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

Part 601: Design and characteristics of contact (stylus) instruments

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

Partie 601: Conception et caractéristiques des instruments à contact (palpeur)

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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 document 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).

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This document was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 290, *Dimensional and geometrical product specification and verification,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 25178-601:2010), which has been technically revised, and cancels and replaces ISO 3274:1996, whose contents have been revised and incorporated into this document and others, see Annex C for more information.

The main changes are as follows:

— removal of information about the general metrological characteristics for the areal topography measuring method, which are specified in ISO 25178-600;

— removal of the terms and definitions now specified in ISO 25178-600;

— revision of all terms and definitions for clarity and consistency with other ISO standards documents;

— addition of Clause 4 for instrument requirements, which summarizes normative features and characteristics;

— addition of an information flow concept diagram in Clause 4;

— addition of Clause 5 on metrological characteristics;

— addition of Clause 6 on design features, which clarifies the types of instruments relevant to this document;

— revision of Annex A describing the principles of instruments addressed by this document;

— addition of Annex B on the metrological characteristics and influence quantities; replacement of the normative table of influence quantities with an informative description of common error sources and how these relate to the metrological characteristics in ISO 25178-600;

— inclusion of nominal characteristics of a contact stylus instrument, which have been transferred from ISO 3274 to this document.

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 (GPS) standard and is to be regarded as a general GPS standard (see ISO 14638). It influences chain link F of the chains of standards on profile and areal 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 on the relation of this document to other standards and the GPS matrix model, see Annex D.

This document includes terms and definitions relevant to contact stylus instruments for the measurement of areal surface topography. Annex A briefly summarizes contact stylus instruments and methods to clarify the definitions and to provide a foundation for Annex B, which describes common sources of uncertainty and their relation to the metrological characteristics of contact stylus instruments.

The stylus instrument for the profile method was previously defined in ISO 3274. Based on this, this document was published in 2010. Since this is the more modern instrument standard and stylus instruments for the profile method and the areal method differ only in the presence of a *y*-axis (drive unit *y*), this edition of this document replaces not only the previous version of ISO 25178-601 but also ISO 3274:1996 (and the Technical Corrigendum of 1998), see Annex C for more details.

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

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

Part 601:
Design and characteristics of contact (stylus) instruments

1 Scope

This document specifies the design, metrological characteristics and nominal characteristics of contact stylus instruments for the areal measurement of surface topography. Because surface profiles can be extracted from areal surface topography data, the methods described in this document are also applicable to profiling measurements.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 25178-600, *Geometrical product specifications (GPS) — Surface texture: Areal — Part 600: Metrological characteristics for areal topography measuring methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 25178-600 and the following apply.

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

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

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

3.1
contact stylus instrument
measuring instrument that explores surfaces using a *stylus* (3.5) that physically moves along the surface to acquire a representation of the surface and provide the data for further computation (analytics)

Note 1 to entry: The method of using a contact stylus instrument is defined in ISO 25178-6, and is called “contact stylus scanning”.

Note 2 to entry: See Figure 2 for an information flow concept diagram for a contact stylus instrument.

3.2
probing system
<surface texture> component of the instrument consisting of a *probe* (3.3), a *stylus* (3.5) and an optional *stylus changing interface* (3.7)

Note 1 to entry: See Figures A.2 to A.4 for examples of probing systems.

3.3
probe
<surface texture> device that generates the signals during *scanning* (3.4)

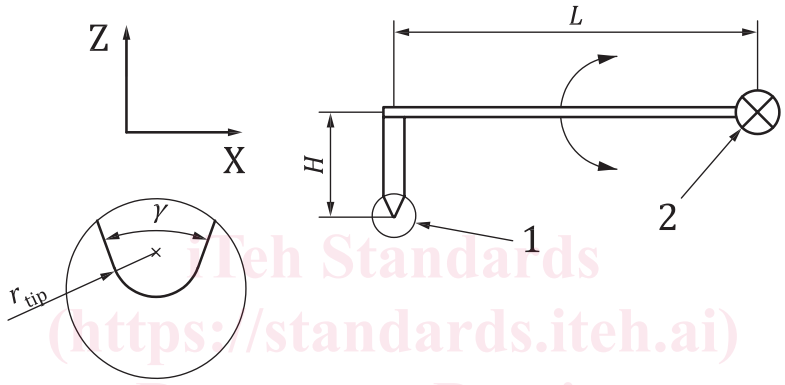
Note 1 to entry: In earlier standards, “transducer” was a separate term and a part of the probe.

3.4
scanning
<surface texture> moving the *probe* (3.3) over the surface to be measured while the *stylus tip* (3.6) contacts the surface

3.5
stylus
<surface texture> mechanical device consisting of a *stylus tip* (3.6) and a *probe* (3.3) arm

Note 1 to entry: For coordinate measuring machines, the term “shaft” is used instead of “probe arm”, see ISO 10360-1:2000, 4.1.

Note 2 to entry: A typical stylus is shown in Figure 1. Other designs are also used, e.g. flexures, linear probes.



Key

1	stylus tip	H	height of the probe arm
2	pivot	r_{tip}	tip radius
L	length of the probe arm	γ	cone angle of the tip

Figure 1 — Characterization of the typical stylus

3.6
stylus tip
<surface texture> element that consists of a nominally right circular cone of defined cone angle and of a nominally spherical tip of defined radius

3.7
stylus changing interface
<surface texture> element that enables the change of the *stylus* (3.5)

Note 1 to entry: There are *probing systems* (3.2) without a stylus changing interface.

3.8
linear reference guide
component of the instrument that generates the intersection plane and the reference profile, in which the *probing system* (3.2) moves relative to the surface being measured according to a theoretically exact trajectory

3.9
areal reference guide
component(s) of the instrument that generate(s) the reference surface, in which the *probing system* (3.2) 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 (see ISO 25178-2:2021, 3.1.10).

Note 2 to entry: The areal reference guide can be achieved through the use of two perpendicular *linear reference guides* (3.8) or one reference surface guide.

[SOURCE: ISO 25178-600:2019, 3.2.1, modified — Note 1 to entry has been modified and Note 2 to entry has been added.]

3.10
lateral scanning system
system that performs the *scanning* (3.4) of the surface to be measured in the (*x*, *y*) plane

Note 1 to entry: There are essentially four components to a surface texture scanning instrument system: the *x*-axis drive, the *y*-axis drive, the *z*-measurement *probe* (3.3) and the surface to be measured.

[SOURCE: ISO 25178-600:2019, 3.2.2. modified — Note 2 to entry has been deleted.]

3.11
drive unit *x*
component of the instrument that moves the *probing system* (3.2) 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

[SOURCE: ISO 25178-600:2019, 3.2.3, modified — "*x*-drive unit" has been replaced by "drive unit *x*" as the term and "of the profile" has been deleted from the definition. Note 1 to entry has been deleted.]

3.12
drive unit *y*
component of the instrument that moves the *probing system* (3.2) 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

[SOURCE: ISO 25178-600:2019, 3.2.3, modified — "*x*-drive unit" has been replaced by "drive unit *y*" as the term, "*x*-axis" has been replaced by "*y*-axis", " *x*-coordinate" has been replaced by "*y*-coordinate" and "of the profile" has been deleted from the definition. Note 1 to entry has been deleted.]

3.13
lateral position sensor
component of the drive unit that provides the lateral position of the measured point

Note 1 to entry: The lateral position is customarily measured or inferred by using, for example, a linear encoder, a laser interferometer or a rotary encoder coupled with a micrometer screw.

[SOURCE: ISO 25178-600:2019, 3.2.4]

3.14
critical dynamic of the probing system
$v_{dyn,c}$
maximum value of the *scanning* (3.4) speed above which the output signal is distorted

Note 1 to entry: : The critical dynamic of the probing system depends on the mechanical inertia of the moving parts and the surface to be measured.

Note 2 to entry: Below the critical dynamic of the probing system, a range of measurement speeds is generally acceptable.

4 Instrument requirements

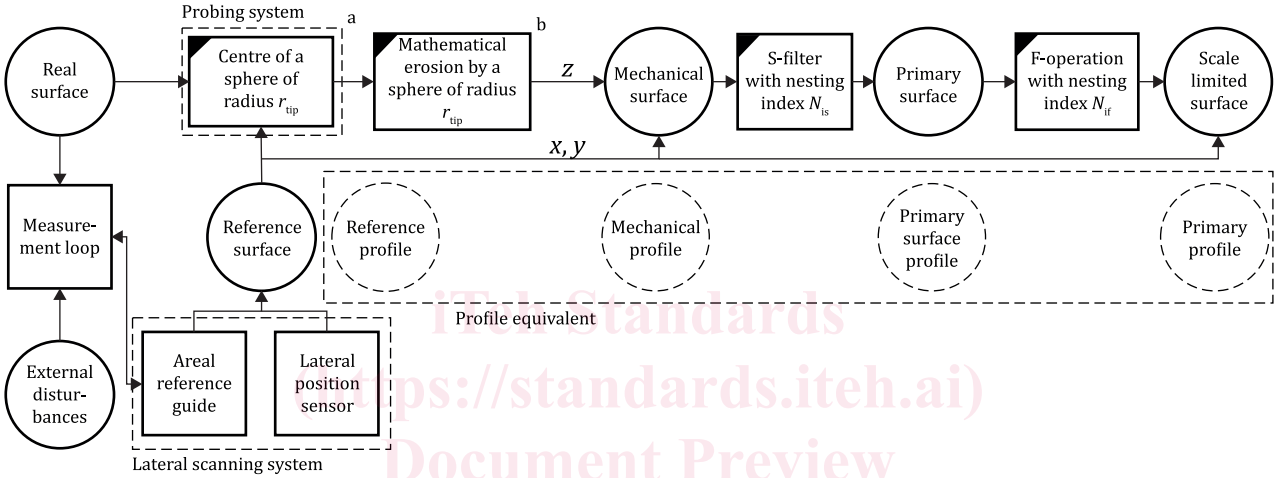
To perform surface topography measurements of a sample surface according to the method of contact stylus scanning, a contact stylus instrument shall be used.

The instrument shall comprise a probing system, an areal reference guide, a lateral scanning system, a drive unit *x*, a drive unit *y*, and a lateral position sensor.

NOTE In instruments for profiling measurements, the drive unit *y* is optional and the areal reference guide can be replaced by a linear reference guide.

The instrument shall acquire data by moving the stylus tip in contact over the surface and generating height data relative to the areal reference guide.

Figure 2 shows the information flow between these elements for a contact stylus instrument, from the real surface to a scale-limited surface. Example contact stylus instrument hardware, techniques and error sources are given in Annexes A and B.



Key

measurand (surface or profile)

operator with intended modification

operator without intended modification

a This acts as a "dilation" operator.

b In the profile method, the erosion is performed by a circular disk.

NOTE The sequence of the "dilation" and "erosion" operators represents a morphological closing filter.

Figure 2 — Information flow concept diagram for a contact stylus instrument

5 Metrological characteristics

The standard metrological characteristics for areal surface texture measuring instruments are listed and explained in ISO 25178-600. Additional metrological characteristics or error sources for an instrument, or both, according to this document consist of stylus tip, areal reference guide, lateral scanning system, drive unit *x*, drive unit *y*, and lateral position sensor. All shall be considered when designing and calibrating the instrument.

Annex B describes sources of measurement error that can influence the calibration result.