International Standard

ISO 25178-603

Second edition
2025-02

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

Part 603: Design and characteristics of non-contact (phase shifting interferometry) instruments

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

Partie 603: Conception et caractéristiques des instruments sans contact (à interférométrie à glissement de franges)

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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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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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*, 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 25178-603:2013), which has been technically revised.

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The main changes are as follows:

— 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 Clause 5 on metrological characteristics;

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

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

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

— addition of Annex B on 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.

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.

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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 C.

This document includes terms and definitions relevant to the phase shifting interferometry (PSI) instruments for the measurement of areal surface topography. Annex A briefly summarizes PSI 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 PSI.

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 PSI instruments. This document is not intended to establish priority for any intellectual property, nor does it imply a license to proprietary technologies described herein.

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

Part 603:
Design and characteristics of non-contact (phase shifting interferometry) instruments

1 Scope

This document specifies the design and metrological characteristics of phase shifting interferometry (PSI) 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 25178-600:2019, *Geometrical product specifications (GPS) — Surface texture: Areal — Part 600: Metrological characteristics for areal topography measuring methods*

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3 Terms and definitions

ISO 25178-603:2025

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
phase shifting interferometry
PSI
method for measuring areal surface topography from the surface height dependence of an interferometric signal, whereby the interference phase is estimated from two or more digitized interference images acquired over a sequence of controlled phase shifts

Note 1 to entry: In this document, PSI refers specifically to methods that employ time-dependent *phase shifting mechanisms* (3.8). Other methods of acquiring and analysing interference patterns, including parallel or instantaneous methods using polarization or carrier fringes, are outside the scope of this document.

Note 2 to entry: ISO/TR 14999-2:2019, 6.4.4, provides further information on synchronous detection and PSI.

Note 3 to entry: PSI instruments are most often employed for measurements of optically smooth surfaces, as defined in ISO 25178-600:2019, 3.4.4.

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3.2
interference objective
microscope objective adapted with a reference path and reference surface for the generation of interference patterns superimposed on the image of a sample surface

Note 1 to entry: Interference objectives are used in *PSI* (3.1) instruments that are configured as microscopes. Other configurations of PSI instruments, particularly for fields of view larger than about 10 mm, can have interferometer designs that are not based on microscope objectives.

Note 2 to entry: Annex A provides example types of interference objective in common usage.

3.3
linear phase shifting interferometry
linear PSI
PSI (3.1) method that relies on sampling an interference signal over a sequence of evenly spaced interference phase shifts

3.4
sinusoidal phase shifting interferometry
sinusoidal PSI
PSI (3.1) method that relies on sampling an interference signal over a sequence of sinusoidally-varying interference phase shifts

3.5
phase shifting interferometry algorithm
PSI algorithm
algorithm for the data processing procedure, including the mathematical equations, used to calculate the topography from two or more digitized interference images acquired over a sequence of controlled phase shifts

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3.6
equivalent wavelength
λ_{eq}
constant value equal to twice the change in surface topography height that produces one full cycle of interference phase change (equivalent to one interference fringe)

Note 1 to entry: The equivalent wavelength is a definition in the context of *PSI* (3.1) for the measurement optical wavelength, defined as the "effective value of the wavelength of the light used to measure a surface" in ISO 25178-600:2019, 3.3.3.

Note 2 to entry: This definition corresponds to the measurement configuration described in Annex A. There can be different definitions for other measurement configurations.

Note 3 to entry: The equivalent wavelength can be calculated from contributions such as the light source wavelength together with other factors related to the instrument design, or can be calibrated using a procedure corresponding to the definition of the equivalent wavelength.

3.7
phase change on reflection
PCOR
change in interference phase attributable to the optical properties of a sample surface independent of surface height

Note 1 to entry: The PCOR is most relevant to non-dielectric materials such as metals and surfaces that have thin layers of differing materials producing thin-film effects.

Note 2 to entry: The PCOR can vary over the sample surface comprised of an optically non-uniform material (see ISO 25178-600:2019, 3.4.6).

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3.8
phase shifting mechanism
device that imparts controlled phase shifts to an interference signal

Note 1 to entry: The phase shift mechanism can generate phase shifts by an axial scan motion of the part or of the interference objective (see ISO 25178-607:2019, 3.5), or other methods, such as displacement of the reference surface.

3.9
phase unwrapping algorithm
algorithm used to extend the surface topography measurement range beyond a single cycle of interference phase (equivalent to one interference fringe), by removing excess multiples of 2π between the phase values of neighbouring image points

Note 1 to entry: ISO/TR 14999-2:2019, 6.6, provides further details regarding phase unwrapping.

3.10
fringe-order error
2π error
<phase shifting interferometry> error in the identification of the correct fringe when calculating relative heights using interference phase for surface topography calculations

Note 1 to entry: Fringe-order errors are integer multiples of one-half the *equivalent wavelength* (3.6) in height.

4 Instrument requirements

An instrument according to this document shall perform areal surface topography measurements of a sample surface using PSI. The instrument can comprise an interference objective or alternative interferometer assembly and a phase shifting mechanism. The instrument shall acquire data using linear PSI, sinusoidal PSI or other phase shifting patterns consistent with the definition of PSI. The instrument shall convert acquired data to an areal topography using a PSI algorithm and a calculated or assumed equivalent wavelength. A phase unwrapping algorithm shall be employed as needed to reduce fringe-order error.

Figure 1 shows the information flow between these elements for a PSI microscope, from the real surface to a scale-limited surface. Example PSI hardware, techniques and error sources are given in Annexes A and B.

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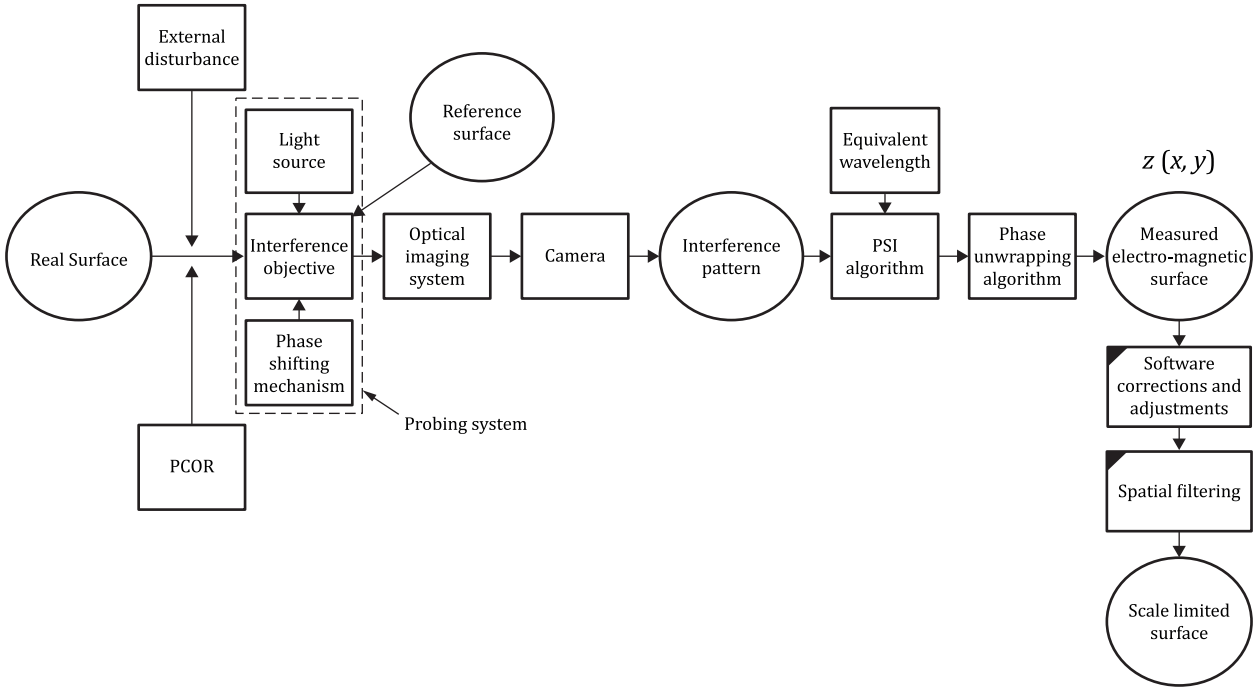

Key

measurand

operator with intended modification

operator without intended modification

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Figure 1 — Information flow concept diagram for PSI

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5 Metrological characteristics

The standard metrological characteristics for areal surface texture measuring instruments specified in ISO 25178-600 shall be considered when designing and calibrating the instrument.

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

6 Design features

Standard design features described in ISO 25178-600 shall be considered in the design.

Annex A provides examples of specific design features of PSI instruments.

7 General information

The relationship between this document and the GPS matrix model is given in Annex C.

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