INTERNATIONAL STANDARD

ISO 10110-1

Third edition
2019-10

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

Part 1: General

Optique et photonique — Indications sur les dessins pour éléments et systèmes optiques —

Partie 1: Généralités

Reference number
ISO 10110-1:2019(E)

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Published in Switzerland

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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 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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 172, *Optics and photonics*, Subcommittee SC 1, *Fundamental standards.*

This third edition cancels and replaces ISO 10110-1:2006 and ISO 10110-10:2004, which have been technically revised and merged into one single document.

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

a) Drawing scale and the reference wavelength are required to be included on the drawing;

b) provisions have been added to allow coordinate systems to be defined for each surface and for the part as a whole;

c) new tabular formats have been added to allow more surfaces on a tabular drawing, partially tabulated drawings, and new types of assembly drawings;

d) a new notation for special surfaces has been added;

e) in addition, many more examples of drawings and notations have been provided;

f) and various detailed notes have been added, and corrections and modifications have been made for improved clarity;

g) GSP defaults by definition no longer apply, they have to be specifically invoked.

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 1: General

1 Scope

This document specifies the general layout of drawings and provides examples of indications in the ISO 10110 series, which standardizes drawing indications for optical elements and systems.

This document specifies the presentation in drawings of the characteristics, including the tolerances, of optical elements and systems. This document also includes the popular tabular format, formerly presented in ISO 10110-10. This tabular format, now described in 5.1, is the preferred format for ISO 10110 drawings.

Rules for preparation of technical drawings as well as for dimensioning and tolerancing are given in various ISO Standards. These general standards apply to optical elements and systems only if the necessary rules are not given in the various parts of ISO 10110.

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 128-24, *Technical drawings — General principles of presentation — Part 24: Lines on mechanical engineering drawings*

ISO 10110-6, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 6: Centring tolerances*

ISO 10110-11, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 11: Non-toleranced data*

ISO 10110-12, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 12: Aspheric surfaces*

ISO 10110-18, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 18: Stress birefringence, bubbles and inclusions, homogeneity, and striae*

ISO 10110-19, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 19: General description of surfaces and components*

ISO 12123, *Optics and photonics — Specification of raw optical glass*

ISO 80000-1, *Quantities and units — Part 1: General*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Fundamental stipulations

All indications in drawings for optical elements and systems shall apply to the finished optical component or assembly, i.e., to its final form as described on the drawing, except where other parts of ISO 10110 stipulate otherwise or if explicitly stated on the drawing.

Whenever details or symbols specified in this document are found to be inadequate to clearly define the requirement, the information should be supplemented by a note or special instruction (see 5.1.2).

All linear dimensions are in millimetres, unless otherwise stated.

All units shall be shown using either a decimal comma or a decimal point, in accordance with ISO 80000-1. One or the other format should be used; the two conventions shall not be mixed on one drawing. Delimiters for the thousands place shall never be used, regardless of the decimal format.

All optical and dimensional data refer to the reference temperature of 20 °C[1)], unless specified otherwise.

Unless specified elsewhere, the omission of a permissible deviation or material imperfection from the drawing shall indicate that the provisions of ISO 10110-11 apply. By definition none of the GPS defaults, including the decision rules, apply unless specifically invoked in ISO 10110.

Surface form and transmitted wavefront deviation shall be specified in units of nanometers or, if preferred, micrometers or fringe spacings. Because of the existence of older (national) standards for optical drawings, a possibility of incorrect interpretation of data exists. For this reason, a reference to ISO 10110 shall appear on each drawing. In addition, as described in ISO 7944, wavelengths other than e-line or d-line may be used as the reference wavelength. Therefore if waves or fringe spacings are used, the reference wavelength shall always be indicated[2)]. For example:

“Indications in accordance with ISO 10110; λ = 546,07 nm”

or

“Ind. acc. ISO 10110; λ = 632,8 nm”.

These indications should preferably be together and associated with the title field of the drawing (see Annex A as well as Figures 1 and 2).

While it is preferred to only use one wavelength in an optical element drawing, the usage of other wavelengths is permitted, e.g. a reference wavelength of 546,07 nm but indicating a different wavelength for refractive index and Abbe number (n_e, ν_d, etc.). In those cases, the different wavelength strictly applies only to the property indicated with the different wavelength. Any other value not separately indicated shall be considered using the reference wavelength.

NOTE For legacy drawings created prior to the publication of this revision, the default wavelength was 546,07 nm.

1) 20 °C is the reference temperature in accordance with ISO 1. In the 1996 edition of ISO 10110-1, the default value for the reference temperature was 22 °C.

2) In earlier editions of ISO 10110-1, the default value for the reference wave length was 546,07 nm.

5 Presentation and dimensioning

5.1 Drawing format

5.1.1 General

The preferred layout of a drawing of optical elements or subassemblies is the tabular format. It was originally described in ISO 10110-10, but has been incorporated here for ease of use. All of the rules regarding line type, notation and symbology given below apply to drawings in a tabular format, unless they are explicitly contradicted by this part of the standard.

The tabulated drawing shall consist of the following three fields (see Figures 1 and 2 for sample layouts):

— drawing field in accordance with 5.1.2;

— table field in accordance with 5.1.3;

— title field in accordance with 5.1.4.

5.1.2 Drawing field

In this field, a schematic drawing of the optical element (e.g. lens, mirror, or prism) or cemented assembly shall be given, together with all information not given in the table field. A drawing scale shall be indicated and the drawing shall be a true-to-scale technical drawing.

It is sometimes desirable to exaggerate the surface deviations for non-spherical surfaces for clarity. If this is desired, a separate inset drawing not-to-scale is permitted. It shall be indicated that the inset drawing is not-to-scale; e.g. by giving an exaggeration factor along the z-axis.

The definition of a local coordinate system for each surface is possible. In this case, for every surface on the drawing the coordinate system shall be indicated in the table field. Centring tolerances and (if applicable) the datum axis for centring specification shall be indicated on the drawing as applicable per ISO 10110-6. Additionally, the surface texture specification (see ISO 10110-8) may be shown either in the drawing or the table field.

Notes, instructions and additional information are allowed within the drawing field using a leader line, or may be numbered and tabulated, with a notes table placed in the drawing field in any convenient location. Each note shall have a number for ease of reference.

5.1.3 Table field

This field contains dimensions, tolerances, surface treatment and coating references, permissible material imperfections of the optical element or cemented assembly, and local coordinate system references, if any. The table field is subdivided into subfields.

The number and contents of the subfields depend on the type of component or assembly being specified. Whenever possible, the table subfields should follow the path of the light. Table 1 lists detailed descriptions of the properties which may be indicated. In the event that the local coordinate system for each surface is provided, it shall be indicated directly below the surface label. See 5.3 for more information and Figures A.16 and A.17 for examples of local coordinates.

a) In the case of a single element with two optical surfaces:

   — the left subfield refers to the left surface (or, if desired, surface 1) of the optical element;

   — the central subfield refers to the material specification;

   — the right subfield refers to the right surface (or, if desired surface 2) of the optical element.

   See Figures A.1, A.2, A.3 and A.4.

b) In the case of a single element with three or more optical surfaces:

- each surface subfield (e.g. A1, A2, etc.) shall be labelled, and the surface indicated in the drawing;
- the subfield labelled “Material” shall be for the material specifications;
- the subfields can be horizontally or vertically aligned;
- whenever possible, the table subfields should follow the path of the light.

See Figures A.5, A.6, A.7 and A.8.

c) In the case of a cemented assembly:

- the minimum number of subfields equals the number of surfaces;
- additional subfields may be included which identify the element information such as element number, drawing number, or part number, either in the same row as the surface subfields or above the surface subfields. For clarity, a label for these additional subfields is recommended;
- cemented or contacted surfaces are counted as one surface, and information about the interface such as tolerances on the thickness and wedge of the cement or contact area may be given in the surface field.

See Figures A.9 and A.10.

d) In the case of a cemented assembly without individual element drawings; fully tabulated:

- the number of subfields depends upon the number of elements;
- each element has a subfield for a left surface, a material, and a right surface;
- each interface between elements has a subfield where information about the interface such as tolerances on the thickness and wedge of the cement or contact area are shown.

See Figure A.11.

e) In the case of a cemented assembly without individual element drawings; partially tabulated:

- the number of subfields depends upon the number of elements;
- each element has a subfield for each surface;
- the subfields shall be ordered left to right, or as numbered on the drawing
- each interface between elements has a subfield where information about the interface such as tolerances on the thickness and wedge of the cement or contact area are shown;
- the materials tolerances are indicated with a leader line in the drawing field.

See Figure A.12.

f) In the case of a system (e.g. an assembly with air spaces) with individual element drawings; partially tabulated:

- the number of subfields depends upon the number of elements;
- an additional table of system attributes may also be shown.

See Figure 35.

5.1.4 Title field

This field is provided for general indications. This shall include a reference to ISO 10110, the reference wavelength, and other indications such as name, type and/or reference number of the optical element or cemented assembly, part number, designer and/or approver's name, and company name and logo, if desired.

5.1.5 Alternative drawing layout

While the tabular format is preferred, it is not required. An alternative layout is allowed which has only a drawing field and a title field. In this case, all surface and materials tolerances are indicated in the drawing field with leader lines to the appropriate material or surface.

See Figures A.13, A.14 and A.15.

5.1.6 Examples

Annex A gives examples of indications for optical elements and cemented assemblies.

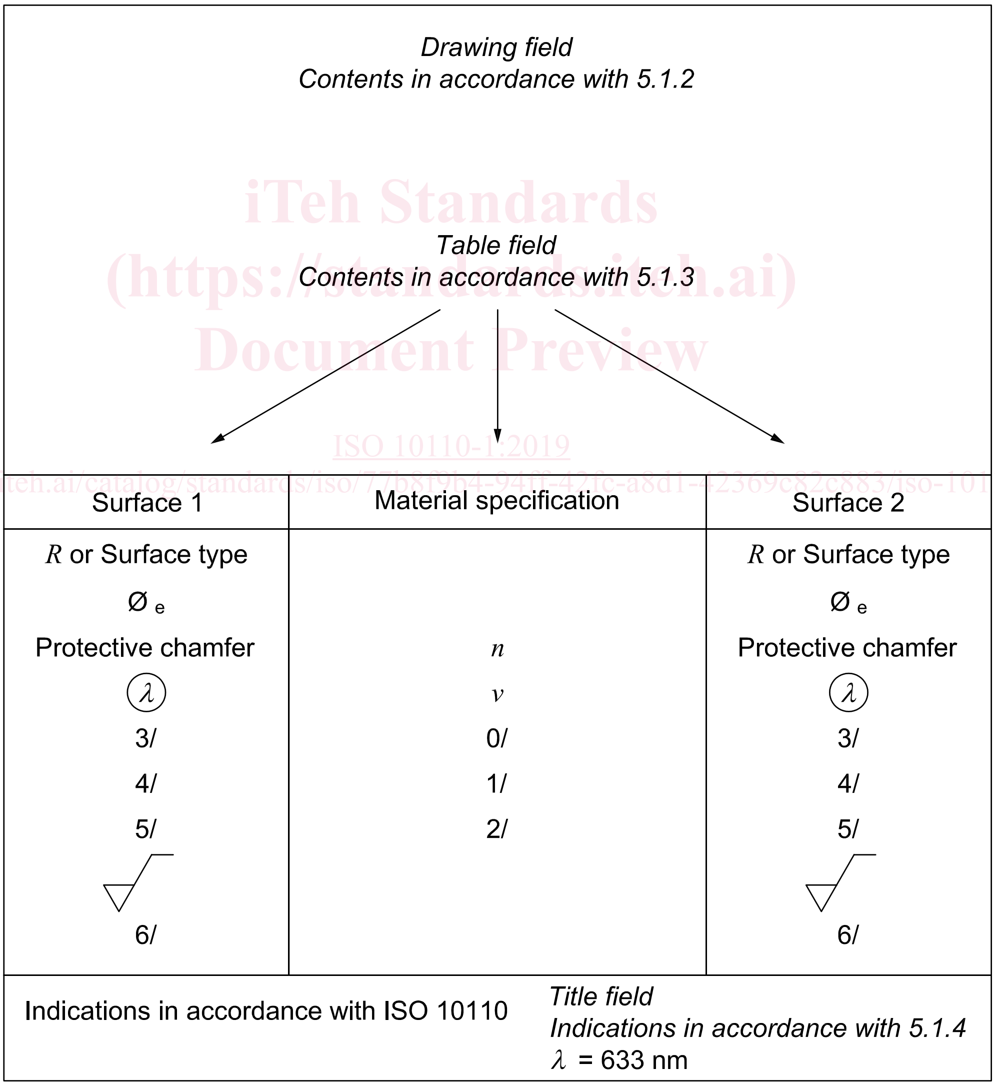
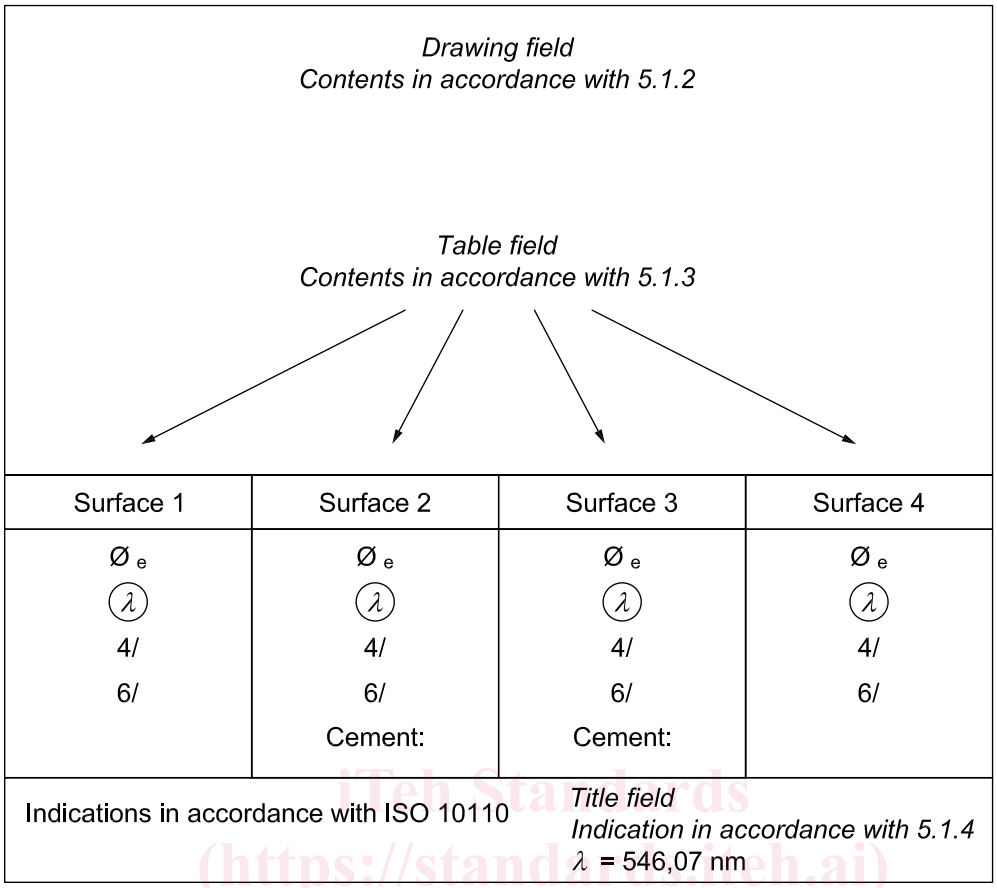


Figure 1 — Tabular indication of data for a single element



NOTE 5/, 13/ and/or 15/ specifications can be added to the table field if appropriate.

Figure 2 — Tabular indication of data for a cemented assembly (triplet)

5.2 Views

Optical elements shall be shown with incident light entering from the left and the optical axis horizontal, unless otherwise specified. Rotationally invariant parts and assemblies may be shown with just one cross section drawing.

The preferred method is that components be drawn in cross section and hatched with short-long-short strokes in accordance with ISO 128-50, as shown in Figure 3. Back edges and hidden lines should normally be omitted. However, for the sake of clarity, such lines may be included.

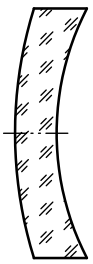


Figure 3 — Hatching

Components of subassemblies, such as cemented components, shall be hatched in alternate directions.

For the purpose of simplification, optical parts may be drawn without hatching, as shown in Figure 4. Mixing of hatched and unhatched parts in one drawing shall not be used.

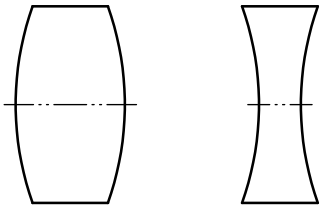


Figure 4 — Simplified drawings of lens elements

Lens elements with surfaces having two meridians of symmetry, such as cylindrical and toric surfaces, shall be drawn in two cross sections corresponding to these meridians (see Figures 5 and 6).

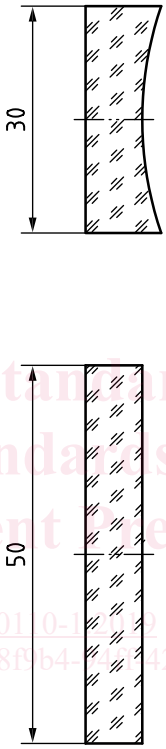


Figure 5 — Rectangular cylindrical lens element

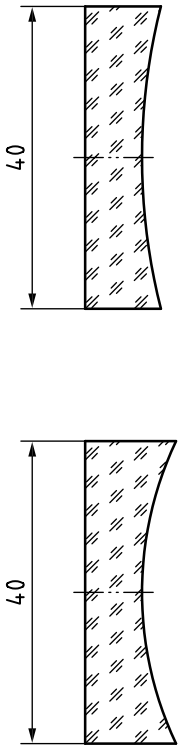


Figure 6 — Square toric lens element

5.3 Global and Local Coordinate Systems

It is sometimes necessary to indicate local coordinate systems to describe complex surface shapes. This is often the case with parts that are drawn using the generalized surface descriptions given in ISO 10110-12 and ISO 10110-19. When required, a right-hand orthogonal Cartesian coordinate system shall be drawn as follows: two lines with line type 01.2, ISO 128-24 perpendicular to each other shall indicate two of the three axes (typically the Z and Y axes). The positive direction of each axis shall be indicated by an arrowhead which is labelled by an axis identifier ("z", "y"). The missing X axis which either points into or onto the plane of projection should be indicated in the form of a circle with either a centred point (out of the page) or a cross (into the page) (see Figure 7). If only one coordinate system is shown in the drawing field, it shall be the global coordinate system. If additional coordinate systems are shown in the drawing, the global coordinate system axes shall be indicated with a subscript G, and other coordinate system axes shall be indicated with a subscript by surface (e.g. "z_1", "z_2" for surface 1 and 2).

It is recommended that all three axes be indicated, however it is important to note that, since all coordinate systems are right-handed, it is possible to indicate only two of the three axes, and the direction of the third axis can be inferred. Examples of this are shown in Figures 8 and 9.

If local coordinate systems are used, and the global coordinate system is not the coordinate system of the first surface, the global coordinate system shall be indicated in the drawing field.

All local coordinate systems shall be indicated with respect to the global coordinate system. The local coordinate systems shall be indicated by coordinate transformations between the global coordinate system and the local coordinate systems of the individual surfaces. In these cases the local coordinate system for each surface is illustrated in the drawing field. Each surface shall have a set of global reference values, which describe the position of the local coordinate system with respect to the global one. Each set consists of six values; a, b, c, α, β, and γ. To move from the global coordinate system to the local coordinate system, one has to first translate along the x, y, and z axes by the indicated translation amounts a, b, and c (the order of translation is irrelevant because they are orthogonal). Secondly rotate around the new x axis by the angle α. Then rotate around the new y axis by the angle β and finally around the new z axis by the angle γ. The rotations are right-handed. When they are required, the

specifications of the local coordinate system shall be the first entry in each surface description in the tabular field. The entry shall be in the following form:

(a, b, c), α, β, γ

The units for α, β, and γ are degrees and the units for a, b, and c in the declared unit for dimensions. References should be used in order to link the surfaces to measureable datums of the part.

If the global coordinate system is the coordinate system of the first surface, the local coordinate system of the first surface shall be indicated as (0, 0, 0) 0°, 0°, 0°.

ISO 10110-19 includes more information on local and global coordinate systems and how they relate.

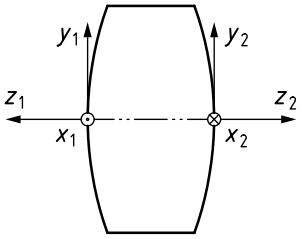


Figure 7 — Coordinate systems with all axes

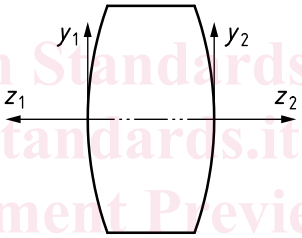


Figure 8 — Coordinate systems without X axis

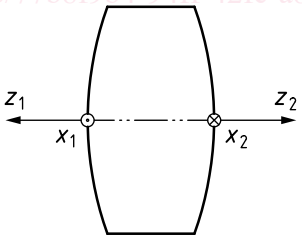


Figure 9 — Coordinate systems without Y axis

5.4 Axes

Axes shall be drawn as follows:

Rotation axes, axes of symmetry, and centre lines:	Line type 04.1, ISO 128-24
Optical axis, beamline or base ray:	Line type 05.1, ISO 128-24

If an optical axis coincides with a rotation axis or centre line, the optical axis shall be drawn. An intentional displacement or tilt of axes (e.g. of the centre line of an element with respect to the optical axis) shall be indicated and dimensioned (see Figure 10). Very small shifts may be drawn out of scale to exaggerate the displacement. Exaggerated dimensions shall be underlined.

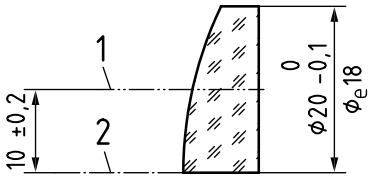


Figure 10 — Axes

5.5 Leader lines

Leader lines shall have a dot at the end for leaders terminating within the outline of a part (see Figure 11), and an arrowhead for leaders terminating on the outline (see Figure 12). Arrowheads shall touch the edge or surface in order to prevent misunderstanding.

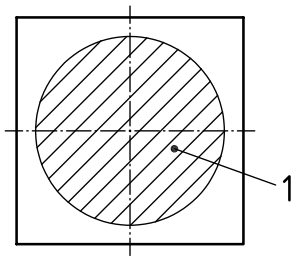


Figure 11 — Leader line to an area

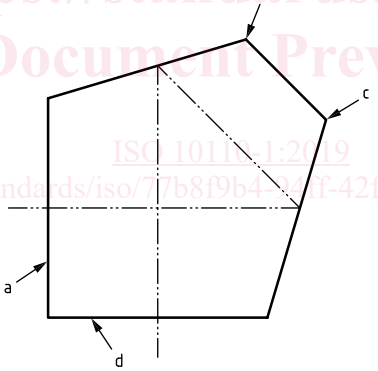


Figure 12 — Leader lines to edges and surfaces

5.6 Test regions

If testing of a complete surface or volume is not required, the test regions or optically effective surfaces shall be shown on the drawings. If no test region is indicated, but an effective aperture is indicated, then the test region shall be the effective aperture. For example, in the case of circular parts if the diameter of the circular test region is not otherwise defined, the "effective diameter", indicated by "$Ø_e$" shall be the diameter of the test region. (see Figures 13, 23, A.1 and A.2). It defines the region of the component surface that has optical significance[3)].

3) Former practice (and specification of the 1996 edition of ISO 10110-1) has been to assign the effective diameter to a surface by a leader line. This former practice could be misinterpreted as an indication for the radius of curvature.