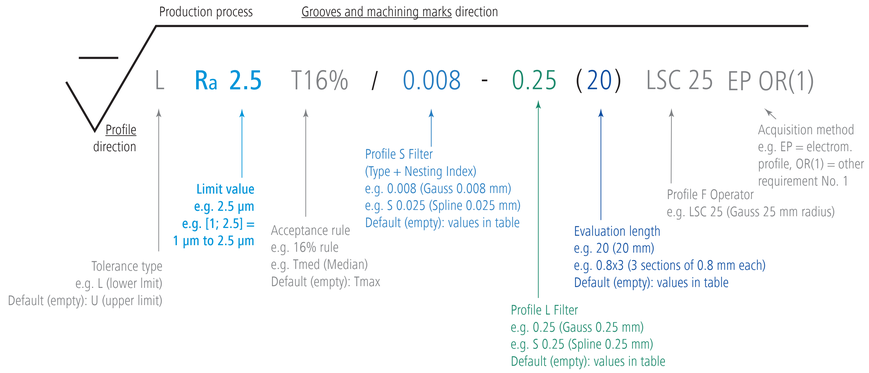
Specification symbols

With the help of the specification symbols for the surface parameters, the type of surface processing can be defined.

All processing methods allowed ("APA" – Any Process Allowed)

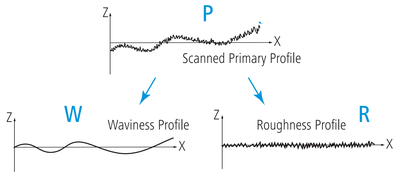
Material removal mandatory ("MRR" – Material Removal Required)

Material removal inadmissible / surface remains in delivery condition ("NMR" - No Material Removal)



Surface definitions

Every technical surface contains roughness, waviness and shape.
Roughness: Surface structure with short intervals.
Waviness: Surface structure with longer intervals.
Shape: Surface structure including even longer intervals.



The most important abbreviations and terms are listed here:

P Primary Profile: The aligned overall profile filtered with N_{is}. The primary profile consists of roughness, waviness and shape.

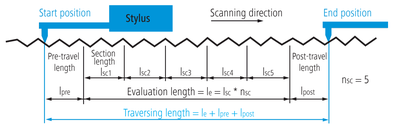
R Roughness Profile: Profile in which the long-wave components are attenuated with the filter N_{ic} (primary profile without waviness).

W Waviness Profile: Profile in which long-wave and short-wave profile components with N_{ic} and F are attenuated in their amplitudes.

Nis Nesting Index S: Cutoff wavelength for Profile S filter (S = Short). Low-pass: Profile S filter removes short-wave components (repl. λs).

Nic Nesting Index C: "Cutoff wavelength" for profile L filters (L = Long). High-pass: Profile L filter removes long-wave components (repl. λc).

F F Operator: Removal of the nominal shape to obtain a shape-free roughness profile (replaces λf).



le Evaluation Length: The part of the acquired distance that is evaluated (replaces lm or ln).

lsc Single Measurement Section (Section Length): For parameters calculated from several sections, e.g. Rz, Rp, Rv.

nsc Number of Sections: For parameters calculated from several sections, e.g. Rz, Rp, Rv.

rtip Maximum Nominal Stylus Tip Radius (Radius of stylus tip) in µm.

dx Maximum Profile Point Spacing (Distance of points) in µm.

Scx Setting Class, e.g. Sc1, Sc2, ... Defines the column to be used for the setting values in the table with gray background.

Default values

For the roughness parameters, it is sufficient to specify either the Setting Class *Sc* or the Nesting Index *Nic* (for P parameters *Nis*) to activate the other defaults in the same column. So, for example, the following indication may be sufficient: Rvt 0.6 / Sc2 This specification is complete then: Rvt 0.6 Tmax / 0.0025 - 0.25 (5x0.25)

Sc (Setting Class)	Sc1	Sc2	Sc3	Sc4	Sc5
Nic	0.08 mm	0.25 mm	0.8 mm	2.5 mm	8 mm
le	0.4 mm	1.25 mm	4 mm	12.5 mm	40 mm
	Exception: For P parameters, the value for *le* is the length of the specified element				
Nis	2.5 µm	2.5 µm	2.5 µm	8 µm	25 µm
dx	0.5 µm	0.5 µm	0.5 µm	1.5 µm	5 µm
rtip	2 µm	2 µm	2 µm	5 µm	10 µm
Only for parameters from profile sections (e.g. Rz, Rp, Rv):					
lsc	0.08 mm	0.25 mm	0.8 mm	2.5 mm	8 mm
nsc	5	5	5	5	5

For the parameters Ra, Rq, Rz, Rp, Rv, Rzx and Rt, default values are specified in ISO 21920, which depend on the size of the tolerance value. These are indicated in the table below. As a result, all other setting values of the same setting class *Sc* also apply. So, for example, the following indication may be sufficient: Ra 0.2

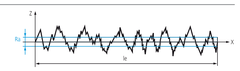
Parameter	Upper tolerance limit (U) of the specified parameter				
The following **upper** tolerance limits define the Setting Class *Sc*:					
Rz in µm	U ≤ 0.16	0.16 < U ≤ 0.8	0.8 < U ≤ 16	16 < U ≤ 80	U > 80
Ra in µm	U ≤ 0.02	0.02 < U ≤ 0.1	0.1 < U ≤ 2	2 < U ≤ 10	U > 10
Rp in µm	U ≤ 0.06	0.06 < U ≤ 0.3	0.3 < U ≤ 6	6 < U ≤ 30	U > 30
Rv in µm	U ≤ 0.10	0.10 < U ≤ 0.5	0.5 < U ≤ 10	10 < U ≤ 50	U > 50
Rq in µm	U ≤ 0.032	0.032 < U ≤ 0.16	0.16 < U ≤ 3.2	3.2 < U ≤ 16	U > 16
Rzx in µm	U ≤ 0.23	0.23 < U ≤ 1.15	1.15 < U ≤ 23	23 < U ≤ 115	U > 115
Rt in µm	U ≤ 0.26	0.26 < U ≤ 1.3	1.3 < U ≤ 26	26 < U ≤ 130	U > 130
Sc (Setting Class)	Sc1	Sc2	Sc3	Sc4	Sc5

Parameter	Lower tolerance limit (L) of the specified parameter				
The following **lower** tolerance limits define the Setting Class *Sc*:					
Rz in µm	L ≤ 0.08	0.08 < L ≤ 0.4	0.4 < L ≤ 8	8 < L ≤ 40	L > 40
Ra in µm	L ≤ 0.01	0.01 < L ≤ 0.05	0.05 < L ≤ 1	1 < L ≤ 5	L > 5
Rp in µm	L ≤ 0.03	0.03 < L ≤ 0.15	0.15 < L ≤ 3	3 < L ≤ 15	L > 15
Rv in µm	L ≤ 0.05	0.05 < L ≤ 0.25	0.25 < L ≤ 5	5 < L ≤ 25	L > 25
Rq in µm	L ≤ 0.016	0.016 < L ≤ 0.08	0.08 < L ≤ 1.6	1.6 < L ≤ 8	L > 8
Rzx in µm	L ≤ 0.115	0.115 < L ≤ 0.57	0.57 < L ≤ 11.5	11.5 < L ≤ 57	L > 57
Rt in µm	L ≤ 0.13	0.13 < L ≤ 0.65	0.65 < L ≤ 13	13 < L ≤ 65	L > 65
Sc (Setting Class)	Sc1	Sc2	Sc3	Sc4	Sc5

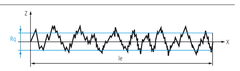
Important roughness parameters ISO 21920

The most important parameters according to ISO 21920-2 are listed here:

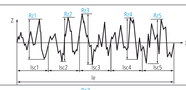
Ra Ra is the arithmetic mean value of the amounts of all profile values within the measurement section *le*. Ra corresponds to the terms AA (arithmetic average) and CLA (center line average).



Rq Rq is the root mean square of the magnitudes of all profile values within the measurement section *le*.

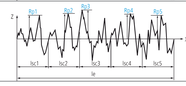


Rz The "maximum height" Rz corresponds to the arithmetic mean of the peak-to-valley distances of all individual measurement sections *lsc*.



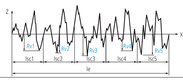
Rp Rp corresponds to the arithmetic mean of the peak heights of all individual measurement sections.

$Rp = \frac{1}{n}(Rp1+Rp2+...+Rpn)$

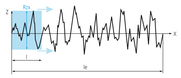


Rv Rv corresponds to the arithmetic mean of the valley depths of all individual measured sections.

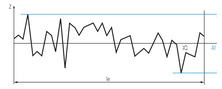
$Rv = \frac{1}{n}(Rv1+Rv2+...+Rvn)$



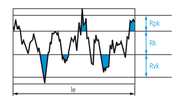
Rzx The "maximum section roughness" Rzx is the largest peak-to-valley distance within any section of length *l* (usually *l* = *lsc*) within the evaluation length *le*.



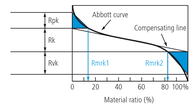
Rt
Rpt
Rvt The total height Rt is the sum of the greatest peak height and the greatest valley depth. The "maximum peak height" Rpt is the largest peak height of all section lengths. The "maximum valley bottom depth" Rpt is the greatest valley bottom depth of all section lengths.



Rk
Rpk
Rvk The core height Rk is the distance between the highest and lowest level of the core profile. This is calculated from the Abbott curve. The "reduced peak height" Rpk and the "reduced valley depth" Rvk can be calculated in the same way.



Rmrk1
Rmrk2 The material fraction of the hills is defined as Rmrk1, the material fraction of the valleys as Rmrk2. The proportions are calculated from the Abbott curve. They allow functional descriptions of highly stressed functional surfaces, e.g. sealing surfaces and lubricating sliding surfaces (replaces Mr1 and Mr2).



Rc Rc is the "average height" of the roughness profile. It is calculated as the arithmetic mean of the individual heights Zs of the profile elements.

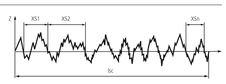
Rc = 1/n * (Z1 +Z2 + ... + Zn)

Rcx Rc is the "maximum height" of the roughness profile. It is calculated as the maximum value of the individual heights Z of the profile elements.

Rcx = max(Z1 +Z2 + ... + Zn)

Rsm Rsm is the arithmetic mean value of the individual distances XS of the profile elements.

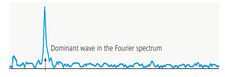
$Rsm = \frac{1}{n}(XS1+XS2+...+XSn)$



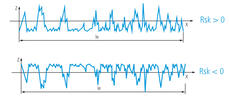
Rpc The peak count parameter Rpc is the number of average profile element gaps per unit length (usually *lsc*). It is calculated from the average distance of the profile elements Rsm.

Rpc = *lsc* / Rsm

Rsw The parameter Rsw ("dominant wavelength") is the wavelength corresponding to the largest absolute value of the amplitude density spectrum. A Fourier transform is required for their calculation.



Rsk The "skewness" Rsk is the quotient of the mean third power of the magnitudes of all profile values within the measured distance *le* and the third power of Rq.



Rku The "kurtosis" Rku is the quotient of the mean fourth power of the magnitudes of all profile values within the measured distance *le* and the fourth power of Rq.

Groove and profile direction

The groove direction (machining) can be defined as follows:

= Longitudinal: The required direction of the machining tracks is parallel to the specified direction.

⊥ Transverse: The required direction of the machining tracks is perpendicular to the specified direction.

X Crossed: The required two directions of the machining tracks are crossed to the specified direction.

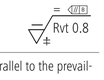
C Centric: The surface directions of the machining marks are circular on the surface.

R Radial: The surface directions of the machining marks are radial on the surface.

M Multidirectional: The surface directions of the machining tracks go in many directions.

P Particular: The surface grooves are particular, non-directional or protruding.

The profile direction (measurement) can be defined as follows (see example on the right):



Longitudinal: The measurement must be parallel to the prevailing direction.

Transverse: The measurement must be made perpendicular to the prevailing direction.

45° Inclined: The measurement shall be made at a specified angle to the prevailing direction (0° < n < 90°).

Circular: The measurement shall be circular to the center of the surface to which the symbol applies.

Important surface standards

ISO 3274	GPS – Profile method
ISO 5436	GPS – Profile method – Measurement standards DIN EN 10049:2014-03
EN 10049	Measurement of Ra and RPc
ISO 12085	GPS – Motif parameters
ISO 12179	Calibration of contact (stylus) instruments
ISO 13565-1	GPS – Surface texture – Filtering
ISO 16610	GPS – Filtering
ISO 21920	Surface texture: Profile
ISO 25178	Surface texture: Areal
ASME B46.1	US standard for surface texture
ISO 1302	(withdrawn) GPS – Surface texture
ISO 4287	(withdrawn) Profile method – Definitions
ISO 4288	(withdrawn) Profile method – Rules
ISO 13565-2	(withdrawn) GPS – Flatness
VDA 2005	(withdrawn) VDA guideline for indication of the surface texture
VDA 2006	(withdrawn) VDA guideline for evaluation of the surface texture

Carl Zeiss Industrielle Messtechnik GmbH
73446 Oberkochen
Germany

Tel.: +49 7364 20-6336
Fax: +49 7364 20-3870
Email: info.metrology.de@zeiss.com
Website: www.zeiss.com/imt

EN_60_050_0038 Printed in Germany CZ-VIII/2023 © Carl Zeiss Industrielle Messtechnik GmbH
ZEISS endeavors to ensure that all information is correct. However, the accuracy of the information cannot be guaranteed and ZEISS assumes no liability regarding the accuracy or completeness of the information.

Surface parameters – ISO 21920

ZEISS ACADEMY
METROLOGY

Further information on Geometric Product Specification (ISO/GPS and ASME standardization) is available in the seminars and books of the ZEISS Academy Metrology. Books can be ordered here: shop.metrology.zeiss.com