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

Part 6:
Centring tolerances

Optique et instruments d'optique — Indications sur les dessins pour éléments et systèmes optiques —

Partie 6: Tolérances de centrage

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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.

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.

International Standard ISO 10110-6 was prepared by Technical Committee ISO/TC 172, *Optics and optical instruments*, Subcommittee SC 1, *Fundamental standards*.

ISO 10110 consists of the following parts, under the general title *Optics and optical instruments — Preparation of drawings for optical elements and systems*:

— *Part 1: General*

— *Part 2: Material imperfections — Stress birefringence*

— *Part 3: Material imperfections — Bubbles and inclusions*

— *Part 4: Material imperfections — Inhomogeneity and striae*

— *Part 5: Surface form tolerances*

— *Part 6: Centring tolerances*

— *Part 7: Surface imperfection tolerances*

— *Part 8: Surface texture*

— *Part 9: Surface treatment and coating*

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— *Part 10: Table representing data of a lens element*

— *Part 11: Non-toleranced data*

— *Part 12: Aspheric surfaces*

— *Part 13: Laser irradiation damage threshold*

Annex A of this part of ISO 10110 is for information only.

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

Part 6:
Centring tolerances

1 Scope

ISO 10110 specifies the presentation of design and functional requirements for optical elements and systems in technical drawings used for manufacturing and inspection.

This part of ISO 10110 specifies rules for indicating centring tolerances for optical elements, sub-assemblies, and assemblies. They apply to rotationally symmetric optical systems only.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 10110. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10110 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1101:1983, *Technical drawings — Geometrical tolerancing — Tolerancing of form, orientation, location and run-out — Generalities, definitions, symbols, indications on drawings.*

ISO 10110-5:1996, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 5: Surface form tolerances.*

ISO 10110-7:1996, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 7: Surface imperfection tolerances.*

3 Definitions

For the purposes of this part of ISO 10110, the following definitions apply.

3.1 optical system: Optical element, sub-assembly or assembly.

3.2 optical axis (of an optical system): Theoretical axis, about which the optical system is nominally rotationally symmetric.

NOTE 1 Exception: deflecting elements and systems, such as plane mirrors, prisms, etc.

3.3 datum axis: Axis selected by consideration of specific features of an optical system.

NOTE 2 It serves as a reference for the location of surfaces, elements and assemblies. In this part of ISO 10110, definitions of the datum axes are made in accordance with the general principles given in ISO 5459.

3.4 datum point: Specified point on the datum axis.

NOTE 3 It serves as an additional reference to the location of an optical system. The indication of the datum point is described in 5.2.

3.5 tilt angle of a spherical surface: Angle between the datum axis and the normal to the surface at its intersection point with the datum axis (see figure 1).

3.6 tilt angle of an aspherical surface: Angle between the rotation axis of the aspheric surface and the datum axis of the part, sub-system, or system to which the aspheric surface belongs.

3.7 lateral displacement of an aspheric surface: Distance from the point of rotational symmetry of the aspheric surface to the datum axis.

3.8 tilt angle of an optical element or sub-system: Angle between the datum axis and the element or sub-system and the datum axis of the system of which the element or sub-system is a part (see figure 2).

3.9 lateral displacement of an optical element or sub-system: Distance between the datum axis of the element or sub-system and the datum axis of the system of which the element or sub-system is a part, measured at the datum point of the sub-system (see figure 2).

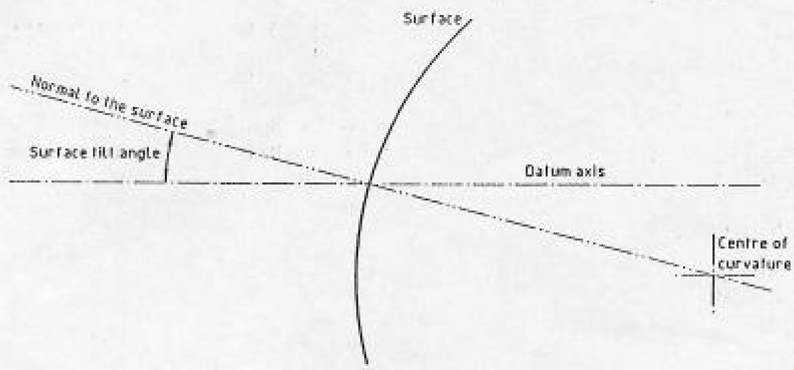


Figure 1 — Tilt angle of a single spherical surface

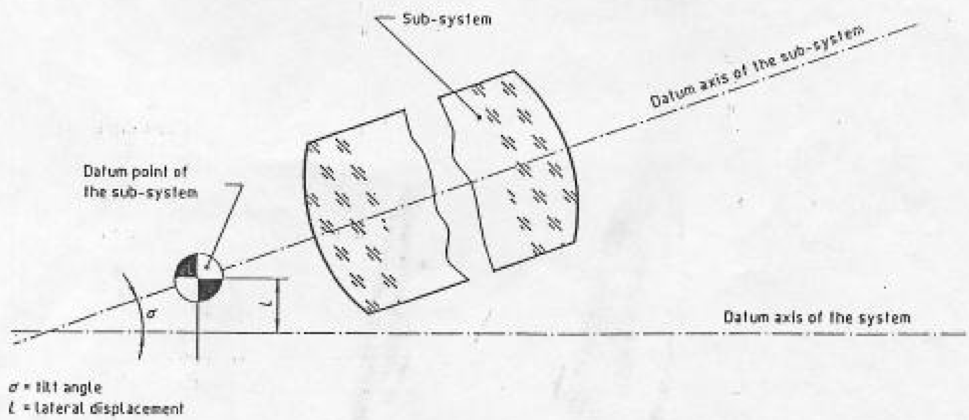


Figure 2 — Tilt angle and lateral displacement of an optical sub-system

4 Specification of centring tolerances

For individual spherical surfaces, the centring error consists of a surface tilt angle, as defined in 3.5. In all other cases (aspheric surfaces, elements and sub-systems), the centring error consists of a tilt angle between two datum axes and a lateral displacement, as defined in 3.6 to 3.9.

4.1 Individual spherical surfaces

For individual spherical surfaces, the maximum permissible tilt angle (σ) with respect to the datum axis shall be indicated (see 3.5).

4.2 Individual aspheric surfaces

For individual aspheric surfaces, the maximum permissible values of the tilt angle (σ), as defined in 3.6, and the lateral displacement (L), as defined in 3.7, shall be indicated.

If the aspherical effect of the surface is small compared to its spherical power, the centring tolerance can be specified in accordance with 4.1, i.e. as if it were a spherical surface.

Alternatively, the centring tolerances for aspheric surfaces can be specified in accordance with ISO 1101. (See ISO 10110-12.)

4.3 Optical elements and sub-systems

For optical elements and sub-systems, the maximum permissable values of the tilt angle (σ), as defined in 3.8, and the lateral displacement (L), as defined in 3.9, shall be indicated.

4.4 Cement wedge in cemented optical assemblies

For cemented optical assemblies, it is possible to specify a tolerance for the wedge angle of the cement layer.

4.5 Surface without optical function

The centring tolerances of surfaces of optical elements which have no optical function (such as the edge cylinder), shall be specified according to the rules specified in ISO 1101. (See figures 14 and 15.)

4.6 Field stops, reticles, etc.

The centring tolerances for field stops, reticles, etc. shall be specified using the methods specified in ISO 1101. (See figure 16.)

5 Indication in drawings

5.1 Datum axis

The datum axis shall be indicated by the application of datum triangles to one or two features in accordance with ISO 1101; these are to be identified by capital Roman letters [see, for example, figures 3 a) and 4].

In drawings in which centring tolerances of individual surfaces are indicated, there are two cases in which the datum axis need not be indicated:

— the datum axis references the outer cylinder of an element [see figure 3 b)];

— the datum axis references the centre of curvature of a surface and the central point of this surface [see figure 5 b)].

5.2 Datum point

The datum point shall be indicated by the following symbol:

The datum point need not be indicated if it coincides with the intersection point of the datum axis and the first (counted in the direction of light) optical surface of the optical system to which it relates.

For single rotationally symmetric aspheric surfaces, the datum point coincides with the point of symmetry of the surface; it is not necessary to indicate it.

5.3 Centring tolerance

5.3.1 The indication of centring tolerances consists of a code number, one or two tolerance values and, if necessary (see figure 17), a reference to the elements of the datum axis.

For the indication of cement wedge angle tolerances, the triangular delta symbol (Δ) shall precede the tolerance value.

5.3.2 The code number for centring tolerances is 4.

5.3.3 Structure of the indication: the indication shall have one of the following three forms:

4/σ

or

4/σ(L)

or

4/$\Delta\tau$

where σ is the maximum permissible tilt angle, L is the maximum permissible lateral displacement, and τ (following the triangular symbol Δ), is the maximum permissible cement wedge angle.

5.3.4 The centring tolerances refer to the datum axis of the optical element or sub-system. If more than one datum axis is indicated in the drawing, the reference letters of the appropriate datum axis shall be appended to the tolerance values (see figure 17).

5.3.5 The values for the tolerances shall be specified in minutes ['] or seconds ["] of arc for angular dimensions and in millimetres for linear dimensions.

5.4 Location

The indication shall be shown in connection with a leader to the surface or optical system to which it refers (see figures 3 to 7).

For surfaces, the preferred method is to associate the indication with those of surface form tolerances and surface imperfection tolerances (see ISO 10110-5 and ISO 10110-7). Examples of such an indication are given in ISO 10110-1:1996, annex A. Alternatively, the indication may be given in a table in accordance with ISO 10110-10.

In optical layout drawings the centring tolerances may be given in a table; if no datum axis is indicated, all centring tolerances refer to the theoretical optical axis. An example of the indication of tilt angle and lateral displacement tolerances of sub-systems in a layout-drawing is given in ISO 10110-1:1996, figure 30.

6 Examples

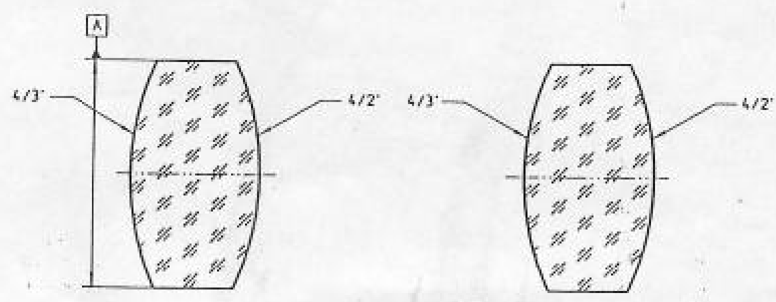
Examples for single elements are shown in figures 3 to 7, 14 and 15; for sub-assemblies and assemblies in figures 8 to 13 and in figures 16 and 17.

In figure 3 a) the datum axis is the axis of the outer cylinder. (This axis is recommendable only when the edge thickness of the element is sufficient.) If no datum axis is indicated and tilt angle tolerances for both optically effective surfaces are specified [see figure 3 b)] then the datum axis is the axis of the outer cylinder.

The datum axis shown in figure 4 is the line joining the centre of curvature of the left surface and the central point of cross-section B.

In figure 5 a) the datum axis is the line joining the centre of curvature and the central point of the left surface. If no datum axis is indicated and only one tilt angle tolerance is specified [as in figure 5 b)], the datum axis is defined as in figure 5 a).

In figure 6 the datum axis is perpendicular to plane B and pierces the central point of the left surface.



a) Explicit indication

b) Abbreviated indication

Figure 3 — Datum axis referencing outer cylinder

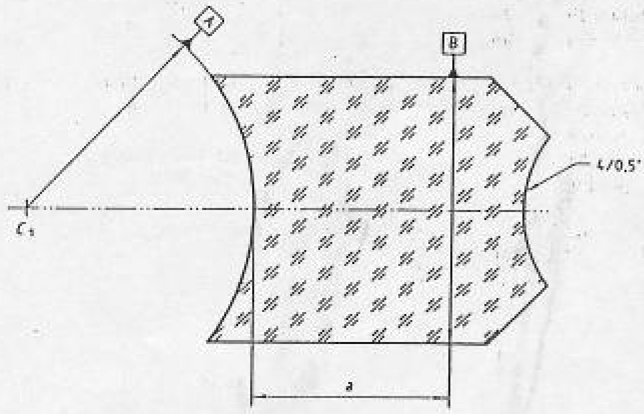
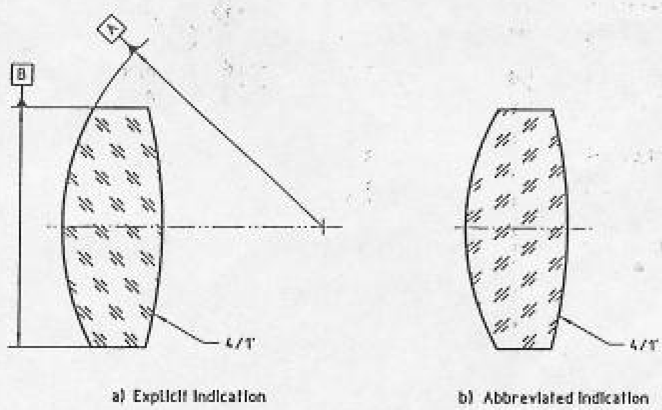


Figure 4 — Datum axis referencing centre of curvature of a surface and centre of an indicated cross-section



a) Explicit indication b) Abbreviated indication

Figure 5 — Datum axis referencing centre of curvature and central point of the same surface

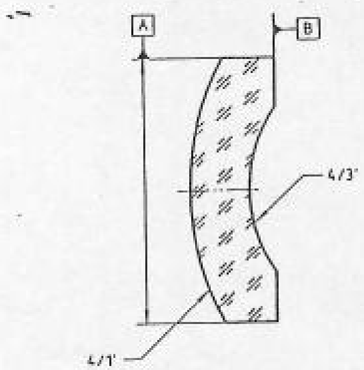


Figure 6 — Datum axis referencing a plane and the central point of an optically effective surface

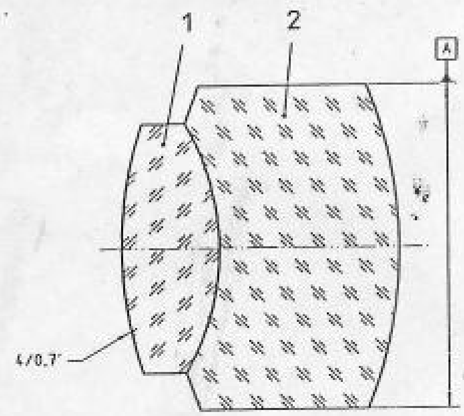


Figure 8 — Datum axis referencing outer cylinder

Figure 7 shows, as an example, the indication of a centring tolerance for an aspheric surface in accordance with 4.2.

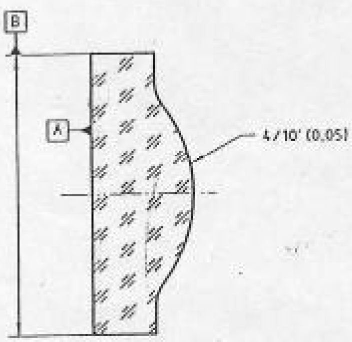


Figure 7 — Centring tolerance for an aspheric surface

The datum axes in figures 8 and 11 are defined similarly to those in figure 3 a).

The definitions of the datum axes in figures 9 and 12 are the same as those in figure 5 a).

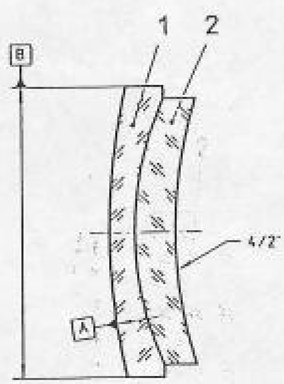


Figure 9 — Datum axis referencing centre of curvature and central point of the same surface

In figure 10 the datum axis is the line joining the centres of curvature of the surfaces of lens 1 (i.e. the optical axis of lens 1).

Figure 13 shows a datum axis referencing mechanical surfaces and defined analogously to figure 6.

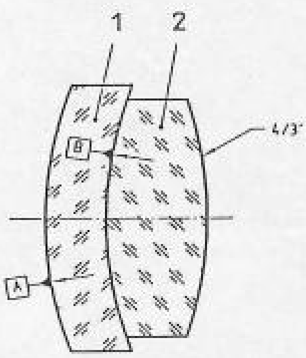


Figure 10 — Datum axis referencing the centres of curvature of two surfaces

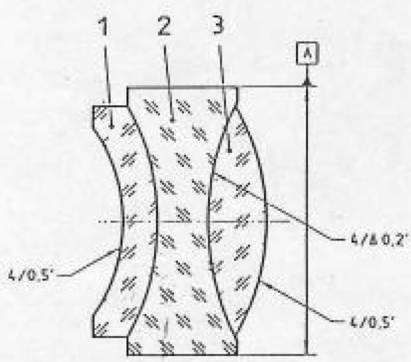


Figure 11 — Subassembly, including indication of a cement wedge tolerance; datum axis referencing outer cylinder

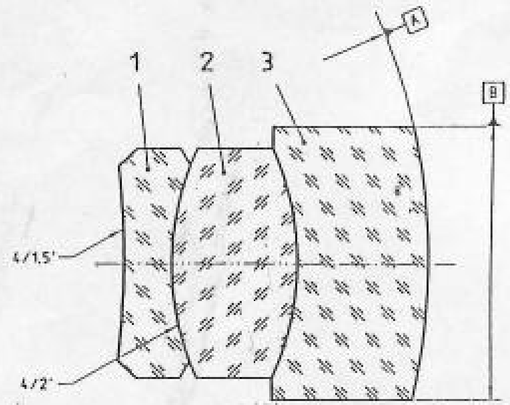


Figure 12 — Datum axis referencing centre of curvature and central point of the same surface

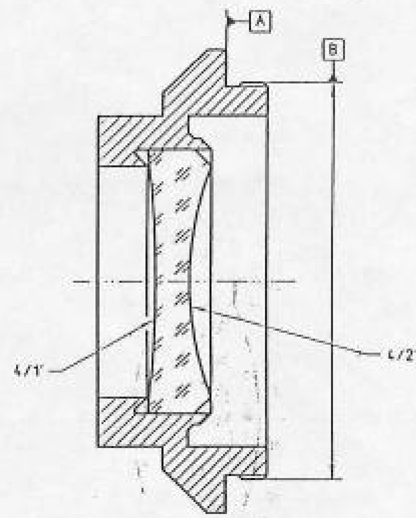


Figure 13 — Datum axis referencing mechanical elements

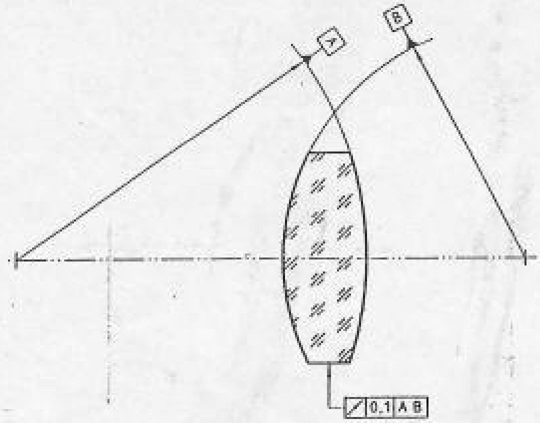


Figure 14 — Centring tolerance indication of a surface without optical function

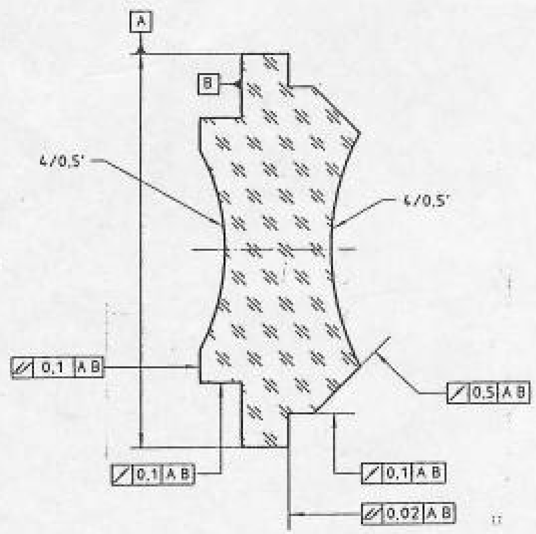


Figure 15 — Centring tolerance indication of surfaces with and without optical function

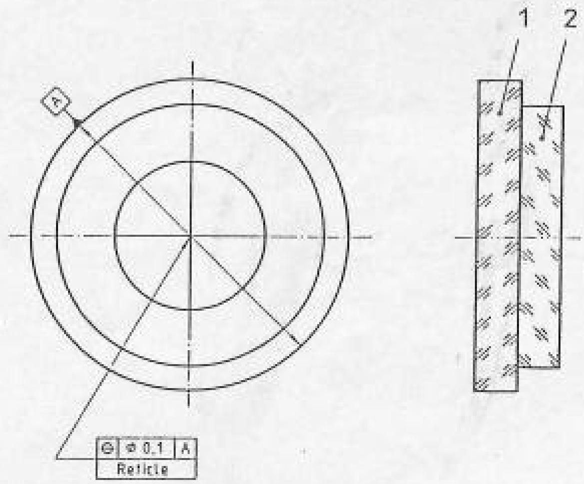


Figure 16 — Centring tolerance indication for a reticle

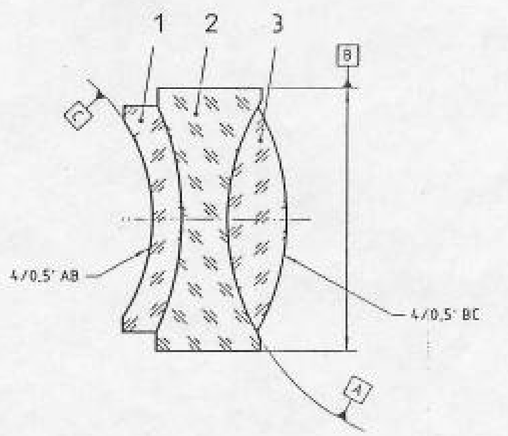


Figure 17 — Centring tolerance indication for a compound element referencing two different datum axes

Annex A
(informative)

Bibliography

[1] ISO 5459:1981, *Technical drawings — Geometrical tolerancing — Datums and datum-systems for geometrical tolerances.*

[2] ISO 10110-1:1996, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 1: General.*

[3] ISO 10110-10:1996, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 10: Table representing data of a lens element.*

[4] ISO 10110-12:—[1], *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 12: Aspheric surfaces.*

1) To be published.

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