MarSurf® Surface Texture Parameters

Definitions

Real Surface separates a body from the surrounding medium. (EN ISO 4287)

Stylus instrument enables two-dimensional tracing of a surface. The stylus is traversed normal to the surface at constant speed. (EN ISO 3274)

Traced profile is the enveloping profile of the real surface acquired by means of a stylus instrument. The traced profile consists of form deviations, waviness and roughness components. (EN ISO 3274, DIN 4760)

Parameters usually are defined over the sampling length. An average parameter estimate is calculated by taking the arithmetic mean of the parameter estimates from all the individual sampling lengths. For roughness profile parameters the standard number of sampling lengths is five.

For curves and related parameters (e.g. material ratio) the basis for the calculation of the parameters' values is the evaluation length. (EN ISO 4288)

Traversing length l_t is the overall length traveled by the stylus when acquiring the traced profile. It is the sum of pre-travel, evaluation length l_n, and post-travel.

Cutoff λ_c of a profile filter determines which wavelengths belong to roughness and which ones to waviness.

Sampling length l_r is the reference for roughness evaluation. Its length is equal to the cutoff wavelength λ_c.

The sampling lengths **l_p** and **l_w**, respectively, are the reference lengths for the P-profile and the W-profile evaluation.

Evaluation length l_n is that part of the traversing length l_t over which the values of surface parameters are determined. The standard roughness evaluation length comprises five consecutive sampling lengths.

Pre-travel is the first part of the traversing length l_t.

Post-travel is the last part of the traversing length l_t. Pre-travel and post-travel are required for phase correct filtering.

Geometrical Product Specification

ISO/TR 14638, DIN V 32950

Geometrical Product Specification (GPS) implies different kinds of standards dealing with the geometric characteristics of products during product design, manufacture, inspection, quality assurance, etc.

In the **GPS matrix model**, the lines comprise chains of standards dealing with one and the same characteristic such as e.g. size, distance, form features, roughness, waviness, etc. The columns (i.e. the links of the chains) then are:

1. Drawing specifications (EN ISO 1302)
2. Theoretical definitions (EN ISO 4287, 11562, 12085, and 3565)
3. Parameter definitions (EN ISO 4288, 11562, 12085, and 3565)
4. Assessment of deviations (EN ISO 4288 and 12085)
5. Measurement equipment requirements (EN ISO 3274 and 11562)
6. Calibration requirements (EN ISO 5436 and 12179)

The most important standards in the field of **surface texture** are detailed in parentheses ().

Profile Filter

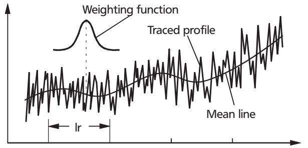
EN ISO 11562, ASME B46.1

Profile filters separate profiles into long wave and short wave components. The λ_c profile filter separates the roughness profile from long wave components (e.g. waviness).

Mean line is generated by a phase correct filter by calculating the weighted average for each point of the profile.

Weighting function indicates for each point of the profile the assessment factor with which the adjacent profile points enter into averaging (Gaussian curve).

R-profile (roughness profile) represents the deviations of the primary profile from the mean line of the λ_c profile filter. When presenting the roughness profile, the mean line is the zero line.



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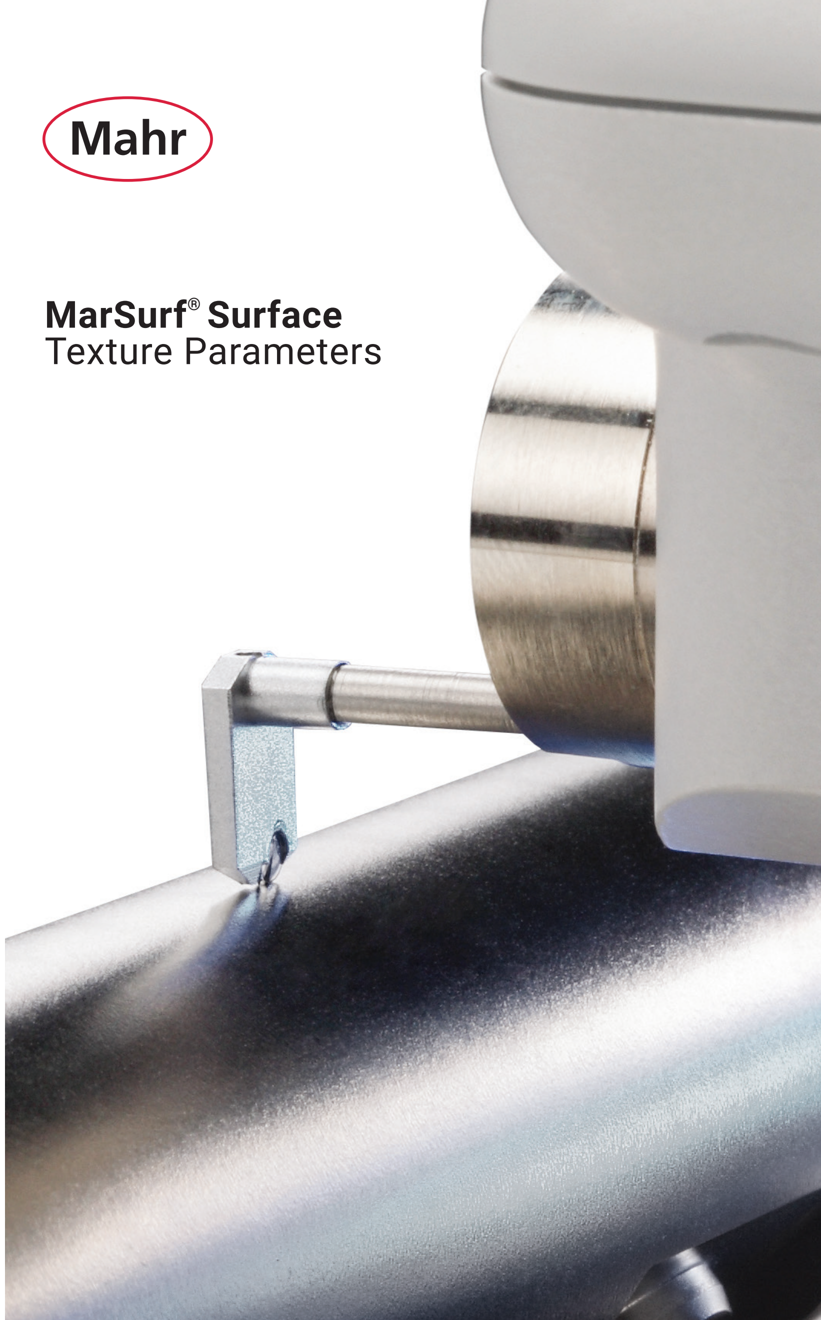


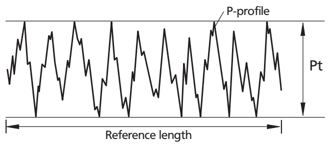
Profile Depth P_t

EN ISO 4287

Profile depth P_t (total height of P-profile) is the sum of the largest profile peak height and the largest profile valley depth of the P-profile within the evaluation length l_n (reference length). The reference length has to be stated.

P-profile (primary profile) is computed from the traced profile

- by excluding the nominal form by using the method of best fit least squares of the type indicated in the drawing, e.g. a linear regression line and
- by excluding ultra-short wavelengths from the evaluation by using the λ_s profile filter, which considerably increases comparability. (EN ISO 3274)



Selection of Cutoff λ_c

EN ISO 4288, ASME B46.1

Periodic profiles	Nonperiodic profiles		Cutoff	Sampl./ Eval. length
R_{sm} (mm)	R_z (µm)	R_a (µm)	λ_c (mm)	l_r / l_n (mm)
over .013 up to .04	up to .1	up to .02	.08	.08 / .4
over .04 up to .13	over .1 up to .5	over .02 up to .1	.25	.25 / 1.25
over .13 up to .4	over .5 up to 10	over .1 up to 2	.8	.8 / 4
over .4 up to 1.3	over 10 up to 50	over 2 up to 10	2.5	2.5 / 12.5
over 1.3 up to 4	over 50 up to 200	over 10 up to 80	8	8 / 40

Roughness Depth R_z, R_{max}

EN ISO 4287, ASME B46.1

Single roughness depth R_{zi} is the vertical distance between the highest peak and the deepest valley within a sampling length.

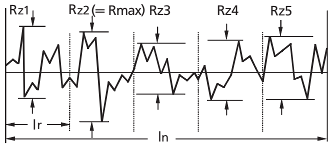
Mean roughness depth R_z is the arithmetic mean value of the single roughness depths R_{zi} of consecutive sampling lengths:

$$R_z = \frac{1}{n}(R_{z1} + R_{z2} + \ldots + R_{zn})$$

The R_z definition is identical to the definition in DIN 4768:1990.The ten point height R_z as well as the parameter symbol R_y of ISO 4287:1984 have been canceled.

Maximum roughness depth R_{max} is the largest single roughness depth within th e evaluation length.

(cf. EN ISO 4288; R_{max} is also called R_{z1max})

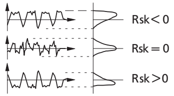


R_{sk}, R_{ku}

EN ISO 4287, ASME B46.1

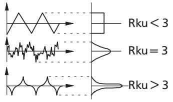
Skewness R_{sk} is a measure of the asymmetry of the amplitude density curve. A negative skewness value indicates a surface with good bearing properties.

$$R_{sk} = \frac{1}{R_q^3}\frac{1}{l}\int_0^l Z^3(x)\,dx$$



Kurtosis R_{ku} is a measure of the peakedness of the amplitude density curve. For a profile with a Gaussian amplitude density curve R_{ku} is 3.

$$R_{ku} = \frac{1}{R_q^4}\frac{1}{l}\int_0^l Z^4(x)\,dx$$



Skewness and Kurtosis are strongly influenced by isolated peaks and valleys, fact which reduces their practical importance.

Material Ratio R_{mr}, t_p

EN ISO 4287, ASME B46.1

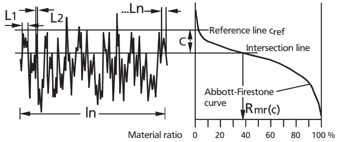
Material ratio R_{mr} (ASME: bearing length ratio t_p) is the ratio expressed in percent of the material-filled length to the evaluation length l_n at the profile section level c.

$$R_{mr} = \frac{1}{l_n}(L_1 + L_2 + \ldots + L_n)\ 100\ [\%]$$

The profile section level c is the distance between the evaluated intersection line and the specified reference line c_{ref}.

Material ratio curve (Abbott-Firestone curve) shows the material ratio R_{mr} as a function of the profile section level c.

The material ratio can also be evaluated on the P- or the W-profile (**P_{mr}** or **W_{mr}**).



R_k, R_{pk}, R_{vk}, M_{r1}, M_{r2}

EN ISO 13565-1 and -2

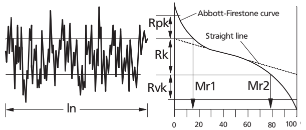
The roughness profile as per 13565-1 is generated by a special filtering technique minimizing profile distortions due to deep valleys in plateau profiles. A straight line divides the Abbott-Firestone curve into three areas from which the parameters are then computed as per 13565-2:

Core roughness depth R_k is the depth of the roughness core profile.

Reduced peak height R_{pk} is the mean height of the peaks protruding from the roughness core profile.

Reduced valley depth R_{vk} is the mean depth of the valleys protruding from the roughness core profile.

M_{r1} and **M_{r2}** are the smallest and the highest material ratios of the roughness core profile.



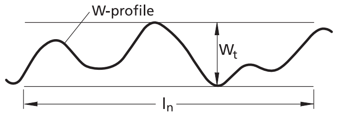
Waviness Height W_t

EN ISO 4287, ASME B46.1

Waviness height W_t (total height of W-profile) is the sum of the largest profile peak height and the largest profile valley depth of the W-profile within the evaluation length l_n (reference length).

The evaluation length l_n (reference length) has to be stated.

W-profile (waviness profile) is the mean line generated from the P-profile by the l_c profile filter. The long wave profile components which belong to the form are excluded.



Mean Roughness R_a, R_q

EN ISO 4287, ASME B46.1

Roughness average R_a is the arithmetic average of the absolute values of the roughness profile ordinates.

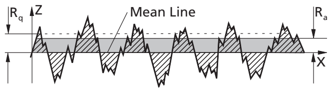
$$R_a = \frac{1}{L}\int_0^L |Z(x)|\,dx$$

Root mean square (RMS) **roughness R_q** is the root mean square average of the roughness profile ordinates.

$$R_q = \sqrt{\frac{1}{l}\int_0^l Z^2(x)\,dx}$$

Z(x) = profile ordinates of the roughness profile.

R_a is also called AA and CLA, R_q also RMS.



Peak Height, R_v R_p

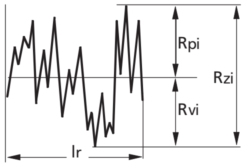
EN ISO 4287, ASME B46.1

R_p is the height of the highest profile peak of the roughness profile within one sampling length.

According to ASME, the R_p mean value (average calculated over the evaluation length) is called R_{pm}.

R_v is the depth of the deepest profile valley of the roughness profile within one sampling length. So far, the parameter symbol R_m was used in place of R_v.

The sum of R_p + R_v is the single roughness depth R_{zi}.



Base Roughness Depth R_{3z}

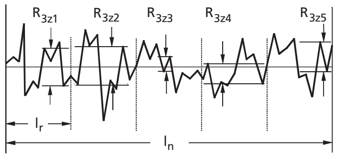
Daimler Benz Standard 31007 (1983)

Single roughness depth R_{3zi} is the vertical distance of the third highest peak to the third deepest valley of the roughness profile within a sampling length l_r.

Base roughness depth R_{3z} is the mean value of the single roughness depths R_{3zi} of five consecutive sampling lengths l_r:

$$R_{3z} = \frac{1}{5}(R_{3z1} + R_{3z2} + R_{3z3} + R_{3z4} + R_{3z5})$$

Profile peak and profile valley must exceed certain vertical and horizontal minimum values.



R_{sm}, $R\Delta q$

EN ISO 4287, ASME B46.1

Mean width of profile elements R_{sm} is the arithmetic mean value of the widths of profile elements of the roughness profile.

$$RSm = \frac{1}{n}\sum_{i=1}^{n} Xsi$$

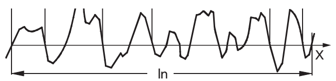
A profile element consists of a profile peak and an adjacent profile valley.

A_r is an older designation for R_{sm}.

Root mean square slope $R_{\Delta q}$ is the root mean square average of all local profile slopes.

$$R\Delta q = \sqrt{\frac{1}{l}\int_0^l \left(\frac{dz}{dx}\right)^2 dx}$$

The local profile slope is computed via a leveling function in order to reduce the influence of noise.



HSC Peak Count RP_c

prEN 10049, ASME B46.1

Peak count RP_c is the number of roughness profile elements (see R_{sm}) per cm which consecutively intersect the specified upper profile section level c_1 and the lower profile section level c_2.

High spot count HSC is the number of roughness profile peaks per cm exceeding the specified upper profile section level c_1.