Precise roughness measurement

Surface texture parameters according to ISO 21920

HOMMEL ETAMIC

Efficient surface texture measurement

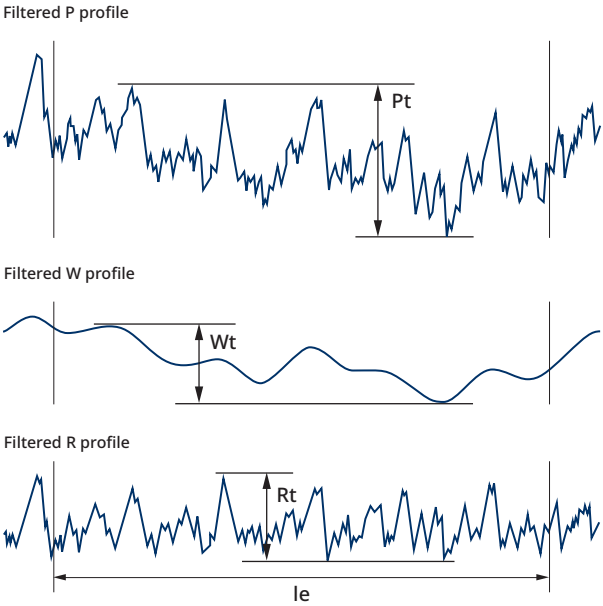
Surface texture is very important where it has a direct influence on the quality of the part. Therefore, it has to be defined as precisely as possible with the help of standardized surface texture parameters.

This leaflet provides an overview of the most important terms and parameters of surface metrology according to ISO 21920.

We manufacture a wide range of roughness measuring systems providing you with a large variety of evaluation possibilities – in the measuring lab as well as on the production line.

A particularly important aspect in metrology is continuous monitoring for the best possible accuracy. In our DAkkS-DKD calibration laboratory, we calibrate your supplied standards for various roughness parameters. For non-accredited parameters we issue a simpler factory calibration certificate.

Breakdown of a surface



Surface profiles – total height of the profile

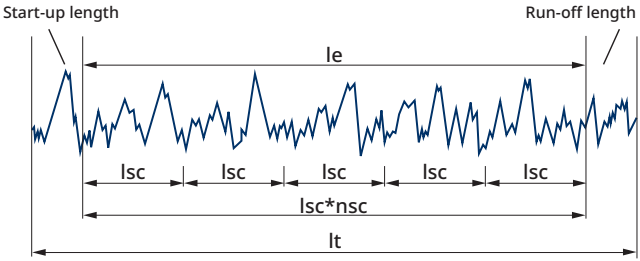
The profile of a surface is recorded two-dimensionally using the tracing system method.

In contrast to ISO 3274, in ISO 21920 the stylus tip radius is calculated from the recorded profile by morphological erosion before this mechanical profile is then used for the calculation of the parameters.

The primary profile (P profile) is the measured surface profile after the stylus tip radius has been removed and filtered with the profile S filter. Further filtering according to ISO 16610 produces the waviness profile (W profile) and the roughness profile (R profile). The determining parameter for the boundary between waviness and roughness is typically the nesting index Nic.

The profile type is identified by the capital letters P, R or W. In accordance with ISO 21920, all parameter definitions, except for Rxxk and Pxxk, apply to the roughness profile as well as to the primary and waviness profile.

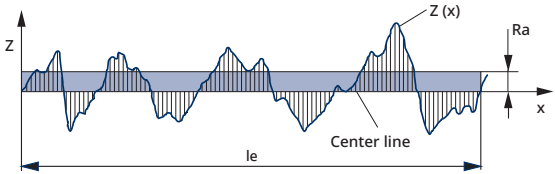
Evaluation lengths – cut-off



The traverse length lt is the total length of the probe movement during the scanning process. It is greater than the evaluation length le in order to be able to form the roughness profile with the profile filter.

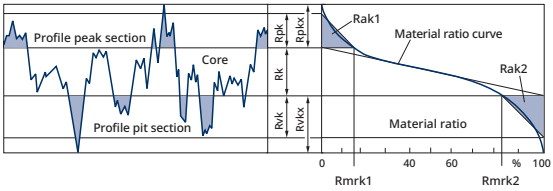
Only for Rpt, Rvt, Rp, Rv, Rz applies: le = lsc * nsc (section length times number of sections).
New in ISO 21920: for Ppt, Pvt, Pp, Pv and Pz also applies nsc = 5 and lsc = le/nsc. For P parameters, typically only the length of the workpiece section (= le) is dimensioned.

Ra



Ra – arithmetic mean height
Ra is the arithmetic mean roughness value from the amounts of all profile values. Ra does not differentiate between peaks and pits and has therefore a relatively weak information character.

Rk, Rpk, Rpkx, Rvk, Rvkx, Rmrk1, Rmrk2, Rak1, Rak2



Rk – core height
Height of the roughness core profile

Rpk – reduced peak height
Reduced height of the peaks protruding from the roughness profile

Rpkx – maximum peak height

Rvk – reduced pit depth
Reduced depth of the pits reaching into the material from the core

Rvkx – maximum pit depth

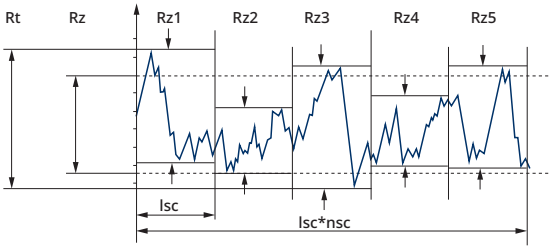
Rrmk1, Rmrk2 – Material ratio of hills or of dales respectively

Rak1, Rak2 – Area of hills or dales respectively

Rpc

Rpc – peak count parameter
Rpc indicates the number of mean spacings of profile elements per unit length L and is calculated with the formula Rpc = L/Rsm.

Rz, Rp, Rv, Rpt, Rvt



Rz – maximum height
Mean value of the individual Rz values from the section lengths lsc

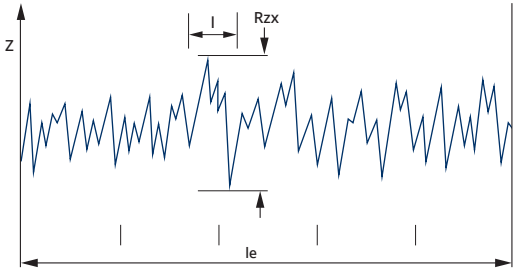
Rp – mean peak height
Mean value of the largest peak heights of all section lengths lsc

Rv – mean pit depth
Mean value of the largest pit depths of all section lengths lsc

Rpt – maximum peak height
Largest peak height of all section lengths lsc

Rvt – maximum pit depth
Largest pit depth of all section lengths lsc

Rzx, Rzx(l)



Rzx, Rzx(l) – maximum height per section
Rzx(l) corresponds to the maximum value of the difference between the highest and the lowest ordinate values within a section of length l moving over le. When the default value l = lsc is used, the specification of the length l is not required (Rzx).

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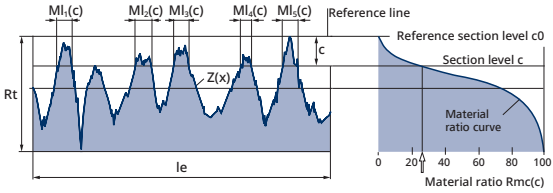
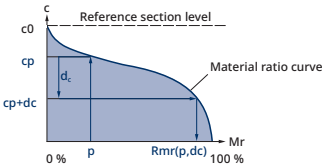
Rmc(c), Rmr(dc), Rmr(p,dc)



Rmc(c) – material ratio

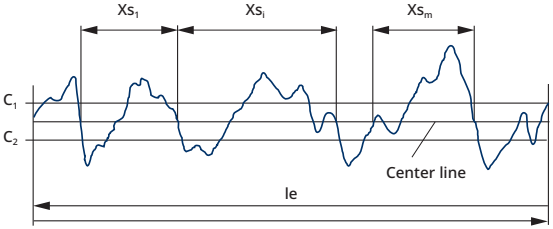
Rmc indicates what ratio the totaled length in the material has assumed relative to the evaluation length (in %). The comparison is made in the specified section level c and the evaluation length le. The material ratio curve indicates the material ratio as a function of the section level.



Rmr(dc), Rmr(p,dc) – relative material ratio

Rmr indicates the material ratio at a section level cp + dc, where cp refers to the material ratio p and dc is a relative profile depth, usually less than 0. The specification of the material ratio p is not required if the default value p = 0 % is used.

Rsm



Rsm – mean profile element spacing

Rsm is the arithmetic mean value of the width of the profile elements of the roughness profile. Default values for the height discrimination for detecting the profile hills and dales in ISO 21920 are 10 % of Rp and Rv, respectively.

Tolerance acceptance rules

According to ISO 21920 the surface measurement should be made where the highest values are to be expected (visual determination).

Tmax

The maximum tolerance acceptance rule Tmax is set as a standard and does not need to be specified in the drawing entries. The surface is accepted as good if the measured values of a parameter do not exceed the specified maximum value.

T16 %

If the 16 % tolerance acceptance rule is to apply, this must be indicated in the drawing entries with the T16 % symbol. The surface is accepted as good if no more than 16 % of the measured values of a parameter exceed the specified maximum value. Further information on this rule can be found in the ISO 21920 standard.

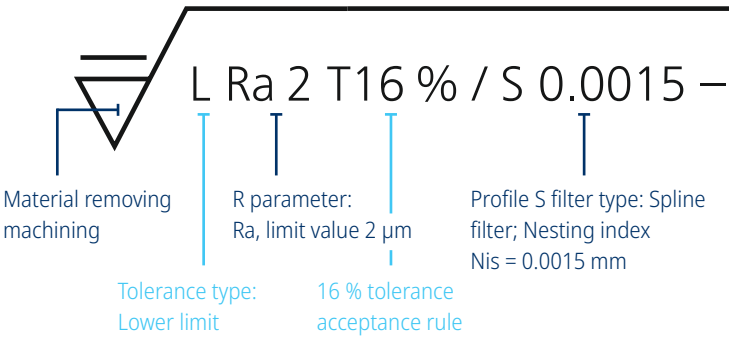
Selection of the measurement conditions

ISO 21920 does not distinguish between a periodic and an aperiodic profile. The selection of the measurement conditions is based on the type of tolerance limit: upper tolerance limit, lower tolerance limit, or bilateral tolerance limits.

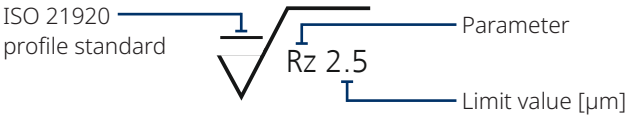
The first parameter mentioned in the drawing specification determines the measuring conditions used. In the simplest case, the tolerance is sufficient.

In the Evovis software, the measurement condition tables are used automatically.

Drawing entries according to ISO 21920

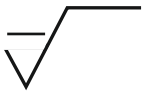


Minimum information in drawings

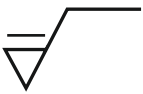


The minimum specification is only allowed for the following parameters with defined defaults: Rz, Ra, Rp, Rv, Rq, Rzx, Rt and Pt.

Information on the machining process



Any machining process allowed



Material removing machining

No material removing machining allowed

RG 0.6 (15) LSC 25 / EP OR(1)

Additional requirements

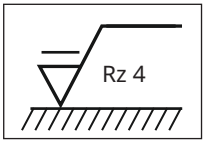
Evaluation length
le = 15 mm

Profile acquisition method:
Electromagnetic profile

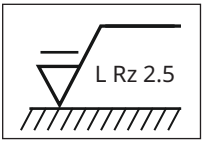
Profile L filter type:
Robust Gaussian filter
Nesting index Nic = 0.6 mm

Profile F operator type: Circle
Method: LS
Nesting index: Circle radius r = 25 mm

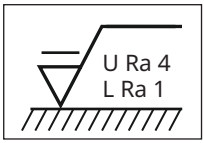
Examples



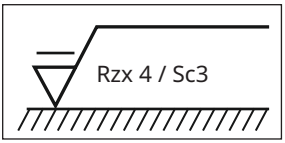
Material removing machining;
Rz = max. 4 µm



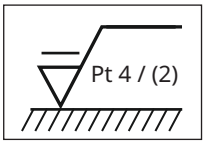
Material removing machining; lower limit value for Rz demanded; Rz = min. 2.5 µm



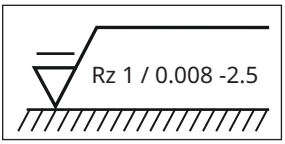
Material removing machining; upper and lower limit value for Ra demanded: Ra = min. 1 µm and max. 4 µm



Material removing machining; Rzx = max. 4 µm; Sc3 determines the measurement and filter conditions (deviating from the default values determined by the tolerance)



Material removing machining; P profile; traverse length = 2 mm; Pt = max. 4 µm



Material removing machining; Rz = max. 1 µm; filter selection Nis = 0.008 mm and Nic = 2.5 mm (the remaining measurement and filter conditions are derived from Nic)