INTERNATIONAL STANDARD

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

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

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

Partie 603: Caractéristiques nominales des instruments sans contact (microscopes interférométriques à glissement de franges)

Reference number
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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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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 213, *Dimensional and geometrical product specifications and verification.*

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

— *Part 1: Areal surface texture drawing indication*

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

— *Part 3: Specification operators*

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

— *Part 70: Material measures*

— *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 interferometric microscopy) instruments*

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

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

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

— *Part 702 Calibration of non-contact (confocal chromatic probe) instruments*

— *Part 703: Calibration and measurement standards for non-contact (interferometric) instruments*

The following part is under preparation: *Part 72: XML file format x3p*

Introduction

This part of ISO 25178 is a Geometrical Product Specification standard and is to be regarded as a general GPS standard (see ISO/TR 14638). It influences the chain link 5 of the chain of standards on areal surface texture.

This part of ISO 25178 describes the metrological characteristics of phase-shifting interferometric (PSI) profile and areal surface texture measuring microscopes, designed for the measurement of surface topography maps. For more detailed information on the phase-shifting interferometry technique, see Annex A and Annex B.

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.

NOTE Portions of this document, particularly the informative clauses, may describe patented systems and methods. This information is provided only to assist users in understanding the operating principles of phase-shifting 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 603:
Nominal characteristics of non-contact (phase-shifting interferometric microscopy) instruments

1 Scope

This part of ISO 25178 describes the metrological characteristics of phase-shifting interferometric (PSI) profile and areal surface texture measuring microscopes.

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) where

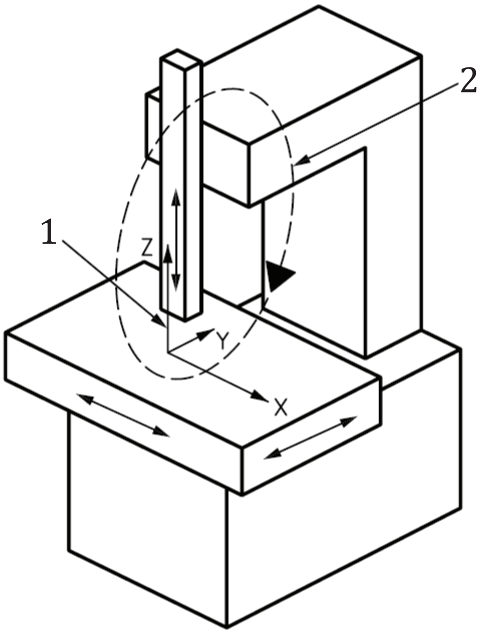
— (x, y) is the plane established by the areal reference of the instrument (note that there are optical instruments that do not possess a physical areal guide);

— 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

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].

SEE: Figure 1.



Key

1 coordinate system of the instrument

2 measurement loop

Figure 1 — Coordinate system and measurement loop of the instrument

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 electromagnetic surface considered for one type of optical instrument may be different from the electromagnetic 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.

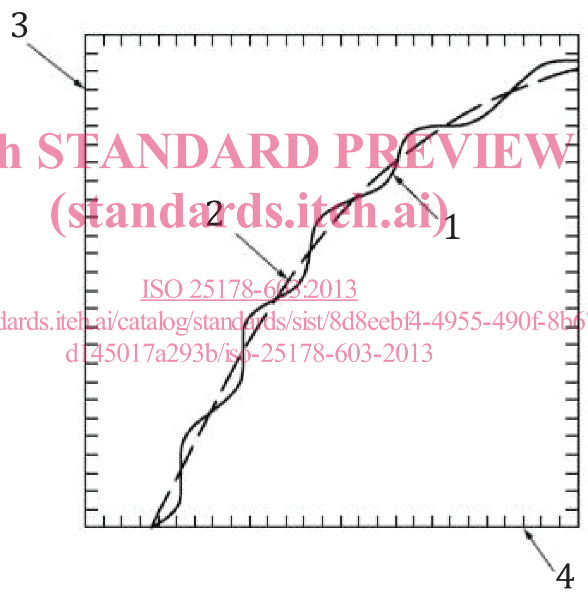
[SOURCE: ISO 25178-601:2010, 3.4.1]

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.

SEE: Figure 2



Key

1 response curve
2 assessment of the linearity deviation by polynomial approximation
3 measured quantities
4 input quantities

Figure 2 — Example of a nonlinear response curve

[ISO 25178-601:2010, 3.4.2]

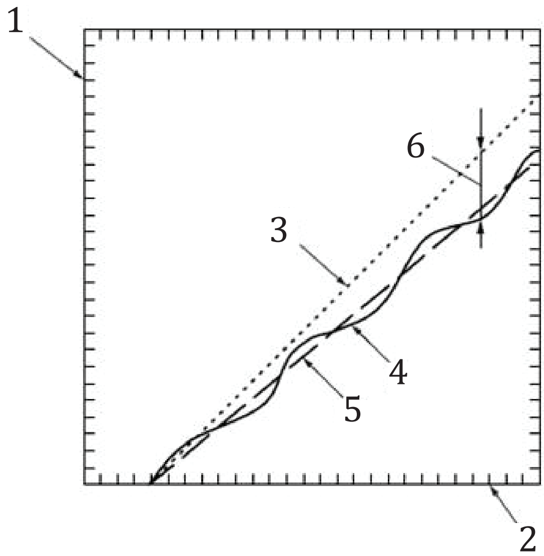
2.1.8
amplification coefficient
α_x, α_y, α_z
slope of the linear regression curve obtained from the *response curve* (2.1.7)

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, 4.12)[1].

SEE: Figure 3



Key

1 measured quantities

2 input quantities

3 ideal response curve

4 linearization of the response curve of Figure 2

5 line from which the amplification coefficient α is derived

6 local residual correction error before adjustment

Figure 3 — Example of the linearization of a response curve

[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 to 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 scale 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. See also A.3.

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. See also A.3.

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

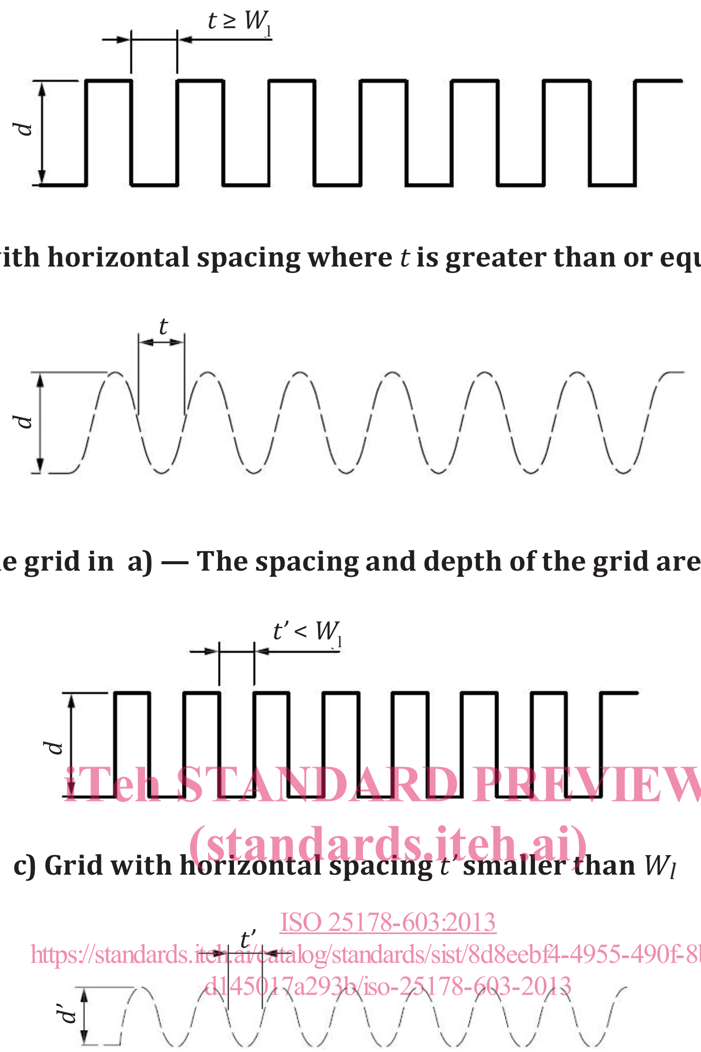
2.1.15
lateral resolution
R_l
smallest distance between two features which can be detected

[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.



a) Grid with horizontal spacing where t is greater than or equal to W_l

b) Measurement of the grid in a) — The spacing and depth of the grid are measured correctly

c) Grid with horizontal spacing t' smaller than W_l

d) Measurement of the grid in c) — The spacing is measured correctly but the depth is smaller ($d' < d$)

Figure 4 — Examples of grids and their measurements

EXAMPLE 1 Measuring a grid for which the grooves are wider than the width limit for full height transmission leads to a correct measurement of the groove depth [see Figure 4 a) and b)].

EXAMPLE 2 Measuring a grid for which the grooves are narrower than the *width limit for full height transmission* leads to an incorrect groove depth [see Figure 4 c) and d)]. In this situation, the signal is generally disturbed and may contain non-measured points.

[SOURCE: ISO 25178-601:2010, 3.4.11, modified — The definition is identical. The notes, examples and figures are different.]