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

Part 602: Design and characteristics of non-contact (confocal chromatic probe) instruments

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

Partie 602: Conception et caractéristiques des instruments sans contact (à capteur confocal chromatique)

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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 25178-602:2010), which has been technically revised.

The main changes are as follows:

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

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

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

— 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.

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 C.

The principle of confocal chromatic probe can be implemented in various set-ups. The configuration described in this document comprises three basic elements: an optoelectronic controller, a linking fibre optic cable and a chromatic objective (sometimes called “optical pen”).

Several techniques are possible to create the axial chromatic aberration or to extract the height information from the reflected light. In addition to implementations as point sensors, chromatic aberration can be integrated into line sensors and field sensors. Annex A describes confocal chromatic imaging and its implementation into distance measurement probes in detail.

This type of instrument is mainly designed for areal measurements, but it is also able to perform profiling measurements.

This document describes the design and the metrological characteristics of an optical profiler using a confocal chromatic probe based on axial chromatic aberration of white light, designed for the measurement of areal surface texture.

For more detailed information on the confocal chromatic probe instrument technique, see Annex A. Reading this annex before the main body can lead to a better understanding of this document.

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

Part 602: Design and characteristics of non-contact (confocal chromatic probe) instruments

1 Scope

This document specifies the design and metrological characteristics of a particular non-contact instrument for measuring surface texture using a confocal chromatic probe based on axial chromatic aberration of white light. Additional metrological characteristics can be found in ISO 25178-600. 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*

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
chromatic aberration
<confocal chromatic probe> optical effect of a lens that focuses light at different lengths depending on the wavelength

Note 1 to entry: Chromatic aberration can be axial (on the optical axis) or lateral (off the optical axis). It is also defined in ISO 10934:2020, 3.1.4.2.

3.2
chromatic objective
objective with axial *chromatic aberration* (3.1)

3.3
confocal chromatic probe
device that senses surface heights using a *chromatic objective* (3.2) mounted into a confocal setup

Note 1 to entry: Various optical configurations are discussed in Annex A.

3.4
confocal chromatic microscopy
surface topography measurement method consisting of a confocal microscope with *chromatic objective* (3.2) integrated with a spectrometer whereby the surface height at a single point is sensed by the wavelength of light reflected from the surface

[SOURCE: ISO 25178-6:2010, 3.3.7, modified — "a detection device (e.g. spectrometer)" has been replaced by "a spectrometer". Note 1 to entry has been deleted.]

3.5
light source
<confocal chromatic probe> source of light containing a continuum of wavelengths in a predefined spectral region

Note 1 to entry: The spectral region emitted by the source should be compatible with the spectral bandwidth of the optical system and the detector.

Note 2 to entry: Usually, this spectral region extends within the visible light, between wavelength values 0,4 µm to 0,8 µm.

3.6
light source pinhole
small hole placed following the *light source* (3.5), to make it a point light source

Note 1 to entry: The system contains two pinholes. The first one is the light source pinhole. It defines a small spot of light that acts as the point light source for the instrument. The second one is the *discrimination pinhole* (3.7). It limits the transmitted beam to the part that is in focus on the sample surface and is reflected by it along the optical axis (see Figure A.1).

Note 2 to entry: In practice, the pinholes are obtained by using a fibre optic which provides spatial discrimination and allows the optical head to be used away from the optoelectronic controller.

3.7
discrimination pinhole
small hole placed in front of the detector, providing depth discrimination on a beam reflected from the sample surface by blocking defocused light

Note 1 to entry: Notes 1 and 2 to entry in 3.6 also apply to the discrimination pinhole.

3.8
vertical range
<confocal chromatic probe> distance measured between the focal point of the shortest wavelength and the focal point of the longest wavelength detected on the spectrometer

Note 1 to entry: The vertical range depends on the depth of field and on the spectral range of the spectrometer.

3.9
optical pen
part of a *confocal chromatic probe* (3.3) that contains a *chromatic objective* (3.2) and that is located close to the surface during the measurement

Note 1 to entry: The optical pen is usually connected to an opto-electronic box through a fibre optic.

3.10
stray light
signal composed of the stray light entering the *discrimination pinhole* (3.7), sensed by the detector when no sample is present, and the internal signal produced by the detector itself

Note 1 to entry: The stray light signal is generally captured during a calibration procedure and subtracted to subsequent measurements.

4 Instrument requirements

An instrument conforming to this document shall perform two operations.

a) A spectral encoding of the measurement space. This encoding is performed by stretching focus points using axial chromatic aberration of the illuminating beam in a controlled manner. It is usually realized using a chromatic objective and a white light source.

b) A spectral decoding of the reflected beam. This decoding identifies the focused wavelength, usually using a spectrometer. Wavelength is then converted to height by a software using calibrated data.

These operations are part of the information flow described in Figure 1. The scale-limited surface obtained at the end of the information flow is used to calculated areal surface texture parameters, according to ISO 25178-2.

Such an instrument is usually referred to as a confocal chromatic profilometer, and the technique is called confocal chromatic microscopy.

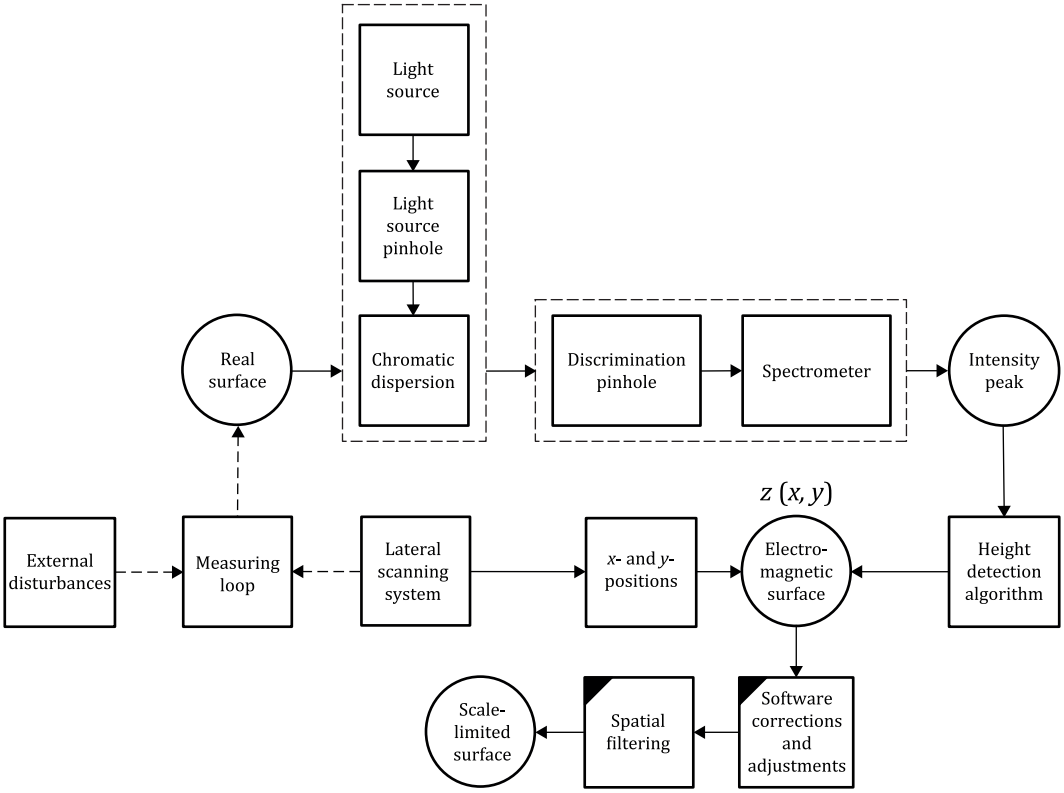
The confocal setup is usually realized using a fibre optic that acts as a source pinhole and as a discrimination pinhole. It also allows the objective to be close to the surface while the rest of the opto-electronic device (light source, spectrometer, power source, ventilation) is installed elsewhere.

The instrument requires a lateral scanning system as follows:

— In the case of a point sensor, it can be mounted on a lateral scanning system in order to measure a profile (along *x*-axis) or a surface (in *x*-axis and *y*-axis).

— In the case of a line sensor, it can be mounted on a lateral scanning system that moves in *y*-axis, while the sensor directly measures a line segment in *x*-axis.

NOTE A point sensor can also be associated with a rotary table in order to realize a non-contact roundness measuring instrument.



Key

measurand

operator with intended modification

operator without intended modification

Figure 1 — Information flow concept diagram for confocal chromatic probe instruments

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 confocal chromatic instruments.

7 General information

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