INTERNATIONAL STANDARD

ISO 25178-600

First edition
2019-02

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

Part 600:
Metrological characteristics for areal topography measuring methods

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

Partie 600: Caractéristiques métrologiques pour les méthodes de mesure par topographie surfacique

Reference number
ISO 25178-600:2019(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

A list of all parts in the ISO 25178 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is a geometrical product specification standard and is to be regarded as a general GPS standard (see ISO 14638). It influences the chain link F of the chains of standards on areal surface texture and profile surface texture.

The ISO/GPS matrix model given in ISO 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 the specifications made in accordance with this document, unless otherwise indicated.

For more detailed information of the relation of this document to other standards and the GPS matrix model, see Annex B.

This document describes the metrological characteristics of areal topography methods designed for the measurement of surface topography maps. Several standards (ISO 25178-601, ISO 25178-602, ISO 25178-603, ISO 25178-604, ISO 25178-605 and ISO 25178-606) have already been developed to define terms and metrological characteristics for individual methods. Although we have striven for consistency throughout the series, some slight differences can appear between them. Therefore Technical Committee ISO/TC 213 decided in 2012 to concentrate all common aspects into one standard – this document – and to describe in ISO 25178-601 to ISO 25178-606 only the terms relevant to each individual method. For the existing standards of ISO 25178-601 to ISO 25178-606 it will be necessary to adapt this decision within the next revision. Until then it will be possible to have different definitions for a single term. Further, if any differences between the current ISO 25178-601 to ISO 25178-606 are discovered that give rise to conflict, then parties involved in the conflict should agree how to handle the differences.

NOTE Portions of this document describe patented systems and methods. This information is provided only to assist users in understanding basic principles of areal surface topography measuring instruments. This document is not intended to establish priority for any intellectual property, nor does it imply a license to any proprietary technologies described herein.

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

Part 600:
Metrological characteristics for areal topography measuring methods

1 Scope

This document specifies the metrological characteristics of areal instruments for measuring surface topography. Because surface profiles can be extracted from surface topography images, most of the terms defined in this document can also be applied to profiling measurements.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 All areal topography measuring methods

3.1.1
areal reference
component of the instrument that generates a reference surface with respect to which the surface topography is measured

3.1.2
coordinate system of the instrument
right handed orthogonal system of axes (x,y,z) consisting of:

— the z-axis oriented nominally parallel to the z-scan axis (for optical systems with z-scan), the optical axis (for non-scanning optical systems) or the stylus trajectory (for stylus or scanning probe instruments);

— an (x,y) plane perpendicular to the z-axis.

Note 1 to entry: See Figure 1.

Note 2 to entry: Normally, the x-axis is the tracing axis and the y-axis is the stepping axis. (Valid for instruments that scan in the horizontal plane.)

Note 3 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].

Note 4 to entry: Certain types of optical instruments do not possess a physical areal guide.

Note 5 to entry: The z-axis is sometimes referred to as the *vertical* axis, and the x- and y-axes are sometimes referred to as the *horizontal* axes.

3.1.3
z-scan axis

<measuring instrument> instrument axis used to scan in the z-direction to measure the surface topography

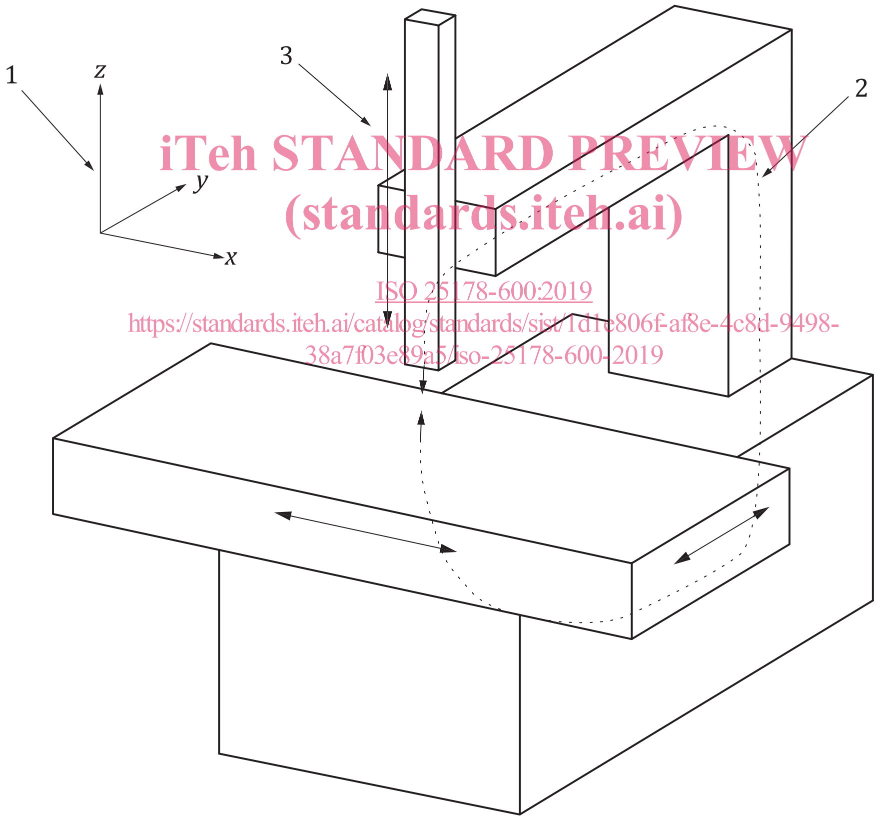
Note 1 to entry: The z-scan axis is nominally but not necessarily parallel to the z-axis of the coordinate system of the instrument.

3.1.4
measurement area

area that is measured by a surface topography instrument

Note 1 to entry: For point optical sensors and stylus methods, the measurement area is typically the scan area of the lateral translation stage(s). For topography microscopes the measurement area can be a single field of view as determined by the objective or a larger area realized by stitching or only part of a field of view as specified by the operator.

Note 2 to entry: For related concepts, *evaluation area* and *definition area*, see ISO 25178-2:2012, 3.1.9 and 3.1.10.



Key

1 coordinate system of the instrument

2 measurement loop

3 z-scan axis

Figure 1 — Coordinate system and measurement loop of the instrument

3.1.5

measurement loop

closed chain which comprises all components connecting the workpiece and the probe, for example the means of positioning, the work holding fixture, the measuring stand, the drive unit and the probing system

Note 1 to entry: See Figure 1.

Note 2 to entry: The measurement loop will be subjected to external and internal disturbances that influence the measurement uncertainty.

3.1.6

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 determined with different optical methods can be different. Examples of optical methods are found in ISO 25178-602 to ISO 25178-607.

[SOURCE: ISO 17450-1:2011, 3.1, modified — Notes to entry added.]

3.1.7

surface probe

device that converts the surface height into a signal during measurement

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

3.1.8

measuring volume

range of the instrument stated in terms of the limits on all three coordinates measurable 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;

— the measuring range of the z-probing system.

3.1.9

response function

F_x, F_y, F_z

function that describes the relation between the actual quantity and the measured quantity

Note 1 to entry: The response curve is the graphical representation of the response function. See Figure 2.

Note 2 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 3 to entry: The response function can be used for adjustments and error corrections.

3.1.10

amplification coefficient

α_x, α_y, α_z

slope of the linear regression line obtained from the response function

Note 1 to entry: See Figure 2.

Note 2 to entry: There will be amplification coefficients applicable to the x, y and z quantities.

Note 3 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 4 to entry: See also *sensitivity of a measuring system* (VIM, 4.12[10]).

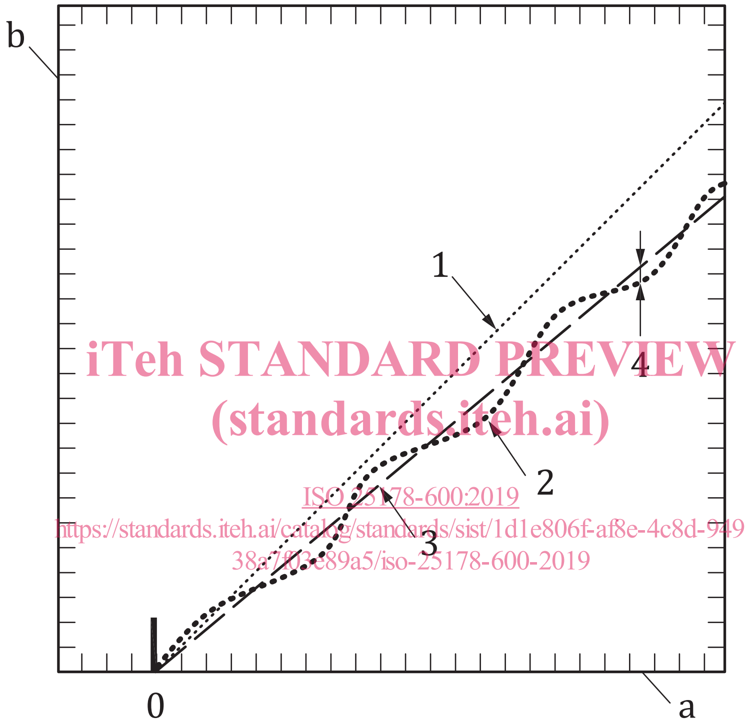
Note 5 to entry: This quantity is also termed *scaling factor*.

3.1.11
linearity deviation

l_x, l_y, l_z

maximum local difference between the line from which the amplification coefficient is derived and the response function

Note 1 to entry: For example, see element 4 in Figure 2.



Key

a	actual input quantities
b	measured quantities
0	coordinate origin
1	ideal response curve
2	actual response curve of the instrument
3	line from which the amplification coefficient α (slope) is calculated
4	local linearity deviation (l)

Figure 2 — Example of linearity deviation of a response curve

3.1.12
flatness deviation

z_{FLT}

deviation of the measured topography of an ideally flat object from a plane

Note 1 to entry: Flatness deviation can be caused by residual flatness of an imperfect areal reference or by imperfection in the optical setup of an instrument.

3.1.13

x-y mapping deviation

$\Delta_x (x,y)$, $\Delta_y (x,y)$

gridded image of x- and y-deviations of actual coordinate positions on a surface from their nominal positions

Note 1 to entry: The mapping deviations can be used to calculate the x- and y- linearity deviations, and x-y axis perpendicularity.

3.1.14

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, such as that arising in amplifiers, or optical noise, such as that arising from stray light.

Note 2 to entry: The S-filter according to ISO 25178-3 can reduce the high spatial frequency components of this noise.

Note 3 to entry: For some instruments, instrument noise cannot be completely separated from other types of measurement noise because the instrument only takes data while moving. If so, any measured noise includes a dynamic component. See also *static noise* (3.2.6) and *dynamic noise* (3.2.7).

Note 4 to entry: Because noise is a bandwidth-related quantity, its magnitude depends on the time over which it is measured or averaged.

3.1.15

measurement noise

N_{M}

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

Note 1 to entry: 3.1.14 Notes to entry 2 and 4 also apply to this definition.

Note 2 to entry: Measurement noise includes the instrument noise as well as components arising from the environment (thermal, vibration, air turbulence) and other sources.

Note 3 to entry: Figure 3 provides an illustration of typical sources of noise and shows the contrast between laboratory conditions producing instrument noise and measurement noise.

3.1.16

surface topography repeatability

closeness of agreement between successive measurements of the same surface topography 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 VIM[10], 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 estimating measurement noise and other time-varying errors, such as drift.