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Geometrical product specifications (GPS) — Surface texture: Areal —

Part 604:
Nominal characteristics of non-contact (coherence scanning interferometry) instruments

Spécification géométrique des produits (GPS) — État de surface: Surfacique —

Partie 604: Caractéristiques nominales des instruments sans contact (à interférométrie par balayage à cohérence)

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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The committee responsible for this document is ISO/TC 213, *Dimensional and geometrical product specifications and verification*. The document was prepared in collaboration with Technical Committee CEN/TC 290, *Dimensional and geometrical product specifications and verification*.

ISO 25178 consists of the following parts, under the general title *Geometrical product specifications (GPS) — Surface texture: Areal*:

— Part 1: *Indication of surface texture*

— *Part 2: Terms, definitions and surface texture parameters*

— *Part 3: Specification operators*

— *Part 6: Classification of methods for measuring surface texture*

— *Part 70: Physical measurement standards*

— *Part 71: Software measurement standards*

— *Part 601: Nominal characteristics of contact (stylus) instruments*

— *Part 602: Nominal characteristics of non-contact (confocal chromatic probe) instruments*

— *Part 603: Nominal characteristics of non-contact (phase shifting interferometric microscopy) instruments*

— *Part 604: Nominal characteristics of non-contact (coherence scanning interferometry) instruments*

— *Part 605: Nominal characteristics of non-contact (point autofocus probe) instruments*

— *Part 606: Nominal characteristics of non-contact (focus variation) instruments*

— *Part 701: Calibration and measurement standards for contact (stylus) instruments*

The following part is under preparation:

— *Part 72: XML file format x3p*

Introduction

This part of ISO 25178 is a geometrical product specification (GPS) standard and is to be regarded as a general GPS standard (see ISO/TR 14638). It influences chain link 5 of the chains of standards on roughness profile, waviness profile, primary profile and areal surface texture.

The ISO/GPS Masterplan given in ISO/TR 14638 gives an overview of the ISO/GPS system of which this document is a part. The fundamental rules of ISO/GPS given in ISO 8015 apply to this document and the default decision rules given in ISO 14253-1 apply to specifications made in accordance with this document, unless otherwise indicated.

For more detailed information on the relation of this part of ISO 25178 to other standards and to the GPS matrix model, see Annex E.

This part of ISO 25178 describes the metrological characteristics of coherence scanning interferometric microscopes, designed for the measurement of surface topography maps. For more detailed information on the coherence scanning technique, see Annex A and Annex B.

NOTE Portions of this document, particularly the informative texts, may describe patented systems and methods. This information is provided only to assist users in understanding the operating principles of coherence scanning interferometry. This document is not intended to establish priority for any intellectual property, nor does it imply a license to any proprietary technologies that may be described herein.

Geometrical product specifications (GPS) — Surface texture: Areal —

Part 604:
Nominal characteristics of non-contact (coherence scanning interferometry) instruments

1 Scope

This part of ISO 25178 specifies the metrological characteristics of coherence scanning interferometry (CSI) systems for 3D mapping of surface height.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

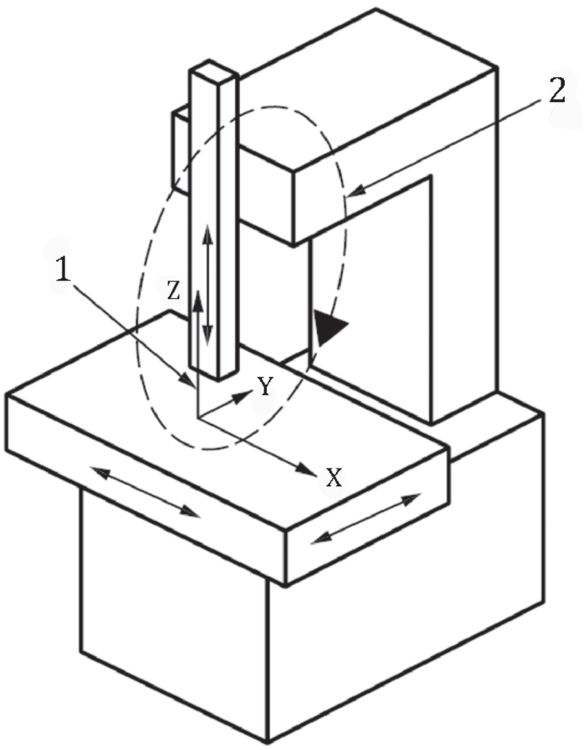
2.1 Terms and definitions related to all areal surface texture measurement methods

2.1.1
areal reference
component of the instrument that generates a reference surface with respect to which the surface topography is measured

2.1.2
coordinate system of the instrument
right hand orthonormal system of axes (x, y, z) defined as:

— (x, y) is the plane established by the areal reference of the instrument (note that there are optical instruments that do not possess a physical areal guide)

— z-axis is mounted parallel to the optical axis and is perpendicular to the (x, y) plane for an optical instrument; the z-axis is in the plane of the stylus trajectory and is perpendicular to the (x, y) plane for a stylus instrument (see Figure 1)



Key
1 coordinate system of the instrument
2 measurement loop

Figure 1 — Coordinate system and measurement loop of the instrument

Note 1 to entry: Normally, the *x*-axis is the tracing axis and the *y*-axis is the stepping axis. (This note is valid for instruments that scan in the horizontal plane.)

Note 2 to entry: See also "specification coordinate system" [ISO 25178-2:2012, 3.1.2] and "measurement coordinate system" [ISO 25178-6:2010, 3.1.1].

2.1.3
measurement loop
closed chain which comprises all components connecting the workpiece and the probe, e.g. the means of positioning, the work holding fixture, the measuring stand, the drive unit, the probing system

Note 1 to entry: The measurement loop will be subjected to external and internal disturbances that influence the measurement uncertainty.

SEE: Figure 1.

2.1.4
real surface of a workpiece
set of features which physically exist and separate the entire workpiece from the surrounding medium

Note 1 to entry: The real surface is a mathematical representation of the surface that is independent of the measurement process.

Note 2 to entry: See also "mechanical surface" [ISO 25178-2:2012, 3.1.1.1 or ISO 14406:2010, 3.1.1] and "electromagnetic surface" [ISO 25178-2:2012, 3.1.1.2 or ISO 14406:2010, 3.1.2].

Note 3 to entry: The electro-magnetic surface considered for one type of optical instrument may be different from the electro-magnetic surface for other types of optical instruments.

2.1.5
surface probe
device that converts the surface height into a signal during measurement

Note 1 to entry: In earlier standards, this was termed "transducer".

2.1.6
measuring volume
range of the instrument stated in terms of the limits on all three coordinates measured by the instrument

Note 1 to entry: For areal surface texture measuring instruments, the measuring volume is defined by the measuring range of the *x*- and *y*- drive units, and the measuring range of the *z*-probing system.

[SOURCE: ISO 25178-601:2010, 3.4.1]

2.1.7
response curve
F_x, F_y, F_z
graphical representation of the function that describes the relation between the actual quantity and the measured quantity

Note 1 to entry: An actual quantity in x (respectively y or z) corresponds to a measured quantity x_M (respectively y_M or z_M).

Note 2 to entry: The response curve can be used for adjustments and error corrections.

[SOURCE: ISO 25178-601:2010, 3.4.2]

2.1.8
amplification coefficient
α_x, α_y, α_z
slope of the linear regression curve obtained from the *response curve* (2.1.7)

Note 1 to entry: There will be amplification coefficients applicable to the x, y and z quantities.

Note 2 to entry: The ideal response is a straight line with a slope equal to 1, which means that the values of the measurand are equal to the values of the input quantities.

Note 3 to entry: See also "sensitivity of a measuring system" (ISO/IEC Guide 99:2007,[1] 4.12)

[SOURCE: ISO 25178-601:2010, 3.4.3, modified —Note 3 to entry has been added.]

2.1.9
instrument noise
N_i
internal noise added to the output signal caused by the instrument if ideally placed in a noise-free environment

Note 1 to entry: Internal noise can be due to electronic noise, as e.g. amplifiers, or optical noise, as e.g. stray light.

Note 2 to entry: This noise typically has high frequencies and it limits the ability of the instrument to detect small spatial wavelengths of the surface texture.

Note 3 to entry: The S-filter according ISO 25178-3 may reduce this noise.

Note 4 to entry: For some instruments, instrument noise cannot be estimated because the instrument only takes data while moving.

2.1.10
measurement noise
N_M
noise added to the output signal occurring during the normal use of the instrument

Note 1 to entry: Notes 2 and 3 of 2.1.9 apply as well to this definition.

Note 2 to entry: Measurement noise includes *instrument noise* (2.1.9).

2.1.11
surface topography repeatability
repeatability of topography map in successive measurements of the same surface under the same conditions of measurement

Note 1 to entry: Surface topography repeatability provides a measure of the likely agreement between repeated measurements normally expressed as a standard deviation.

Note 2 to entry: See ISO/IEC Guide 99:2007,[1] 2.15 and 2.21, for a general discussion of repeatability and related concepts.

Note 3 to entry: Evaluation of surface topography repeatability is a common method for determining the measurement noise.

2.1.12
sampling interval in *x*
D_x
distance between two adjacent measured points along the *x*-axis

Note 1 to entry: In many microscopy systems, the sampling interval is determined by the distance between sensor elements in a camera, called pixels. For such systems, the terms pixel pitch and pixel spacing are often used interchangeably with the term sampling interval. Another term, pixel width, indicates a length associated with one side (*x* or *y*) of the sensitive area of a single pixel and is always smaller than the pixel spacing. Yet another term, sampling zone, may be used to indicate the length or region over which a height sample is determined. This quantity could either be larger or smaller than the sampling interval.

2.1.13
sampling interval in *y*
D_y
distance between two adjacent measured points along the *y*-axis

Note 1 to entry: In many microscopy systems, the sampling interval is determined by the distance between sensor elements in a camera, called pixels. For such systems, the terms pixel pitch and pixel spacing are often used interchangeably with the term sampling interval. Another term, pixel width, indicates a length associated with one side (*x* or *y*) of the sensitive area of a single pixel and is always smaller than the pixel spacing. Yet another term, sampling zone, may be used to indicate the length or region over which a height sample is determined. This quantity could either be larger or smaller than the sampling interval.

2.1.14
digitization step in *z*
D_z
smallest height variation along the z-axis between two ordinates of the extracted surface

2.1.15
lateral resolution
R_l
smallest distance between two features which can be detected

[SOURCE: ISO 25178-601:2010, 3.4.10, modified —The word “separation” has been removed before “distance”.]

2.1.16
width limit for full height transmission
W_l
width of the narrowest rectangular groove whose measured height remains unchanged by the measurement

Note 1 to entry: Instrument properties (such as the sampling interval in *x* and *y*, the digitization step in *z*, and the short wavelength cutoff filter) should be chosen so that they do not influence the lateral resolution and the width limit for full height transmission.

Note 2 to entry: When determining this parameter by measurement, the depth of the rectangular groove should be close to that of the surface to be measured.

[SOURCE: ISO 25178-601:2010, 3.4.11, modified —The notes have been changed.]

2.1.17
lateral period limit
D_{LIM}
spatial period of a sinusoidal profile at which the height response of an instrument falls to 50 %

Note 1 to entry: The lateral period limit is one metric for describing spatial or lateral resolution of a surface topography measuring instrument and its ability to distinguish and measure closely spaced surface features. Its value depends on the heights of surface features and on the method used to probe the surface. Maximum values for this parameter are listed in ISO 25178-3:2012, Table 3, in comparison with recommended values for short wavelength (s-)filters and sampling intervals.

Note 2 to entry: Spatial period is the same concept as *spatial wavelength* and is the inverse of *spatial frequency*.

Note 3 to entry: One factor related to the value of D_{LIM} for optical tools is the *Rayleigh criterion* (2.3.7). Another is the degree of focus of the objective on the surface.

Note 4 to entry: One factor related to the value of D_{LIM} for contact tools is the stylus tip radius, r_{TIP} (see ISO 25178-601).

Note 5 to entry: Other terms related to *lateral period limit* are *structural resolution* and *topographic spatial resolution.*

2.1.18
maximum local slope
greatest local slope of a surface feature that can be assessed by the probing system

Note 1 to entry: The term "local slope" is defined in ISO 4287:1997, 3.2.9.

2.1.19
instrument transfer function
ITF
f_{ITF}
function of spatial frequency describing how a surface topography measuring instrument responds to an object surface topography having a specific spatial frequency

Note 1 to entry: Ideally, the ITF tells us what the measured amplitude of a sinusoidal grating of a specified spatial frequency ν would be relative to the true amplitude of the grating.

Note 2 to entry: For several types of optical instruments, the ITF may be a nonlinear function of height except for heights much smaller than the optical wavelength.

2.1.20
hysteresis
$x_{\mathrm{HYS}}, y_{\mathrm{HYS}}, z_{\mathrm{HYS}}$
property of measuring equipment, or characteristic whereby the indication of the equipment or value of the characteristic depends on the orientation of the preceding stimuli

Note 1 to entry: Hysteresis can also depend, for example, on the distance travelled after the orientation of stimuli has changed.

Note 2 to entry: For lateral scanning systems, the hysteresis is mainly a repositioning error.

[SOURCE: ISO 14978:2006, 3.24, modified —Note 2 to entry and the symbols have been added.]

2.1.21
metrological characteristic
metrological characteristic of a measuring instrument
<measuring equipment> characteristic of measuring equipment, which may influence the results of measurement

Note 1 to entry: Calibration of metrological characteristics may be necessary.

Note 2 to entry: The metrological characteristics have an immediate contribution to measurement uncertainty.

Note 3 to entry: Metrological characteristics for areal surface texture measuring instruments are given in Table 1.

Table 1 — List of metrological characteristics for surface texture measurement methods

Metrological characteristic	Symbol	Definition	Main potential error along
Amplification coefficient	α_x, α_y, α_z	2.1.8	*x*, *y*, *z*
Linearity deviation	l_x, l_y, l_z	Maximum local difference between the line from which the amplification coefficient is derived and the response curve.	*x*, *y*, *z*
Residual flatness	z_{FLT}	Flatness of the areal reference	*z*
Measurement noise	N_M	2.1.10	*z*
Lateral period limit	D_{LIM}	2.1.17.	*z*
Perpendicularity	Δ_{PERxy}	Deviation from 90° of the angle between the *x*- and *y*-axes	*x*, *y*

[SOURCE: ISO 14978:2006, 3.12, modified — The notes are different and the table has been added.]

2.2 Terms and definitions related to *x*- and *y*-scanning systems

2.2.1
areal reference guide
component(s) of the instrument that generate(s) the reference surface, in which the probing system moves relative to the surface being measured according to a theoretically exact trajectory

Note 1 to entry: In the case of *x*- and *y*-scanning areal surface texture measuring instruments, the areal reference guide establishes a reference surface [ISO 25178-2:2012, 3.1.8]. It can be achieved through the use of two linear and perpendicular reference guides [ISO 3274:1996, 3.3.2] or one reference surface guide.

2.2.2
lateral scanning system
system that performs the scanning of the surface to be measured in the (*x*, *y*) plane

Note 1 to entry: There are essentially four aspects to a surface texture scanning instrument system: the x-axis drive, the y-axis drive, the *z*-measurement probe and the surface to be measured. There are different ways in which these may be configured and thus there will be a difference between different configurations as explained in Table 2.

Note 2 to entry: When a measurement consists of a single field of view of a microscope, *x*- and *y*-scanning is not used. However, when several fields of view are linked together by stitching methods, see Reference [2] the system is considered to be a scanning system.

Table 2 — Possible different configurations for reference guides (x and y)

		Drive unit				
		Two reference guides (x and y)[a]			One areal reference guide	
		Px o Cy	Px o Py	Cx o Cy	Pxy	Cxy
Probing System	A: without arcuate error correction	Px o Cy-A	Px o Py-A	Cx o Cy-A	Pxy-A	Cxy-A
	S: without arcuate error or with arcuate error corrected	Px o Cy-S	Px o Py-S	Cx o Cy-S	Pxy-S	Cxy-S

a For two given functions f and g, f o g is the combination of these functions

Px = probing systems moving along the x-axis

Py = probing systems moving along the y-axis

Cx = component moving along the x-axis

Cy = component moving along the y-axis

2.2.3
drive unit x
component of the instrument that moves the probing system or the surface being measured along the reference guide on the x-axis and returns the horizontal position of the measured point in terms of the lateral x coordinate of the profile

2.2.4
drive unit y
component of the instrument that moves the probing system or the surface being measured along the reference guide on the y-axis and returns the horizontal position of the measured point in terms of the lateral y coordinate of the profile

2.2.5
lateral position sensor
component of the drive unit that provides the lateral position of the measured point

Note 1 to entry: The lateral position can be measured or inferred by using, for example, a linear encoder, a laser interferometer, or a counting device coupled with a micrometre screw.

2.2.6
speed of measurement
v_x
speed of the probing system relative to the surface to be measured during the measurement along the x-axis

[SOURCE: ISO 25178-601:2010, 3.4.13]

2.2.7
static noise
N_S
combination of the *instrument noise* (2.1.9) and environmental noise on the output signal when the instrument is not scanning laterally

Note 1 to entry: Environmental noise is caused by e.g. seismic, sonic and external electromagnetic disturbances.

Note 2 to entry: Notes 2 and 3 in 2.1.9 also apply to this definition.

Note 3 to entry: Static noise is included in *measurement noise* (2.1.10)