



Surface Roughness

(Drawing Entry, Measuring Conditions, Profile Filters, Parameters)

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. The present standard describes rules for the indication of the surface texture in the engineering product documents (e.g., drawings, specifications) by means of graphical symbols and texts.

1.2 Applicability. BOM/BOD's (e.g., AS&F PMT Sealing BOM Level III).

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ISO 1302

ISO 4288

ISO 13565-2

ISO 16610-21

ISO 4287

ISO 13565-1

2.2 GM Standards/Specifications.

GMW3059

3 Test Preparation and Evaluation

3.1 Resources.

3.1.1 Facilities. According to the relevant specification.

3.1.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.1.2 Equipment. According to the relevant specification.

3.1.3 Test Vehicle/Test Piece. According to the relevant specification.

3.1.4 Test Time. Not applicable.

3.1.5 Test Required Information. According to the relevant specification.

3.1.6 Personnel/Skills. According to the relevant specification.

3.2 Preparation. According to the relevant specification.

3.3 Conditions.

3.3.1 Environmental Conditions. According to the relevant specification.

3.3.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

3.4 Instructions. According to the relevant specification.

3.5 Data. According to the relevant specification.

3.6 Safety.

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

4 Requirements and Procedure

4.1 Statement of Surface Texture in Engineering Product Documents

4.1.1 Purpose and Application. Preferably the average roughness value R_a shall be indicated. If due to functional requirements, e.g., for sealing surfaces (example see Appendix A-A1.1), it is necessary to restrict the surface roughness the maximum roughness value R_{z1max} shall be indicated in addition to the average roughness value R_a .

For the description of highly stressed technical surfaces (e.g., Sliding surfaces) the specification with R_a and R_{z1max} is not in most cases sufficient alone. There is the necessity to indicate for such surfaces additional roughness parameters referred to the function. In addition the roughness characteristics belong R_{mr} (c) according to ISO 4287 or R_{pk} , R_k , R_{vk} , Mr_1 and Mr_2 for "surfaces having stratified functional properties" according to ISO 13565-1 and ISO 13565-2 (example see Appendix A-A1.3).

Data on surface roughness, manufacturing methods or machining allowances shall only be made if they are required for functional purposes or the aesthetic or physiological appearance and only on those surfaces where this is necessary. The indication of the surface roughness is not necessary if the usual manufacturing methods already ensure a sufficient finishing state of the surface.

4.1.2 Symbols. Symbols without Specifications, see Table 1.

Table 1: Symbols without Specifications

	Symbols	Meaning/Explanations
4.1.2.1		Basic symbol: The basic symbol consists of two straight lines of different length which are inclined by $\approx 60^\circ$ in relation to the line representing the surface concerned. This symbol in itself, without any additional information (for exception see paragraph 4.2.4), is not expressive. It shall only be used if it means "surface concerned". When the basic symbol is used with additional information, hereby no decision has yet been taken , whether material shall be removed (4.1.2.2) or whether material removal is not permitted (4.1.2.3) to attain the specified surface quality.
4.1.2.2		Extended symbol for material removal: If material removal by mechanical machining is demanded to reach the specified surface quality, a traverse line shall be added to the basic symbol. This symbol with no indication of any other detail shall be used only if it means: surface to be machined.
4.1.2.3		Extended symbol if Material Removal is not permitted: If material removal is not permitted to reach the specified surface quality, a circle shall be added to the basic symbol. This symbol may be used for drawings to be created for a certain operation in order to make clear that a surface shall be left in the state of the previous operation, regardless of whether this state was achieved by machining or by another kind of processing.

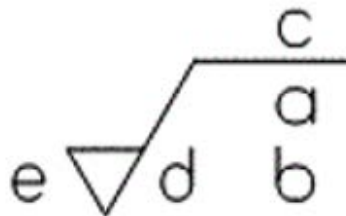
4.1.2.4		Complete Symbol: If special surface information is required, an additional line is to be added to the longer line of the mentioned symbols. Additional Surface Texture Information in the Complete Symbol see 4.1.3.2.
4.1.2.5		Symbols of Simplified Drawing Specifications The meaning of the symbols is explained on the drawings. See also Figure 7.

4.1.3 Indications added to the Symbols.

4.1.3.1 Surface Texture Requirements. In order to ensure the clearness of a certain surface texture requirement in relation to the function of a certain surface, it is necessary to indicate other requirements such as the transmission characteristic, the sampling length, manufacturing methods, position, and orientation of the surface and possible machining tolerances in addition to the surface parameter and its numerical value. It may be necessary to determine several different surface parameters so that the surface texture requirements clearly ensure the functional properties of the surface.

4.1.3.2 Positions of Additional Surface Texture Information in the Complete Symbol. The positions of the different surface texture requirements on the symbol are subsequently stated and described in Figure 1.

**Figure 1: Positions (a through e) for Additional Information
(Areas of Designation on the Complete Symbol)**



Position:	Designation/Description
a	If only one surface texture requirement consisting of the surface parameter, the numerical value and the transmission characteristic/sampling length shall be indicated in the complete symbol. <u>General:</u> Transmission characteristic or sampling length (in mm), one blank, followed by a slash “/”, one blank, followed by the designation of the surface parameter, two blanks, followed by its numerical value (in μm), for which one line shall be used. Example: 0.0025-0.8/Ra 1.0 (position a, see also Note 2) Note 1: The transmission characteristic is indicated by the values of the cut-off wavelengths of the filters (in mm), separated by a separation sign (“-”). First of all, the short-wave filter λ_s is indicated, then the long-wave filter λ_c. It is also possible to indicate only one of the two filters. In this case the second filter has the default value. If only one filter is indicated, <u>the separation sign is maintained</u> in order to distinguish between λ_s- or a λ_c-filter. Example: 0.008- (λ_s-indication) or -0.25 (λ_c-indication) Note 2:

Position:	Designation/Description
	The transmission characteristic shall only indicated if it shall be ensured that the surface is clearly defined by the surface texture requirement. If no transmission characteristic is indicated, the default transmission characteristic is applicable (paragraph 4.3.5, Table 6).
b	For a second (third or more) surface texture requirement. If a third or more requirements are to be indicated, the symbol shall be extended accordingly in the horizontal direction. Example: Ra 0.8 (position a) Rz1max 7 (position b)
c	If it is demanded that the final state of the surface shall be attained by a certain manufacturing method, machining, coating or other requirements to the manufacturing process (such as turning, grinding, rolling or other types), this process shall be written in a full text version or by a sign to be explained in the left-hand lower corner of the drawing, over the horizontal line of the symbol. Example: MILLED (position c)
d	If the direction of lay shall be determined, this shall be stated by an additional symbol according to Table 1. The direction of lay is determined by the prevailing surface pattern which usually is produced as a result of the manufacturing method applied. Example: M (position d)
e	Indication of the machining allowance (in mm). The machining allowance is generally only indicated in those cases in which several process stages are indicated on the same drawing, e.g., on drawings of unmachined parts illustrating cast and rolled workpieces which contain the finished workpiece. Example: 1 (position e)

4.1.3.3 Statement of Numerical Values. With ISO 1302 the graduation of numerical values for roughness variables has become obsolete. The indications are therefore no longer subject to a graduation (e.g., Ra =...0.8; 1.6; 3.2; 6.3...)

4.1.3.4 Tolerances for Numerical Values of Surface Parameters. Two (2) possibilities of interpretation of the specified limits are distinguished:

The 16% - rule or the max- rule.

The max- rule shall be applied, that means, the indicated numerical value for a roughness parameter represents the highest value.

Note 1: In the case of a tolerancing according to the max-rule, ISO 1302 requires the addition "max" after the designation of the parameter (e.g., Ramax). Due to the max-rule to be applied to the numerical values of roughness parameters, this may be omitted.

Note 2: With ISO 4288 the roughness parameter R_{max} was renamed in Rz1max without explanation. This is already a maximum value. Definition of Rz1max (previously R_{max}) see Figure 10.

Note 3: The definition of Rz1max according to ISO 1302 can lead to an inevitable wrong interpretation.

4.1.3.5 Bilateral Tolerance Limits of a Surface Parameter. If it is necessary to establish an upper and a lower limit value, the requirement for the two (2) tolerance limits shall be written in the complete symbol one above the other:

The upper specified limit before which a "U" (for upper limit) shall be placed shall be put over the lower specified limit before which an "L" ("L" for lower limit) shall be placed.

Example: **U Ra 0.8** (position a)
 L Ra 0.35 (position b)

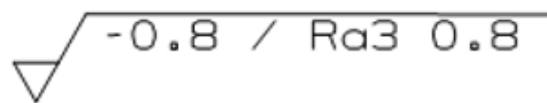
Note: The data for the two (2) tolerance limits may also be written on the “a” position if, e.g., for lack of space, this shall be necessary. Here, the upper tolerance limit shall be specified first, followed by a slash, and then the lower tolerance limit.

Example: U Ra 0.8/L Ra 0.35

4.1.3.6 Deviation from the Default Sampling Length. If the number of sampling lengths l_r within the evaluation length l_n deviates from the default value 5 ($l_n = 5 \times l_r$) stated in paragraph 4.2, the number of sampling lengths shall be indicated in connection with the filter characteristic according to the roughness parameter designation without any blank (see Figure 2).

Note: For workpiece surfaces to which the default sampling length cannot be applied, e.g., due to the dimensions which are too short, the pre-travel and the post-travel per 4.2 shall be taken into consideration when indicating the number of sampling lengths. Regarding a Gaussian filter, this is half each of the sampling length ($\frac{1}{2} \lambda_c$), i.e., when indicating e.g., three (3) sampling lengths at least the length of four (4) sampling lengths shall be available to measure the roughness of the workpiece surface.

Figure 2: Example of Indicating (here: three) Sampling Lengths in Case of a Deviating Default Sampling Length



Meaning/Explanation

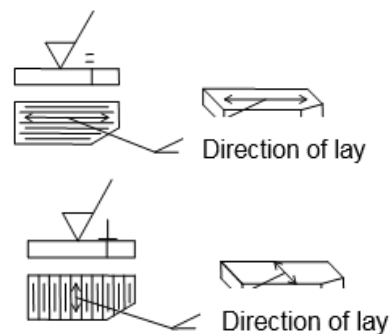
- The machining process shall be material removing (closed roughness symbol)
- Unilateral given upper Ra limit with 0.8 μm
- Transmission characteristic:
Cut-off wavelength λ_c (or sampling length respectively) = 0.8 mm
(Default value for λ_s according to the transmission characteristic = 2.5 μm)
- Evaluation length consisting of three (3) sampling lengths (preset target value)
Note: Evaluation length = 2.4 mm ($3 \times \lambda_c$), Traversed length $l_t = 3.2$ mm (Evaluation length + Pre- and post-travel length – see Figure 10 and 5.4.4)

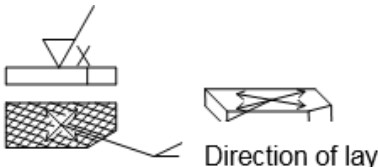
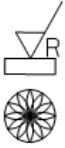
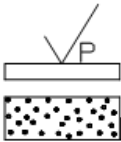
Applied max- rule (without addition “max” after Ra3 according to ISO 1302)

4.1.3.7 Indication of the Direction of Lay. The symbols stated in Table 2 characterize the usual direction of lay.

Table 2: Usual Direction of Lay

Symbols	Explanations
	Parallel to the plane of projection of the view in which the symbol is used.
	Perpendicular to the plane of projection of the view in which the symbol is used.



X	Crossed in two (2) slant directions relative to the plane of projection of the view in which the symbol is used.	
M	Multi-directional.	
C	Approximately circular relative to the center of the surface to which the symbol is applied.	
R	Approximately radial to the center of the surface to which the symbol is applied.	
P	Non-directional, pitted or protuberant.	

Note: If it is necessary to specify a direction of lay not clearly defined by these symbols, then this shall be achieved by a suitable note on the drawing.

4.1.4 Indication on Drawings. The symbols and the inscriptions shall be arranged horizontally. If necessary, the symbol may be connected to the surface by a reference line that shall be provided with an arrow head.

The symbol or the arrow head shall point from outside to the workpiece, either to the body line or to an auxiliary line (see Figure 3) as an extension of the body line.

Note: According to ISO 1302, a vertical arrangement of the symbols and inscriptions to be read from the right-hand side, is permitted.

Figure 3: Surface Data on the Contour Line representing the Surface

