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

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

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

Partie 602: Caractéristiques nominales des instruments sans contact (à capteur confocal chromatique)

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 25178-602 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

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

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

— *Part 3: Specification operators*

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

— *Part 7: 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 701: Calibration and measurement standards for contact (stylus) instruments*

The following parts are under preparation:

— *Part 604: Nominal characteristics of non-contact (coherence scanning interferometry) instruments*

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

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 chain link 5 of the chain of standards on roughness profile, waviness profile and primary profile and areal surface texture.

For more detailed information on the relationship of this standard to the GPS matrix model, see Annex D.

The confocal chromatic optical principle 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 dispersion or to extract the height information from the reflected light. In addition to implementations as point sensors, chromatic dispersion may be integrated into line sensors and field sensors. Annex B describes in detail confocal chromatic imaging and its implementation into distance measurement probes.

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

This part of ISO 25178 describes the metrological characteristics of an optical profiler using a confocal chromatic probe based on axial chromatic dispersion of white light, designed for the measurement of areal surface texture.

For more detailed information on the chromatic probe instrument technique, see Annex B. Reading this annex before the main body may lead to a better understanding of this part of ISO 25178.

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

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

1 Scope

This part of ISO 25178 defines the design and metrological characteristics of a particular non-contact instrument for measuring surface texture using a confocal chromatic probe based on axial chromatic dispersion of white light.

2 Normative references

The following referenced documents are indispensable for the application 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 3274:1996, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Nominal characteristics of contact (stylus) instruments*

ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

ISO 10360-1, *Geometrical Product Specifications (GPS) — Acceptance and reverification tests for coordinate measuring machines (CMM) — Part 1: Vocabulary*

ISO/IEC Guide 99:2007, *International vocabulary of metrology — Basic and general concepts and associated terms (VIM)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3274, ISO 4287, ISO 10360-1, ISO/IEC Guide 99 and the following apply.

NOTE Several of the terms given below are common to other types of instruments that use single point sensors and lateral scanning.

3.1 General terms and definitions

3.1.1
coordinate system of the instrument
orthonormal system of axes (X,Y,Z) defined as:

— (X,Y) is the plane established by the areal reference guide of the instrument;

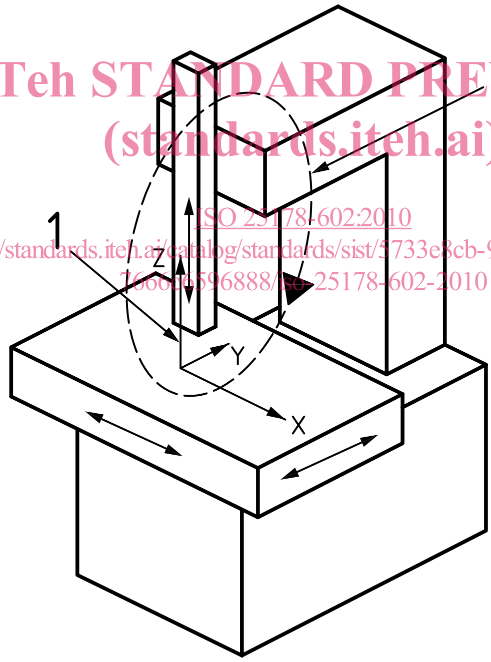
— the Z axis is mounted parallel to the optical axis and is perpendicular to the (X,Y) plane

NOTE Normally, the X-axis is the tracing axis and the Y-axis is the stepping axis.

3.1.2
measurement loop
closed chain which comprises all components connecting the workpiece and the **chromatic probe** (3.3.2), e.g. the means of positioning, the workholding fixture, the measuring stand, the **drive unit** (3.2.3 and 3.2.4) and the **probing system** (3.3.1)

See Figure 1.

NOTE The measuring loop will be subjected to external and internal disturbances which influence the measurement uncertainty.



Key
1 coordinate system of the instrument
2 measurement loop

Figure 1 — Coordinate system and measurement loop of the instrument

3.1.3
real surface of a workpiece
set of features which physically exist and separate the entire workpiece from the surrounding medium

[ISO 14660-1:1999, definition 2.4]

3.1.4
real electro-magnetic surface
surface obtained by the electro-magnetic interaction with the real surface of a work piece

[ISO 14406:—[1)], definition 3.2.2]

NOTE The real electro-magnetic surface considered for the instrument described in this part of ISO 25178 may be different from the real electro-magnetic surface for other types of optical instruments.

3.1.5
primary extracted surface
finite set of data points sampled from the primary surface

[ISO 14406:—[1)], definition 3.7]

3.1.6
measurement error
error of measurement
error
measured quantity value minus a reference quantity value

NOTE 1 The concept of “measurement error” can be used both

a) when there is a single reference quantity value to refer to, which occurs if a calibration is made by means of a measurement standard with a measured quantity value having a negligible measurement uncertainty or if a conventional quantity value is given, in which case the measurement error is known, and

b) if a measurand is supposed to be represented by a unique true quantity value or a set of true quantity values of negligible range, in which case the measurement error is not known.

NOTE 2 Measurement error should not be confused with production error or mistake.

[ISO/IEC Guide 99:2007, definition 2.16]

3.1.7
systematic measurement error
systematic error of measurement
systematic error
component of **measurement error** (3.1.6) that in replicate measurements remains constant or varies in a predictable manner

NOTE 1 A reference quantity value for a systematic measurement error is a true quantity value, or a measured quantity value of a measurement standard of negligible measurement uncertainty, or a conventional quantity value.

NOTE 2 Systematic measurement error, and its causes, can be known or unknown. A **correction** (3.1.11) can be applied to compensate for a known systematic measurement error.

NOTE 3 Systematic measurement error equals measurement error minus **random measurement error** (3.1.8).

[ISO/IEC Guide 99:2007, definition 2.17]

3.1.8
random measurement error
random error of measurement
random error
component of **measurement error** (3.1.6) that in replicate measurements varies in an unpredictable manner

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1) To be published.

NOTE 1 A reference quantity value for a random measurement error is the average that would ensue from an infinite number of replicate measurements of the same measurand.

NOTE 2 Random measurement errors of a set of replicate measurements form a distribution that can be summarized by its expectation, which is generally assumed to be zero, and its variance.

NOTE 3 Random measurement error equals measurement error minus **systematic measurement error** (3.1.7).

[ISO/IEC Guide 99:2007, definition 2.19]

3.1.9
adjustment of a measuring instrument
adjustment
set of operations carried out on a measuring system so that it provides prescribed indications corresponding to given values of a quantity to be measured

NOTE 1 Types of adjustment of a measuring system include zero adjustment of a measuring system, offset adjustment, and span adjustment (sometimes called gain adjustment).

NOTE 2 Adjustment of a measuring system should not be confused with calibration, which is a prerequisite for adjustment.

NOTE 3 After an adjustment of a measuring system, the measuring system must usually be recalibrated.

[ISO/IEC Guide 99:2007, definition 3.11]

NOTE 4 This is an operation normally carried out by the instrument manufacturer because it requires specialized equipment and knowledge that users normally do not have.

3.1.10
user adjustment
⟨measuring instrument⟩ **adjustment of a measuring instrument** (3.1.9) employing only the means at the disposal of the user

NOTE This is an operation normally carried out by the user. It involves the use of a measurement standard, usually supplied with the instrument. The result of this operation automatically or manually adjusts certain parameters in order for the instrument to operate correctly.

3.1.11
correction
compensation for an estimated systematic effect

NOTE 1 See ISO/IEC Guide 98-3:2008, definition 3.2.3, for an explanation of “systematic effect”.

NOTE 2 The compensation can take different forms, such as an addend or a factor, or can be deduced from a table.

[ISO/IEC Guide 99:2007, definition 2.53]

3.1.12
residual correction error
difference between the value of a quantity obtained after correcting the **systematic measurement error** (3.1.7) and the real value of this quantity

NOTE The residual error is composed of **random errors** (3.1.8) and uncorrected systematic errors.

3.2 Terms and definitions relative to the lateral scanning system

3.2.1
lateral scanning system
system that performs the scanning of the surface to be measured in the (X,Y) plane

NOTE Typically, the lateral scanning system is composed of the **drive unit X** (3.2.3) and the **drive unit Y** (3.2.4).

3.2.2
areal reference guide
component of the instrument that generates the reference surface in which the **probing system** (3.3.1) moves relative to the surface being measured according to a theoretically exact trajectory

NOTE In the case of areal surface texture measurement instruments, the reference guide establishes a reference surface (see ISO 25178-2). It can be achieved through the use of two perpendicular reference guides (see ISO 3274:1996, 3.3.2) or one reference surface guide.

3.2.3
drive unit X
component of the instrument that moves the **probing system** (3.3.1) 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 lateral X coordinate of the profile

3.2.4
drive unit Y
component of the instrument that moves the probing system 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 lateral Y coordinate of the profile

3.2.5
lateral position sensor
component of the drive unit that provides the lateral position of the measured point

NOTE The lateral position can be measured or inferred by using, for example, a linear encoder, a laser interferometer, or a counting device coupled with a micrometer screw.

3.3 Terms and definitions relative to the probing system

3.3.1
probing system
⟨surface texture, confocal chromatic probe⟩ components of the instrument called *confocal chromatic probe*, consisting of an optoelectronic controller, a fibre optic cable and a confocal chromatic objective

3.3.2
chromatic probe
device that converts the height of a point on the surface into a signal during measurement, using the confocal chromatic dispersion of a white light source

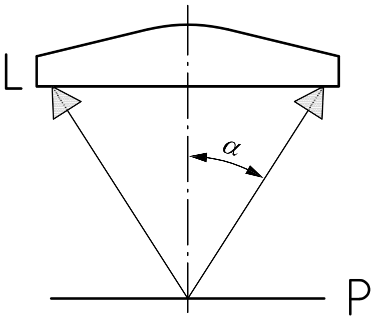
NOTE Chromatic dispersion can be realized by using various optic configurations (see Annex B).

3.3.3
angular aperture
angle of the cone of light entering an optical system from a point on the surface being measured

3.3.4
half aperture angle
α
one half of the **angular aperture** (3.3.3)

See Figure 2.

NOTE This angle is sometimes also called the *half cone angle*.



Key

L lens or optical system

P focal point

α half aperture angle

Figure 2 — Half aperture angle

3.3.5
numerical aperture
A_N
sine of the **half aperture angle** (3.3.4) multiplied by the refractive index n of the surrounding medium

$$A_N = n \sin \alpha$$

NOTE 1 In air, n approximately equals 1 and can be omitted from the equation.

NOTE 2 For a **chromatic probe** (3.3.2), the numerical aperture is dependent on the wavelength of light. Typically the numerical aperture is specified for the wavelength focused at the middle of the **vertical range** (3.3.14).

3.3.6
confocal chromatic microscopy
surface topography measurement method consisting of a confocal microscope with chromatic objective integrated with a detection device (e.g. spectrometer) whereby the surface height at a single point is sensed by the wavelength of light reflected from the surface

[ISO 25178-6:2010, 3.3.7]

3.3.7
achromatic objective
objective that produces a single focus for all wavelengths of the transmitted light

3.3.8
objective with axial chromatic dispersion
objective that produces a different focus along its optical axis for each wavelength of the transmitted light

3.3.9
light source
⟨chromatic probe⟩ source of light containing a continuum of wavelengths in a predefined spectral region

NOTE 1 The spectral region emitted by the source should be compatible with the spectral bandwidth of the detector.

NOTE 2 Typically, this spectral region extends from wavelength values of 0,4 µm to 0,8 µm.

