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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

DRAFT INTERNATIONAL STANDARD

ISO/DIS 10110-6

ISO/TC 172/SC 1

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Optics and photonics — Preparation of drawings for optical elements and systems —

Part 6: Centring and tilt tolerances

*Optique et photonique — Indications sur les dessins pour éléments et systèmes optiques —
Partie 6: Tolérances de centrage et d'inclinaison*

ICS: 37.020; 01.100.20

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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.

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).

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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 172, *Optics and photonics*, Subcommittee SC 1, *Fundamental standards*.

This third edition cancels and replaces the second edition (ISO 10110-6:2015), which has been technically revised.

The main changes compared to the previous edition are as follows:

- Title and scope have been changed to include tilt tolerances as well as centring tolerances
- Clarified the definitions of datum features and datums to be more consistent with standard practice
- Added a definition of a circular datum feature and a circular datum
- Clarified the conditions in which the datums need not be indicated on the drawing
- Removed the use of a target datum symbol and replaced it with the simpler circular datum
- Added examples of surface tilt and beam deviation tolerances for plates and prisms
- Removed [figure 20](#)
- Added an informative [Annex A](#) as a guide to datums, datum features, datum systems, and tolerances

A list of all parts in the ISO 10110 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.

Optics and photonics — Preparation of drawings for optical elements and systems —

Part 6: Centring and tilt tolerances

1 Scope

This document specifies the rules for indicating centring and tilt tolerances for optical elements, subassemblies, and assemblies in the ISO 10110 series, which standardizes drawing indications for optical elements and systems.

This document applies to plano surfaces, rotationally invariant (spherical and aspherical) surfaces, circular and non-circular cylindrical (cylindrical and acylindrical) surfaces, and non-symmetrical surfaces (general surfaces). General surfaces are described using ISO 10110-19.

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 1101, *Geometrical product specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

ISO 10110-1, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 1: General*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1101 and the following 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 <https://www.electropedia.org/>

3.1

optical surface

surface performing an optical function upon the incident light

Note 1 to entry: Optical surfaces can be of different degrees of complexity. Correspondingly, the number of the degrees of freedom needed for describing the orientation and location of the surface increases with complexity.

Note 2 to entry: Optical functions may include e.g. reflection, refraction, spectral filtration, and patterning (as in a reticle or CGH.)

3.2

optical element

part with one or more *optical surfaces* (3.1) providing an optical function

EXAMPLE One optical surface (e.g. parabolic mirror), two optical surfaces (e.g. lens), or more than two optical surfaces (e.g. cube corner prism).

3.3

optical subassembly

combination of one or more *optical elements* (3.2) cemented (e.g. doublets, triplets, cube or colour beamsplitters) or uncemented (e.g. Schmidt–Pechan prism)

3.4

opto-mechanical subassembly

combination of an *optical element* (3.2) and/or an *optical subassembly* (3.3) and one or more mechanical elements including a mechanical interface to the superior system

EXAMPLE A lens element fixed in a barrel.

3.5

assembly

combination of *optical elements* (3.2), *optical subassemblies* (3.3), *opto-mechanical subassemblies* (3.4) and/or other mechanical parts

3.6

optical system

complete system providing a function with defined optical performance

3.7

optical axis

theoretical axis which is given by the optical design and represents the central path for the main function of the *optical system* (3.6)

Note 1 to entry: The optical axis may be located off-axis from the axis connecting the nominal centers of curvature of a series of optical elements, or the aspheric datum axis.

3.8

datum feature

real (non-ideal) integral feature used for establishing a *datum* (3.9)

Note 1 to entry: A datum feature should be accessible and of sufficient size to permit its use (such as the outer edge of the lens cylinder or a spherical surface).

Note 2 to entry: As datum features are subject to manufacturing imperfections and variations, it could be necessary, where appropriate, to specify tolerances of form to them (see ISO 5459).

[SOURCE: ISO 5459:2011, 3.2, modified — Note 1 and Note 2 from ISO 5459:2011, 3.2, are irrelevant for the purposes of this part of ISO 10110 and potentially confusing and therefore, have been omitted. For the purposes of this part of ISO 10110, instead, Note 1 to entry and Note 2 to entry have been added.]

3.9

datum

theoretically exact geometric reference (such as points, axes, planes, etc.) to which toleranced features are related

Note 1 to entry: Datums can be based on one or more *datum features* (3.8) of a part.

3.10

common datum

datum (3.9) established from two or more *datum features* (3.8) considered simultaneously

Note 1 to entry: The two or more features are of equal order of priority (see ISO 5459).

[SOURCE: ISO 5459:2011, 3.9, modified — The Note from ISO 5459:2011, 3.9 is irrelevant for the purposes of this part of ISO 10110 and potentially confusing and therefore, has been omitted. For the purposes of this part of ISO 10110, instead, Note 1 to entry has been added.]

3.11**datum system**

group of two or more separate *datums* (3.9) used as a combined reference for a toleranced feature

Note 1 to entry: The sequence of the indicated datums is of considerable influence on the resulting reference (see ISO 5459).

Note 2 to entry: This document allows implicit and explicit datum notations. If the datum order is not explicitly identified in the 4/ tolerance, the datum order is assumed to be alphabetic.

3.12**datum axis**

theoretically exact axis based on one or more *datums* (3.9)

3.13**datum point**

theoretically exact point based on two or more datums

Note 1 to entry: A datum point serves as an additional reference to the location of an *optical system* (3.6). The indication of the datum point is described in 5.2.

Note 2 to entry: Colloquially, a datum point may be a specified point on the *datum axis* (3.12)

3.14**edge cylinder datum feature**

instance of an outer edge or inner bore of an *optical element* (3.2) or mounting cell

Note 1 to entry: The edge cylinder datum feature is typically the outer lens barrel, but it can also be associated with an inner bore, e.g., the perforation of a primary mirror in a Cassegrain telescope.

3.15**edge cylinder datum**

axis of the smallest cylinder circumscribing an outer *edge cylinder datum feature* (3.14), or axis of the largest cylinder inscribing an inner *edge cylinder datum feature* (3.14)

3.16**spherical surface datum feature**

instance of a nominally spherical *optical surface* (3.1) over the defined useable aperture

3.17**spherical surface datum**

point defined by the centre of curvature of the best-fit sphere to the *spherical surface datum feature* (3.16)

Note 1 to entry: The axis that connects the spherical surface datums of a pair of spherical optical surfaces of an optical element is sometimes referred to as its axis of symmetry.

Note 2 to entry: In a typical rotationally invariant optical system, the axis of symmetry and the *optical axis* (3.7) are the same.

3.18**tilt angle**

<spherical surface> angle between the *datum axis* (3.12) and the normal to the surface at its intersection point with the datum axis

Note 1 to entry: See [Figure 1a](#).

Note 2 to entry: A flat (plano) surface is a special case of a spherical surface with an infinite radius. See [Figure 14](#).

3.19**aspheric surface datum feature**

instance of an aspheric *optical surface* (3.1) over the defined useable aperture

3.20**aspheric surface datum axis**

axis defined by the best rotationally invariant fit to the *aspheric surface datum feature* (3.19)

Note 1 to entry: See [Figure 1b](#).

Note 2 to entry: Depending on the grade of asphericity, it can be difficult to clearly differentiate between decentre and surface deviation (see Reference [3]).

3.21**tilt angle**

<aspheric surface> angle between the *aspheric surface datum axis* (3.20)) and the *datum axis* (3.12) of the *optical element* (3.2), *optical subassembly* (3.3), *opto-mechanical subassembly* (3.4), *assembly* (3.5), and/or *optical system* (3.6) to which the aspheric surface belongs

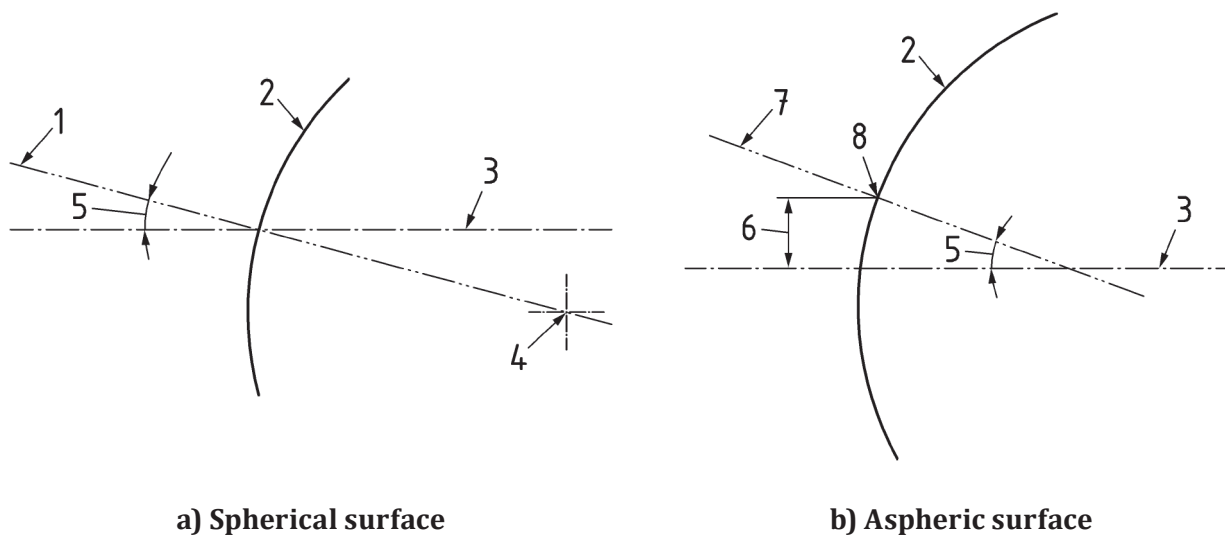
Note 1 to entry: See [Figure 1b](#).

Note 2 to entry: See [Figure 1](#). While the surface tilt angle of the sphere, key 5, has a vertex at the intersection of 1, 2, and 3, the surface tilt angle of the asphere 7 is displaced 6 from the point of rotational symmetry 8. Measuring the surface tilt of an asphere in same manner as a sphere may produce incorrect results.

3.22**lateral displacement**

<aspheric surface> distance from the point where the *aspheric surface datum axis* (3.20) intersects the *aspheric surface datum feature* (3.19) to the *datum axis* (3.12) of the *optical element* (3.2), *optical subassembly* (3.3), *opto-mechanical subassembly* (3.4), *assembly* (3.5), and/or *optical system* (3.6) to which the aspheric surface belongs

Note 1 to entry: See [Figure 1b](#).

**Key**

- 1 normal to the surface
- 2 surface
- 3 datum axis
- 4 centre of curvature
- 5 surface tilt angle
- 6 lateral displacement
- 7 aspheric datum axis
- 8 point of rotational symmetry

Figure 1 — Tilt and lateral displacement tolerances of a single spherical and aspheric surface

3.23**cylindrical surface**

translationally invariant surface having a base radius in one plane, translated linearly along the orthogonal axis

Note 1 to entry: A cylindrical surface is an extrusion-like surface whose cross-section perpendicular to its axis is a portion of a circle.

3.24**cylindrical surface datum feature**

instance of a nominally circular cylindrical *optical surface* (3.1)

3.25**cylindrical surface datum**

axis defined by the centre of curvature of the best fit circular cylinder to the *cylindrical surface datum feature* (3.24)

Note 1 to entry: The *cylindrical surface datum* is established by the *optical surface* (3.1) as distinct from the *edge cylinder datum* (3.15) which is established by the element edge.

3.26**tilt angle**

<cylindrical surface> angle between the *datum system* (3.11) and the *cylindrical surface datum* (3.25)

Note 1 to entry: cylindrical surfaces typically require more than one tilt angle.

Note 2 to entry: A cylindrical surface datum may not exactly intersect a datum axis.

Note 3 to entry: The tilt angles σ_x , σ_y , and σ_z are rotations about those named axes, e.g. σ_x is a rotation within the y-z plane

3.27**non-circular cylindrical surface****acylindrical surface**

translationally invariant surface with a cross-section having a base radius in one axis (like a *cylindrical surface* (3.23)) with non-circular terms added (as with an asphere), translated along the orthogonal axis

Note 1 to entry: A non-circular cylindrical surface is a surface formed by the translation of a non-circular curve along a linear axis.

Note 2 to entry: This surface is a cylindrical analogue to an aspheric surface, presumed to have two orthogonal planes of bilateral symmetry, and no axis of general radial symmetry.

Note 3 to entry: The term “acylindrical” is not a rigorous term; the more rigorous descriptive term for this surface is a “non-circular cylindrical surface,” which, however, is not used in the art whereas the term acylindrical is common parlance for the surface we describe here.

3.28**non-circular cylindrical surface datum feature****acylindrical surface datum feature**

instance of a nominally non-circular cylindrical (acylindrical) surface

3.29**non-circular cylindrical surface datum system****acylindrical surface datum system**

combination of the plane of symmetry defined by the best fit to the *non-circular cylindrical surface datum feature* (3.28) and the line of intersection of this plane and the best fit surface

Note 1 to entry: The plane of symmetry is defined by the best fit to the non-circular cylinder.

Note 2 to entry: The plane of symmetry passes through the axis of line symmetry of the non-circular cylinder.