv, Rvvv	4.5.5.5	Material ratio p	$p = 80 \%$

5.5 Default attribute values for feature parameters

For the determination of profile elements, the default values are as follows:

- peak height discrimination: 10 % of Pp, Rp and Wp for the P-profile, R-profile and W-profile, respectively;
- pit depth discrimination: 10 % of Pv, Rv and Wv for the P-profile, R-profile and W-profile, respectively.

The default attribute values for feature parameters are given in [Table 9](#).

Table 9 — Default attribute values for feature parameters

Parameter	Subclause in ISO 21920-2	Attribute	Default value
Ppc, Wpc, Rpc	5.2.8	Unit length for peak count parameters	$L = 10 \text{ mm}$
Ppd, Wpd, Rpd	5.3.2.1	Wolfprune nesting index $X\%$ of Rz	$X\% = 5 \%$
Pvd, Wvd, Rvd	5.3.2.2	Wolfprune nesting index $X\%$ of Rz	$X\% = 5 \%$
Pmpc, Wmpc, Rmpc	5.3.2.3	Wolfprune nesting index $X\%$ of Rz	$X\% = 5 \%$
Pmvc, Wmvc, Rmvc	5.3.2.4	Wolfprune nesting index $X\%$ of Rz	$X\% = 5 \%$
P5p, W5p, R5p	5.3.2.5	Wolfprune nesting index $X\%$ of Rz	$X\% = 5 \%$
P5v, W5v, R5v	5.3.2.6	Wolfprune nesting index $X\%$ of Rz	$X\% = 5 \%$

6 Default units for parameters from ISO 21920-2

6.1 General

By default, the indication is given without units. The default units of parameters are listed in [6.2](#) to [6.7](#).

6.2 Height parameters

The default units for height parameters are given in [Table 10](#).

Table 10 — Default units for height parameters

Parameter	Subclause in ISO 21920-2	Default unit
Pa, Wa, Ra	4.2.2	µm
Pq, Wq, Rq	4.2.3	µm
Psk, Wsk, Rsk	4.2.4	—
Pku, Wku, Rku	4.2.5	—
Pt, Wt, Rt	4.2.6	µm
Pzx, Wzx, Rzx	4.2.7	µm

6.3 Spatial parameters

The default units for spatial parameters are given in [Table 11](#).

Table 11 — Default units for spatial parameters

Parameter	Subclause in ISO 21920-2	Default unit
Pal, Wal, Ral	4.3.2	µm
Psw, Wsw, Rsw	4.3.3	µm

6.4 Hybrid parameters

The default units for hybrid parameters are given in [Table 12](#).

Table 12 — Default units for hybrid parameters

Parameter	Subclause in ISO 21920-2	Default unit
Pdq, Wdq, Rdq	4.4.2	—
Pda, Wda, Rda	4.4.3	—
Pdt, Wdt, Rdt	4.4.4	—
Pdl, Wdl, Rdl	4.4.5	mm
Pdr, Wdr, Rdr	4.4.6	— ^a
^a Pdr, Wdr and Rdr can be expressed in per cent, e.g. 5 %.		

6.5 Material ratio functions and related parameters

The default units for functions and related parameters are given in [Table 13](#).

Table 13 — Default units for material ratio functions and related parameters

Parameter	Subclause in ISO 21920-2	Default unit
Pml, Wml, Rml	4.5.1.1	mm
Pmc, Wmc, Rmc	4.5.1.2	— ^a
Pcm, Wcm, Rcm	4.5.1.4	µm
Phd, Whd, Rhd	4.5.1.6	1/µm
^a These parameters can be expressed in per cent.		

Table 13 (continued)

Parameter	Subclause in ISO 21920-2	Default unit
Pvm, Wvm, Rvm	4.5.1.8	ml/m ²
Pvv, Wvv, Rvv	4.5.1.9	ml/m ²
Pmr, Wmr, Rmr	4.5.2.1	— ^a
Pdc, Wdc, Rdc	4.5.2.2	µm
Pk, Rk	4.5.3.3	µm
Ppk, Rpk	4.5.3.4	µm
Pvk, Rvk	4.5.3.5	µm
Ppkx, Rpkx	4.5.3.6	µm
Pvkx, Rvkx	4.5.3.7	µm
Pmrk1, Rmrk1	4.5.3.8	— ^a
Pmrk2, Rmrk2	4.5.3.9	— ^a
Pak1, Rak1	4.5.3.10	µm ² /mm
Pak2, Rak2	4.5.3.11	µm ² /mm
Ppq, Rpq	4.5.4.2	µm
Pvq, Rvq	4.5.4.3	µm
Pmq, Rmq	4.5.4.4	— ^a
^a These parameters can be expressed in per cent.		

6.6 Volume parameters

The default units for volume parameters are given in [Table 14](#).

Table 14 — Default units for volume parameters

Parameter	Subclause in ISO 21920-2	Default unit
Pvmp, Wvmp, Rvmp	4.5.5.2	ml/m ²
Pvmc, Wvmc, Rvmc	4.5.5.3	ml/m ²
Pvvc, Wvvc, Rvvc	4.5.5.4	ml/m ²
Pvvv, Wvvv, Rvvv	4.5.5.5	ml/m ²
NOTE The unit ml/m ² is used because oil is usually specified in litres and the amount of oil per square metre for typical applications is of the order of one millilitre. If the film of oil is uniformly distributed, then 1 ml/m ² corresponds to 1 µm height of the film.		

6.7 Feature parameters

The default units for feature parameters are given in [Table 15](#).

Table 15 — Default units for feature parameters

Parameter	Subclause in ISO 21920-2	Default unit
Ppt, Wpt, Rpt	5.1.2	µm
Pp, Wp, Rp	5.1.3	µm
Pvt, Wvt, Rvt	5.1.4	µm
Pv, Wv, Rv	5.1.5	µm
Pz, Wz, Rz	5.1.6	µm

Table 15 (continued)

Parameter	Subclause in ISO 21920-2	Default unit
Psm, Wsm, Rsm	5.2.2	mm
Psmx, Wsmx, Rsmx	5.2.3	mm
Psmq, Wsmq, Rsmq	5.2.4	mm
Pc, Wc, Rc	5.2.5	µm
Pcx, Wcx, Rcx	5.2.6	µm
Pcq, Wcq, Rcq	5.2.7	µm
Ppc, Wpc, Rpc	5.2.8	1/cm
Ppd, Wpd, Rpd	5.3.2.1	1/cm
Pvd, Wvd, Rvd	5.3.2.2	1/cm
Pmpc, Wmpc, Rmpc	5.3.2.3	1/µm
Pmvc, Wmvc, Rmvc	5.3.2.4	1/µm
P5p, W5p, R5p	5.3.2.5	µm
P5v, W5v, R5v	5.3.2.6	µm
P10z, W10z, R10z	5.3.2.7	µm

Annex A (informative)

How to determine specification operators

[Figure A.1](#) shows the general way to determine the specification operators for an existing specification without explicitly specified settings.

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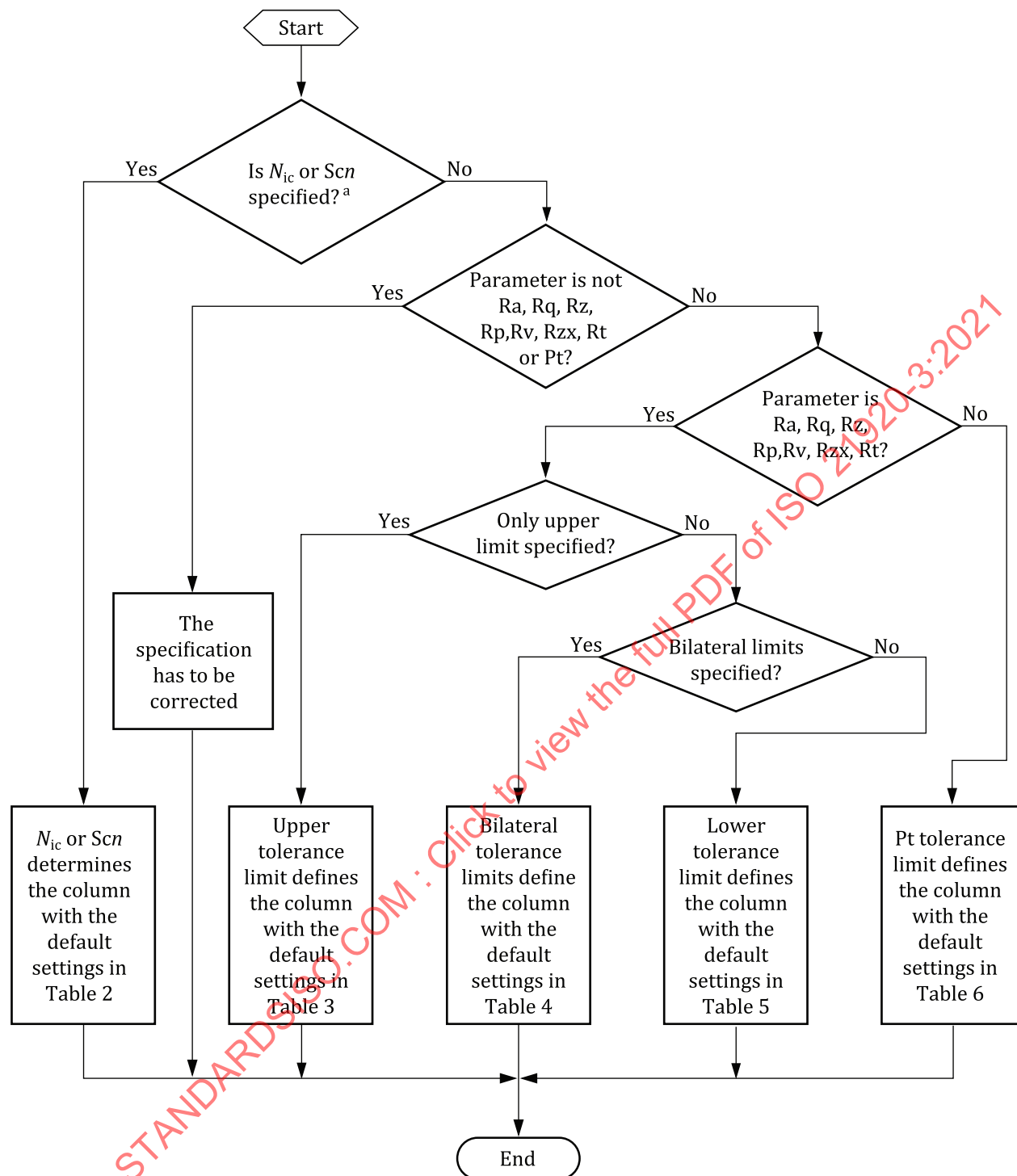


Figure A.1 — How to determine default settings for a minimal indication

Annex B (informative)

Examples of the determination of default settings

B.1 Default settings for a minimal indication based on N_{ic} or Scn

See [Figure B.1](#) for examples of two equivalent options for specifying a minimal indication for R-parameters with defaults according to [Tables 1](#) and [2](#), and see [Table B.1](#) for explanations.

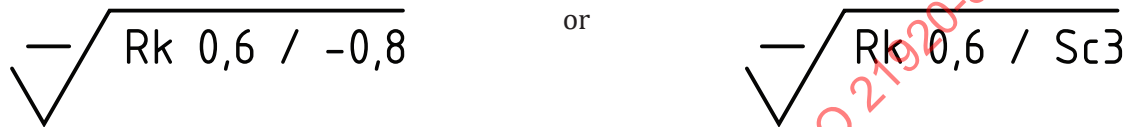


Figure B.1 — Minimal indication for an R-parameter, based on N_{ic} or Scn

Table B.1 — Explanation and valid defaults for the examples in [Figure B.1](#)

Specification element	Explanation
Graphical symbol	Profile surface texture requirement No manufacturing requirements
Rk	R-parameter: Rk
0,6	Tolerance limit value: 0,6 μm
0,8	Profile L-filter nesting index N_{ic} : 0,8 mm, this defines the relevant column of Table 2 , the Sc3 column
or	
Sc3	Setting class: Sc3, this defines the relevant column of Table 2
Default settings according to Tables 1 and 2	
Profile direction	Orthogonal to the surface lay
Tolerance type	Upper tolerance limit
Tolerance acceptance rule	Maximum tolerance acceptance rule
Profile S-filter type	Gaussian filter according to ISO 16610-21
Profile L-filter type	Robust Gaussian filter according to ISO 16610-31
Profile F-operator association method and element	Association and removal of the specified form element with total least square
Evaluation length l_e	4 mm
Profile S-filter nesting index N_{is}	2,5 μm
Maximum sampling distance d_x	0,5 μm
Maximum nominal tip radius r_{tip}	2 μm

B.2 Default settings for Rz, based on the upper tolerance limit

For the R-parameters Rz, Ra, Rp, Rv, Rq, Rzx and Rt, there are default settings based on the tolerance limit. See [Tables 3](#), [4](#) and [5](#) for the upper tolerance limit, bilateral tolerance limits and lower tolerance limit, respectively.

See [Figure B.2](#) for an example of a minimal indication for R_z , based on the upper tolerance limit with defaults according to [Tables 1](#) and [3](#), and see [Table B.2](#) for explanations.

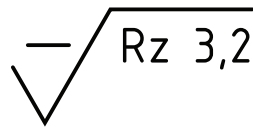


Figure B.2 — Minimal indication for R_z , based on the upper tolerance limit

Table B.2 — Explanation and valid defaults for the example in [Figure B.2](#)

Specification element	Explanation
Graphical symbol	Profile surface texture requirement No manufacturing requirements
R_z	R-parameter: R_z
3,2	Tolerance limit value: 3,2 μm , this defines the relevant column of Table 3 , the $Sc3$ column
Default settings according to Tables 1 and 3	
Profile direction	Orthogonal to the surface lay
Tolerance type	Upper tolerance limit
Tolerance acceptance rule	Maximum tolerance acceptance rule
Profile S-filter type	Gaussian filter according to ISO 16610-21
Profile L-filter type	Gaussian filter according to ISO 16610-21
Profile F-operator association method and element	Association and removal of the specified form element with total least square
Profile L-filter nesting index N_{lc}	0,8 mm
Evaluation length l_e	4 mm
Profile S-filter nesting index N_{ls}	2,5 μm
Maximum sampling distance d_x	0,5 μm
Maximum nominal tip radius r_{tip}	2 μm
Section length l_{sc}	0,8 mm
Number of sections n_{sc}	5

B.3 Default settings for a material ratio parameter

See [Figure B.3](#) for an example of an indication for a material ratio parameter with defaults according to [Tables 1](#) and [2](#), and see [Table B.3](#) for explanations.

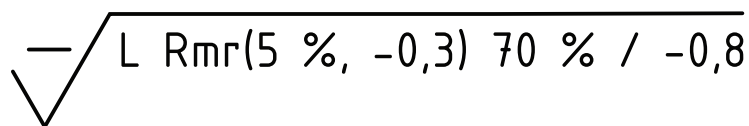


Figure B.3 — Indication for a material ratio parameter

Table B.3 — Explanation and valid defaults for the example in [Figure B.3](#)

Specification element	Explanation
Graphical symbol	Profile surface texture requirement No manufacturing requirements

Table B.3 (continued)

Specification element	Explanation
L	Tolerance type: lower tolerance limit
Rmr(5 %, -0,3)	R-parameter: Rmr with reference level defined by 5 % material ratio and cutting level 0,3 µm below the reference
70 %	Tolerance limit value: 70 %
0,8	Profile L-filter nesting index N_{lc} : 0,8 mm, this defines the relevant column of Table 2, the Sc3 column
Default settings according to Tables 1 and 2	
Profile direction	Orthogonal to the surface lay
Tolerance acceptance rule	Maximum tolerance acceptance rule
Profile S-filter type	Gaussian filter according to ISO 16610-21
Profile L-filter type	Gaussian filter according to ISO 16610-21
Profile F-operator association method and element	Association and removal of the specified form element with total least square
Evaluation length l_e	4 mm
Profile S-filter nesting index N_{is}	2,5 µm
Maximum sampling distance d_x	0,5 µm
Maximum nominal tip radius r_{tip}	2 µm

B.4 Default settings for Ra, based on the upper tolerance limit and an additional setting requirement

For the R-parameters Rz, Ra, Rp, Rv, Rq, Rzx and Rt, there are default settings based on the tolerance limit.

See Figure B.4 for an example of an indication for Ra, based on the upper tolerance limit and an additional setting requirement with defaults according to Tables 1 and 3, and see Table B.4 for explanations.

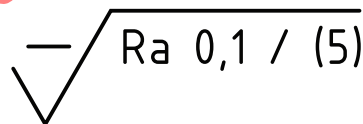


Figure B.4 — Indication for Ra, based on the upper tolerance limit and an additional setting requirement

Table B.4 — Explanation and valid defaults for the example in Figure B.4

Specification element	Explanation
Graphical symbol	Profile surface texture requirement No manufacturing requirements
Ra	R-parameter: Ra
0,1	Tolerance limit value: 0,1 µm, this defines the relevant column of Table 3, the Sc2 column
(5)	Evaluation length l_e : 5 mm
Default settings according to Tables 1 and 3	
Profile direction	Orthogonal to the surface lay
Tolerance type	Upper tolerance limit
Tolerance acceptance rule	Maximum tolerance acceptance rule

Table B.4 (continued)

Specification element	Explanation
Profile S-filter type	Gaussian filter according to ISO 16610-21
Profile L-filter type	Gaussian filter according to ISO 16610-21
Profile F-operator association method and element	Association and removal of the specified form element with total least square
Profile L-filter nesting index N_{lc}	0,25 mm
Profile S-filter nesting index N_{ls}	2,5 μm
Maximum sampling distance d_x	0,5 μm
Maximum nominal tip radius r_{tip}	2 μm

B.5 Default settings for Pt, based on the upper tolerance limit

For Pt, there are default settings based on the tolerance limit.

See [Figure B.5](#) for an example of a minimal indication for Pt, based on the upper tolerance limit with defaults according to [Tables 1](#) and [6](#), and see [Table B.5](#) for explanations.

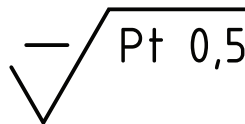


Figure B.5 — Minimal indication for Pt, based on the upper tolerance limit

Table B.5 — Explanation and valid defaults for the example in [Figure B.5](#)

Specification element	Explanation
Graphical symbol	Profile surface texture requirement No manufacturing requirements
Pt	P-parameter: Pt
0,5	Tolerance limit value: 0,5 μm , this defines the relevant column of Table 6 , the Sc2 column
Default settings according to Tables 1 and 6	
Profile direction	Orthogonal to the surface lay
Tolerance type	Upper tolerance limit
Tolerance acceptance rule	Maximum tolerance acceptance rule
Profile S-filter type	Gaussian filter according to ISO 16610-21
Profile F-operator association method and element	Association and removal of the specified form element with total least square
Evaluation length l_e	Length of the specified feature
Profile S-filter nesting index N_{ls}	2,5 μm
Maximum sampling distance d_x	0,5 μm
Maximum nominal tip radius r_{tip}	2 μm

B.6 Default settings for a section length P-parameter, based on the profile S-filter nesting index N_{is}

See [Figure B.6](#) for an example of a minimal indication for a section length P-parameter, based on the profile S-filter nesting index N_{is} with defaults according to [Tables 1](#) and [2](#), and see [Table B.6](#) for explanations.

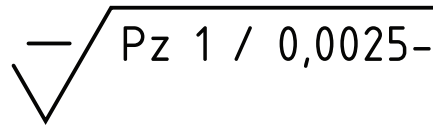


Figure B.6 — Minimal indication for Pz, based on the profile S-filter nesting index N_{is}

Table B.6 — Explanation and valid defaults for the example in [Figure B.6](#)

Specification element	Explanation
Graphical symbol	Profile surface texture requirement No manufacturing requirements
Pz	P-parameter: Pz
1	Tolerance limit value: 1 μm
0,0025	Profile S-filter nesting index N_{is} : 2,5 μm , this defines the relevant column of Table 2 , the Sc1 column
Default settings according to Tables 1 and 2	
Profile direction	Orthogonal to the surface lay
Tolerance type	Upper tolerance limit
Tolerance acceptance rule	Maximum tolerance acceptance rule
Profile S-filter type	Gaussian filter according to ISO 16610-21
Profile F-operator association method and element	Association and removal of the specified form element with total least square
Evaluation length l_e	Length of the specified feature
Maximum sampling distance d_x	0,5 μm
Maximum nominal tip radius r_{tip}	2 μm
Section length l_{sc}	$l_e / 5$
Number of sections n_{sc}	5

B.7 Default settings for Rq, based on bilateral tolerance limits and an additional setting requirement

For the R parameters Rz, Ra, Rp, Rv, Rq, Rzx and Rt, there are default settings based on the tolerance limit.

See [Figure B.7](#) for an example of an indication for Rq, based on bilateral tolerance limits and an additional setting requirement with defaults according to [Tables 1](#) and [4](#), and see [Table B.7](#) for explanations.

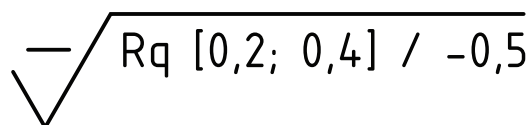


Figure B.7 — Indication for Rq, based on bilateral tolerance limits and an additional setting requirement

Table B.7 — Explanation and valid defaults for the example in Figure B.7

Specification element	Explanation
Graphical symbol	Profile surface texture requirement No manufacturing requirements
Rq	R-parameter: Rq
0,2; 0,4	Bilateral tolerance limits, tolerance centre $C = (0,2 + 0,4)/2 = 0,3 \mu\text{m}$, this defines the relevant column of Table 4, the Sc3 column
0,5	Profile L-filter nesting index N_{lc} : 0,5 mm
Default settings according to Tables 1 and 4	
Profile direction	Orthogonal to the surface lay
Tolerance type	Upper tolerance limit
Tolerance acceptance rule	Maximum tolerance acceptance rule
Profile S-filter type	Gaussian filter according to ISO 16610-21
Profile L-filter type	Gaussian filter according to ISO 16610-21
Profile F-operator association method and element	Association and removal of the specified form element with total least square
Evaluation length l_e	4 mm
Profile S-filter nesting index N_{ls}	2,5 μm
Maximum sampling distance d_x	0,5 μm
Maximum nominal tip radius r_{tip}	2 μm

B.8 Default settings for several parameters within one graphical symbol

If several parameters are specified within one graphical symbol, the parameter in the first line shall be used to select the default settings, see 4.4.1; therefore, it is important which parameter is in the first line.

Figures B.8 and B.9 are examples showing that the order of the parameters within one graphical symbol can lead to different defaults according to Tables 1 and 3; see Tables B.8 and B.9 for explanations.

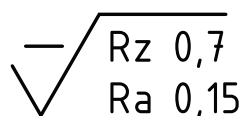


Figure B.8 — Specification for Rz and Ra, where Rz determines the defaults

Table B.8 — Explanation and valid defaults for the example in Figure B.8

Specification element	Explanation
Graphical symbol	Profile surface texture requirement No manufacturing requirements
Rz Ra	R-parameters: Rz and Ra
0,7	Tolerance limit value for Rz: 0,7 μm , this defines the relevant column of Table 3, the Sc2 column for the evaluation of Rz and Ra.
0,15	Tolerance limit value for Ra: 0,15 μm
Default settings according to Tables 1 and 3	

Table B.8 (continued)

Specification element	Explanation
Profile direction	Orthogonal to the surface lay
Tolerance type	Upper tolerance limit
Tolerance acceptance rule	Maximum tolerance acceptance rule
Profile S-filter type	Gaussian filter according to ISO 16610-21
Profile L-filter type	Gaussian filter according to ISO 16610-21
Profile F-operator association method and element	Association and removal of the specified form element with total least square
Profile L-filter nesting index N_{ic}	0,25 mm
Evaluation length l_e	1,25 mm
Profile S-filter nesting index N_{is}	2,5 μm
Maximum sampling distance d_x	0,5 μm
Maximum nominal tip radius r_{tip}	2 μm
Section length l_{sc} (for Rz)	0,25 mm
Number of sections n_{sc} (for Rz)	5

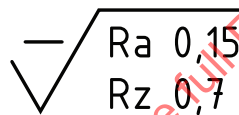


Figure B.9 — Specification for Ra and Rz, where Ra determines the defaults

Table B.9 — Explanation and valid defaults for the example in Figure B.9

Specification element	Explanation
Graphical symbol	Profile surface texture requirement No manufacturing requirements
Ra Rz	R-parameters: Rz and Ra
0,15	Tolerance limit value for Ra: 0,15 μm , this defines the relevant column of Table 3, the Sc3 column for the evaluation of Ra and Rz.
0,7	Tolerance limit value for Rz: 0,7 μm
Default settings according to Tables 1 and 3	
Profile direction	Orthogonal to the surface lay
Tolerance type	Upper tolerance limit
Tolerance acceptance rule	Maximum tolerance acceptance rule
Profile S-filter type	Gaussian filter according to ISO 16610-21
Profile L-filter type	Gaussian filter according to ISO 16610-21
Profile F-operator association method and element	Association and removal of the specified form element with total least square
Profile L-filter nesting index N_{ic}	0,8 mm
Evaluation length l_e	4 mm
Profile S-filter nesting index N_{is}	2,5 μm
Maximum sampling distance d_x	0,5 μm

Table B.9 (continued)

Specification element	Explanation
Maximum nominal tip radius r_{tip}	2 μm
Section length l_{sc} (for Rz)	0,8 mm
Number of sections n_{sc} (for Rz)	5

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