UDC 62-408.8 : 620.179.11 June 1982

# Measuring the surface roughness of workpieces
## Visual and tactile comparison, methods by means of contact stylus instruments

DIN 4775

Prüfen der Rauheit von Werkstückoberflächen; Sicht- und Tastvergleich, Tastschnittverfahren

*As it is current practice in standards published by the International Organization for Standardization (ISO), the comma has been used throughout as a decimal marker.*

For connection with a standard at present being prepared by the International Organization for Standardization (ISO), see Explanations.

Measurements of surface roughness on surfaces produced by engineering processes are subject to a comparatively wide dispersion. The reason for this is indicated in the Explanations.

## 1 Scope

This standard specifies a standard method for assessing the roughness of workpiece surfaces.

## 2 Designation

Designation of the measurement of surface roughness (R) by visual and/or tactile comparison and/or measurement of surface roughness with electrical contact stylus instruments in accordance with DIN 4772

Measurement of surface roughness DIN 4775 – R

## 3 Drawing indication of surface roughness values

The following applies for indicating surface roughness values in drawings:

DIN ISO 1302 Technical drawings – Method of indicating surface texture on drawings

The method of entering surface roughness information (direct specification of numerical values in accordance with DIN ISO 1302 or indication of triangles in accordance with the obsolete preliminary Standard DIN 3141) does not determine the type of measurement (e.g. by comparison with roughness comparison specimens or testing by measurement with electrical contact stylus instruments), see subclauses 5.2 and 5.3.

## 4 Significance of surface roughness values indicated in drawings

It is hardly possible to draw conclusions from a single surface roughness measurement as to whether the surface as a whole complies with the requirements indicated on the drawing. Because of the non-uniformity of the surface one individual value might by chance be very small or very large and might result in a workpiece being rejected without justification. For this reason a number of individual measurements are normally necessary to give a reliable indication of the surface roughness.

The following specifications apply:

- If the upper limiting value of a surface roughness parameter is specified, 16 % of the measured individual values may exceed the upper limiting value. If in addition the lower limiting value of a surfcae roughness parameter is specified, 16 % of the measured individual values may be below the lower limiting value. This specification applies to all parameters of surface roughness, for example $R_a$ and $R_z$, for which no maximum value expressly applies (for example $R_{max}$ = 1,6 µm).
- If the parameter is characterized as a maximum value, for example $R_{max}$ = 1,6 µm, no individual measured value may exceed this limiting value.

For the number of surface roughness measurements see subclause 5.3; for more information on the significance of surface roughness values on drawings see Explanations.

## 5 Method of measuring the roughness of workpiece surfaces

For economic reasons it is only justifiable to carry out the smallest possible number of individual measurements for determining surface roughness.

As regards the method of measurement to be used, the series in accordance with subclauses 5.1 to 5.3 shall be complied with.

### 5.1 Visual inspection

This test method shall give a general impression of the surface being assessed and permit a rough sorting of workpieces for which a measurement of surface roughness is unnecessary or unsuitable. In particular, the visual inspection shall give information on surface defects (scores, cracks, pores, scratches, etc., see DIN 4761) which might result in rejection of a faulty part without any further measurement of surface roughness. If the workpiece surface obviously does not exceed the limiting value specified on the drawing when examined visually, there is no need to proceed to the measurement in accordance with subclauses 5.2 and 5.3.

Continued on pages 2 and 3

### 5.2 Visual and/or tactile comparison

The visual and/or tactile comparison of workpieces with roughness comparison specimens (e.g. to DIN 4769 Part 1 to Part 4) or with samples of known surface roughness taken from production, in most cases permits a rapid and sufficiently accurate sorting out of defective workpieces. The use of roughness comparison specimens is described in DIN 4769 Part 1.

### 5.3 Surface roughness measurement with electrical contact stylus instruments

If it is not possible to make a decision as to whether the surface roughness requirements have been complied with on the basis of visual inspection and visual and/or tactile comparison, the surface roughness shall be measured with an electrical contact stylus instrument (see DIN 4772) under specified conditions. For measurement of $R_a$, $R_z$ and $R_{max}$ the measurement conditions given in DIN 4768 Part 1 shall be used. For the measurement of the profile depth $P_t$ DIN 4771 applies.

Note: Since there are no standardized measurement conditions for other surface roughness parameters, $R_a$ and $R_z$ should be used for preference. $R_{max}$ is for example necessary for surfaces under stress and for sealing surfaces, (for more details see VDI/VDE 2601 Part 1). $P_t$ should only be used if for particular reasons, the sum of the irregularities of surface configuration of the first to fourth order in accordance with DIN 4760 shall be assessed within the reference length applicable for the profile depth or if the surface to be measured is so small that it is not possible to apply the measurement conditions according to DIN 4768 Part 1.

If the upper limiting value of a surface roughness parameter is specified on the drawing, that part of the surface to be tested shall be selected by visual inspection where the maximum surface roughness value is likely to occur. If the lower limiting value of a surface roughness parameter is also specified on the drawing, that part of the surface where the lowest surface roughness values may be expected shall also be selected for testing with respect to this limit.

As regards the number of individual measurements to be made, the following arrangement is recommended as an approximation method:

Surfaces with roughness values not expressly designated as maximum values (e.g. $R_a$, $R_z$) shall be accepted if

- the first measured value lies at least 30 % below the specified limiting value,
- of three measurements, none exceeds the limiting value,
- of six measurements, at the most one exceeds the limiting value,
- of 12 measurements, at the most two exceed the limiting value.

One of these conditions must be complied with in the sequence given above.

If the lower limiting value of a surface roughness parameter is specified on a drawing, the same assessment procedure applies with appropriate alterations.

If however, for example with high grade workpieces, this approximation method is too uncertain or results possibly in parts being rejected without justification, by agreement a larger number of individual measurements may be carried out for example 25, with 4 of the measurements being allowed to exceed the limit.

If a surface roughness parameter is characterized as a maximum value (for example $R_{max}$), at least three individual measurements must be carried out. If the surface appears uniformly rough by visual inspection, the measurement points must be distributed evenly over the entire surface. If it can be seen from visual inspection that there is a particular area of the surface where higher roughness values may be expected, then all three measurements shall be carried out in this area. No individual measured value may exceed the specified maximum value.

## Standards referred to and other documents

| | |
|---|---|
| DIN 4760 | Definitions used in the assessment of surface configuration |
| DIN 4761 | Surface character; geometrical characteristics of surface texture; definitions, symbols |
| DIN 4768 Part 1 | Determination of surface roughness parameters $R_a$, $R_z$ and $R_{max}$ with electric contact stylus instruments; basic data |
| DIN 4769 Part 1 | Roughness comparison specimens; technical delivery conditions, application |
| DIN 4769 Part 2 | Roughness comparison specimens; surfaces produced by cutting with periodic profile |
| DIN 4769 Part 3 | Roughness comparison specimens; surfaces produced by cutting with aperiodic profile |
| DIN 4769 Part 4 | Roughness comparison specimens; shot or sand blasted metal surfaces |
| DIN 4771 | Measurement of the profile height $P_t$ of surfaces |
| DIN 4772 | Electrical contact stylus instruments for measuring surface roughness by the contact stylus method |
| DIN ISO 1302 | Technical drawings; methods of indicating surface texture on drawings |
| VDI/VDE 2601 Part 1 | Requirements on the surface configuration for ensuring the serviceability of surfaces produced by cutting processes; summary of parameters |

## Explanations

Measurements of surface roughness on surfaces produced by engineering processes are subject to considerable dispersion for the following reasons:

- non-uniformity of the microconfiguration of the surface both on a particular part and between different parts of the same production batch
- different accuracy classes of the electrical contact stylus instruments used (see DIN 4772)
- uncertainty in the calibration of electrical contact stylus instruments on physical surface calibration standards
- subjective errors by the person carrying out the measurements

Non-uniformity of the surface results from the production process and cannot be avoided even if great care is taken, for example the cutting properties of the tool change in the case of chip removal production methods (a lathe tool will become blunter and acquires a built-up edge or with a grinding wheel, a blunt grain will break away so that another becomes effective for grinding). These random changes in production conditions affect both single parts and different parts of the same production batch.

This standard conforms essentially to the present status of the discussions in ISO/TC 57 – Metrology and Properties of Surfaces Investigations in the Swiss and German industries have shown that surfaces with surface roughness parameters without the subscript "maximum" in the symbol are generally accepted if not more than 16 % of the measured values exceed the specified limiting value. The limit thereby established as applicable to 84 % of production is equivalent to the range $\mu \pm \delta$ where $\mu$ is the true mean value of the basic population and $\delta$ is the standard deviation of the basic population of obtainable measured values.

## International Patent Classification

G 01 B 7/34