
**Technical product documentation
(TPD) — Presentation of dimensions
and tolerances —**

**Part 1:
General principles**

*Documentation technique de produits — Représentation des
dimensions et tolérances —*

Partie 1: Principes généraux



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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).

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.

This document was prepared by Technical Committee ISO/TC 10, *Technical product documentation*.

This second edition cancels and replaces the first edition (ISO 129-1:2004), which has been technically revised.

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

- that this document does not cover the application of dimensioning tolerances has been clarified;
- property indicator, surface indicator, developed length and between symbols have been discussed;
- flag notes and textual instructions have been discussed;
- dimensioning repeated features and restricted areas have been clarified.

A list of all parts in the ISO 129 series can be found on the ISO website.

Introduction

This document is intended for all fields of application. See other parts of ISO 129 for information pertaining to specific application areas.

The principles of tolerancing and the interpretation of tolerance presentations are given in the ISO 14405 series.

Figures in this document illustrate the rules and are not intended to show complete representations. It should be understood that third-angle projection could equally well have been used without prejudice to the principles established.

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Technical product documentation (TPD) — Presentation of dimensions and tolerances —

Part 1: General principles

1 Scope

This document establishes the general principles for presentation of dimensions and associated tolerances that apply to 2D technical drawings in all disciplines and trades but which can also be applied to 3D applications.

This document does not cover the application of dimensional tolerances and their meaning. See ISO 14405-1 for tolerancing principles. This document can only be used to describe the nominal model of a drawing, not the non-ideal surface model (skin model) used for tolerancing purposes (for more information on tolerancing specifications, see the list of GPS standards listed as normative reference or as bibliography)

Considering the ISO 14405 series, the presentation of tolerance indication is unambiguous when it is applied to a dimension which is a size and ambiguous when the dimension is not a size.

All rules presented in this document are available for any type of drawing (see ISO 29845).

In addition, this document introduces the concept of property indicators, developed length, between, surface indicators, flag notes and textual instructions.

NOTE 1 All figures are shown in 2D views only.

NOTE 2 Additional information and details for construction engineering are given in ISO 6284.

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 128-20, *Technical drawings — General principles of presentation — Part 20: Basic conventions for lines*

ISO 128-22, *Technical drawings — General principles of presentation — Part 22: Basic conventions and applications for leader lines and reference lines*

ISO 128-24:2014, *Technical drawings — General principles of presentation — Part 24: Lines on mechanical engineering drawings*

ISO 3098 (all parts), *Technical product documentation — Lettering*

ISO 10209, *Technical product documentation — Vocabulary — Terms relating to technical drawings, product definition and related documentation*

ISO 14405 (all parts), *Geometrical product specifications (GPS) — Dimensional tolerancing*

ISO 81714-1, *Design of graphical symbols for use in the technical documentation of products — Part 1: Basic rules*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10209 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 <http://www.electropedia.org/>

3.1 Elements of dimensioning

3.1.1 centre line

line or set of two perpendicular lines used to represent a median feature, e.g. an axis or a centre plane

3.1.2 dimension line

straight or curved line with terminators at each end or origin and terminator at each end, indicating the size of a feature or the extent of a feature or between two features, or between a feature and an *extension line* (3.1.3), or between two extension lines

3.1.3 extension line

line which is an extension of a feature outline or of a *centre line* (3.1.1)

3.1.4 origin symbol

circle indicating the start of running dimensioning or coordinate dimensioning

3.2 Dimensions

3.2.1 angular dimension

angle of an angular feature of size or angle between two features

Note 1 to entry: In mechanical engineering drawings, angular dimensions are classified as angular sizes or angular distances; see ISO 14405-2.

3.2.2 dimensional value

nominal numerical value expressed in a specific unit relevant to a *linear* or *angular dimension* (3.2.4, 3.2.1)

Note 1 to entry: The tolerance limits and/or permissible deviations are applied to the dimensional value.

3.2.3 developed length

initial length of material prior to forming, e.g. by bending

3.2.4 linear dimension

linear size of a feature of size or a linear distance between two features

Note 1 to entry: In mechanical engineering drawings, linear dimensions are classified as linear sizes or linear distances; see ISO 14405-2.

3.2.5 property indicator

symbol used to define the shape of a feature or property of an entity composed by several features

4 Presentation of dimensions

4.1 Presentation rules

4.1.1 Dimensions

Only the dimensions necessary to unambiguously define the nominal geometry (nominal model) shall be presented. Each dimension shall be presented only once by using a dimension line, a dimension value preceded, and if necessary, by a property indicator. When there is a need to repeat the presentation of a dimension, auxiliary dimensions may be used.

Dimensional values indicated in decimal notation, shall use a comma as the decimal marker.

Unless otherwise specified, dimensions shall be indicated for the finished state of the dimensioned feature.

The text of all dimensions, graphical symbols and annotations shall be indicated above the dimension line and read from the bottom. When the text of a dimension, symbol or annotation is presented vertically, it shall read from the right. The determination of orientation is based on the centre of the dimension, symbol or annotation.

Dimensions alone are not sufficient to define the requirements of a product. Dimensions shall be used with other specification techniques as applicable, e.g. general tolerances, geometrical tolerancing or surface texture requirements.

4.1.2 Repeated dimensions

When a feature is repeated on the drawing, it is possible to simplify the indication of its dimension on the drawing by indicating:

- on one instance of the feature, the nominal dimension (with a property indicator symbol if appropriate), preceded by the associated number of repetition, followed by a multiplication symbol (\times) and a space (e.g. $2 \times \varnothing 18$) (see [Figure 10](#)). To avoid confusion, it is possible to identify each member of the repetition using a reference identifier (e.g. letter or symbol) (see [Figure 64](#));
- a nominal dimension (with a property indicator symbol if appropriate) above a reference line, which is attached to each member of the repetition (see [Figures 49](#) and [50](#)).

4.1.3 Out of scale dimensions

By default, a dimension line is drawn to the scale of the drawing. In exceptional cases, in 2D drawing only, when the dimension value does not correspond to its dimension scale value (out-of-scale features), the dimension value shall be marked by underlining the dimensional value (see [7.11](#) and [Figure 70](#)).

4.1.4 Auxiliary dimensions

A dimension value can be defined as a dimension for information purposes only. In this case, the dimension value shall be placed into parenthesis, (). This kind of dimension is called an auxiliary dimension (see [7.12](#) and [Figures 65](#) and [66](#)).

4.1.5 Theoretically exact dimensions

When a dimension value shall be considered as a theoretical exact dimension and not associated with general \pm tolerancing or not an auxiliary dimension, it shall be placed in a rectangular frame (in accordance with ISO 1101, [7.13](#) and [Figure 71](#)).

4.1.6 Symmetrical dimensions

When the design of a part has one or more symmetries, it is possible to represent a portion of the part which can allow reconstructing the complete part by symmetry (see 7.9). In this case, the dimensions, shown only on the portion and the dimension line between two symmetrical features, are indicated from the feature shown on the portion with a termination and cross perpendicularly the axis of symmetry without termination (see Figures 65 and 66).

4.1.7 Characters and presentation

Characters on drawings shall be in accordance with the ISO 3098 series.

There shall be only one character height for dimension and tolerance presentation for a specific drawing.

A space shall separate the elements of the dimension indicator (see Figures A.3 and A.4).

The dimension value and the lower deviation shall be at the same distance from the dimension line (see Examples 1 and 2).

When upper and lower tolerance limits are presented in two separate lines (e.g. limit deviations, dimension limit values), the decimal marker of the upper and lower shall be aligned. When a tolerance limit is not shown with a decimal marker, the remaining digits shall be aligned as if the decimal marker had been displayed (see Examples 1 and 2).

Trailing zeros may or may not be presented:

Example 1	Example 2
+0,20	0
2× 55 -0,15	2× 55 -0,15

Deviations shall always be presented with a "+" or "-" sign as appropriate, unless the value is zero, in which case, no sign shall be presented (see Example 2).

For tolerances attached to a dimension displayed in accordance with ISO 286-1, it is not necessary to express the values of the deviations unless they are needed (see Figure 1).

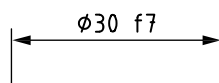


Figure 1

4.2 Positioning of dimensions

Dimensions shall be placed in a view or section which shows the relevant feature(s) most clearly (see Figure 2).

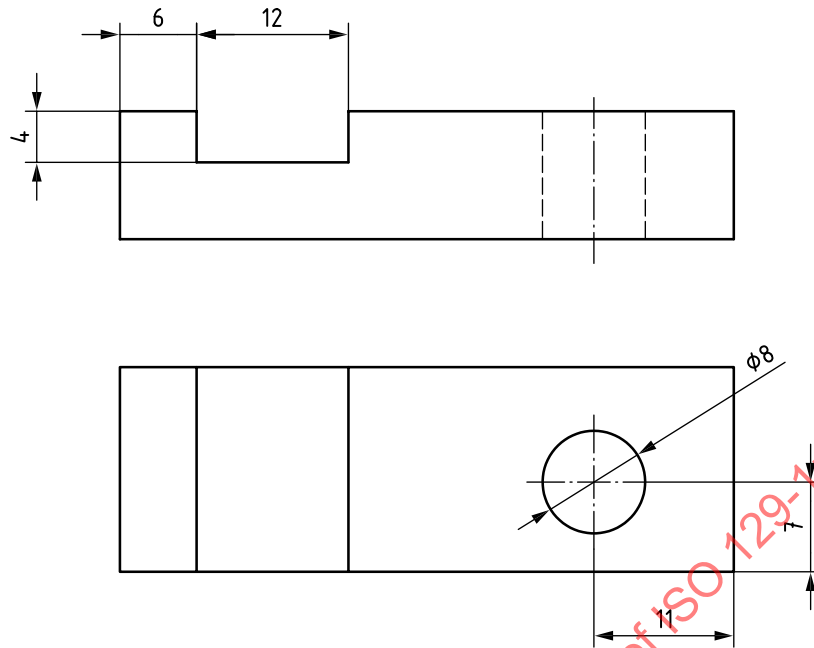


Figure 2

Dimension lines for internal features and dimension lines for external features shall, wherever possible, be arranged and indicated in separate groups of dimensions to improve readability (see [Figure 3](#)).

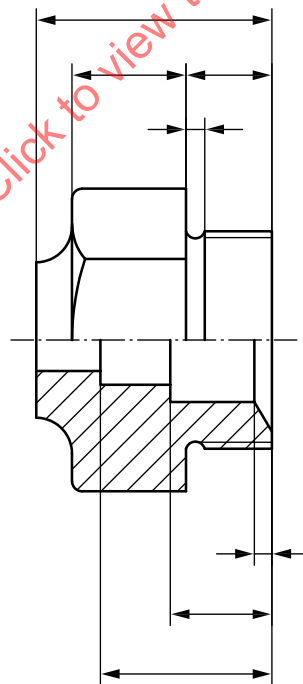


Figure 3

Where several features or objects are depicted in close proximity, their relative dimensions shall be grouped together, separately, for ease of reading (see [Figure 4](#)).

Whenever possible, dimensions should not be placed within the contour of the depicted item.

Dimensioning of hidden features is not recommended and should be avoided unless absolutely necessary and completely unambiguous.

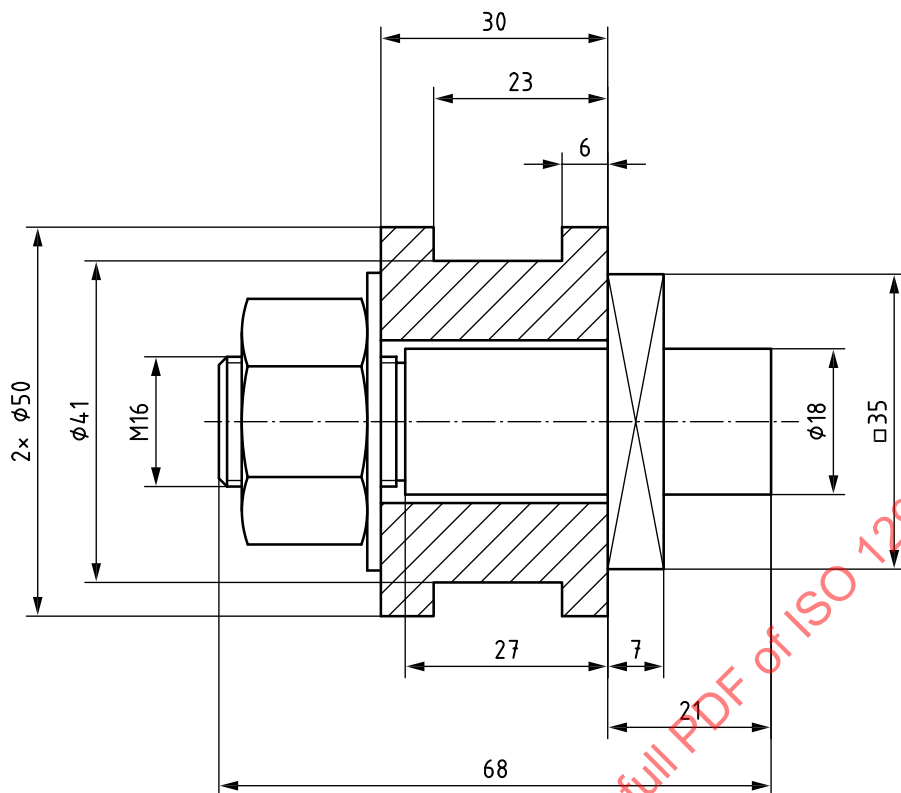


Figure 4

4.3 Units of dimensions

For linear units, the predominant unit on a drawing may be specified on the drawing or in an associated document and the unit omitted from the individual dimensions.

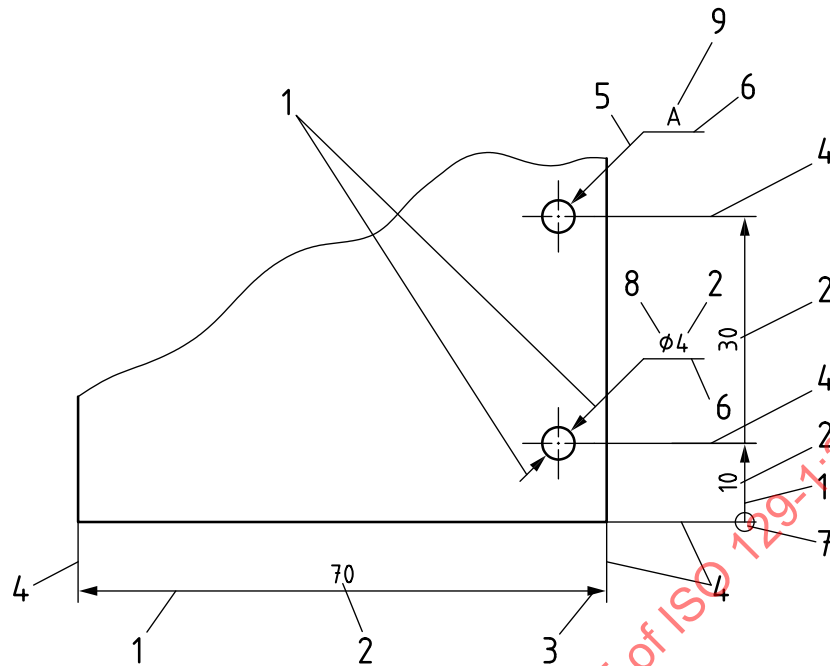
For angular dimensions, the units shall always be specified with the individual dimensions (see [Figure 7](#) and [Figures 34](#) to [37](#)).

Any dimensions expressed in a different unit of measure shall indicate that unit of measure.

5 Elements of dimensioning — Usage

5.1 General

Various elements of dimensioning are illustrated in [Figure 5](#).

**Key**

- 1 dimension line
- 2 nominal dimension value
- 3 terminator (in this case, an arrowhead)
- 4 extension line
- 5 leader line
- 6 reference line
- 7 origin symbol
- 8 property indicator
- 9 reference letter

Figure 5**5.2 Property indicators**

Property indicator symbols (see [Table 1](#)) may be used to describe the shape of the feature and the type of associated dimension. The symbol shall precede the dimension without a space (see figures referenced in [Table 1](#)).

No property indicator is required for the presentation of

- linear dimensions between two parallel planes (see [Figure 9](#)), or two parallel straight lines (see [Figure 41](#)), or
- angular dimensions between two intersecting planes (see [Figures 7](#) and [59](#)) or two intersecting straight lines.

Table 1

Property indicator symbol	Description	Associated property	Example of presentation
\varnothing	Diameter	Cylindrical feature or circular feature described by its diameter.	Figures 2, 6 and 10
R	Radius	Cylindrical feature or circular feature described by its radius.	Figures 8 and 44
□	Square	Square feature with four equal angles and four equal sides described by its side dimension.	Figures 4, 55 to 57
S \varnothing	Spherical diameter	Spherical feature described by its diameter.	Figure 51
SR	Spherical radius	Spherical feature described by its radius.	Figure 52
\frown	Arc length	Curvilinear dimension of non-flat feature (e.g. arc length).	Figures 8, 53 and 54
t=	Thickness (of thin objects)	Two offset features defined by its thickness.	Figure 78
↕	Depth	Depth of a hole or internal feature.	Figures 39 and 41
└┐	Cylindrical counterbore	Cylindrical hole with a flat bottom described by its diameter and depth.	Figure 39
∨	Countersink	Circular chamfer described by a diameter and angle.	Figure 40
Q→	Developed length	Length of feature prior to bending or forming.	Figure 77
↔	Between	Indication of the extent of a restricted area, used in conjunction with reference letters.	Figures 54 and 81

5.3 Dimension line

Dimension lines shall be indicated as continuous narrow lines according to ISO 128-20.

Dimension lines shall be indicated in the case of:

- linear dimension:
 - which is a size of a feature of size indicated by a single dimension line (see [Figures 6 and 27](#));
 - which is radius generated from the geometrical centre of the circle of which the arc is part and leading to the outline of the arc (see [Figure 8](#));
 - which is a distance between two features or an extent of restricted area parallel to the length to be dimensioned (see [Figures 10 and 83](#));
- angular dimensions or dimensions of an arc as a circular arc around the vertex of the angle or the centre of the arc (see [Figures 7 and 8](#)).

Where space is limited, dimension lines may be extended past the extension lines and the arrowheads placed outside of the extension lines and reversed (see [Figure 2](#)).

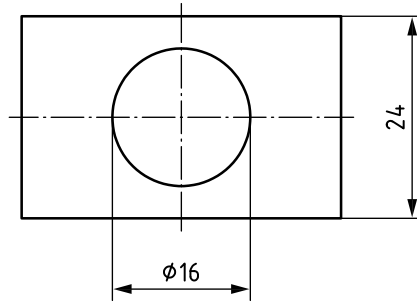


Figure 6

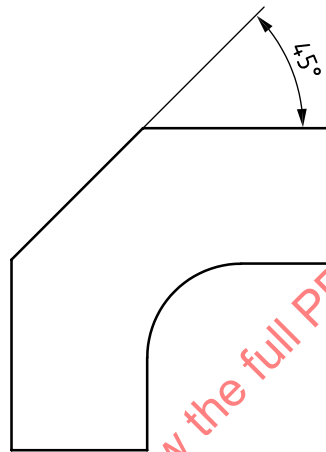


Figure 7

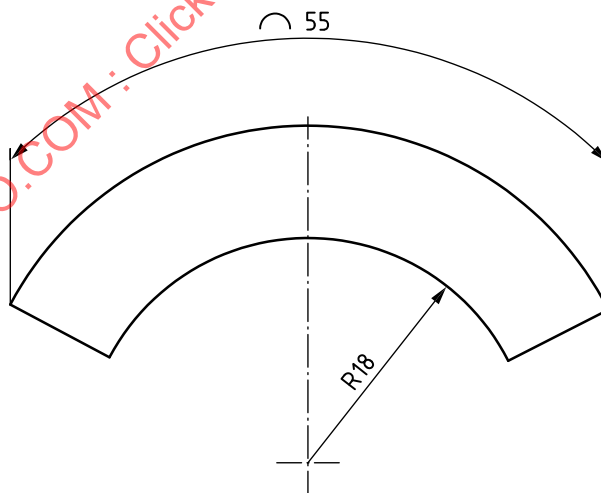


Figure 8

Where the feature is shown broken, the corresponding dimension line shall be shown unbroken (see [Figure 9](#)).

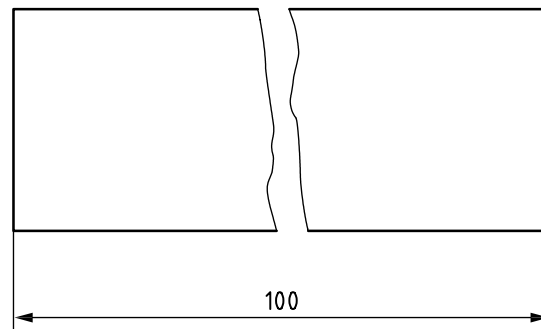


Figure 9

Dimension lines of circular features may be indicated obliquely through the centre of the feature (see [Figure 10](#)).

Intersection of dimension lines with any other line should be avoided, but where intersection is unavoidable, they shall be shown unbroken (see [Figure 10](#)).

Centre lines and the outlines of a feature shall not be used as dimension lines.

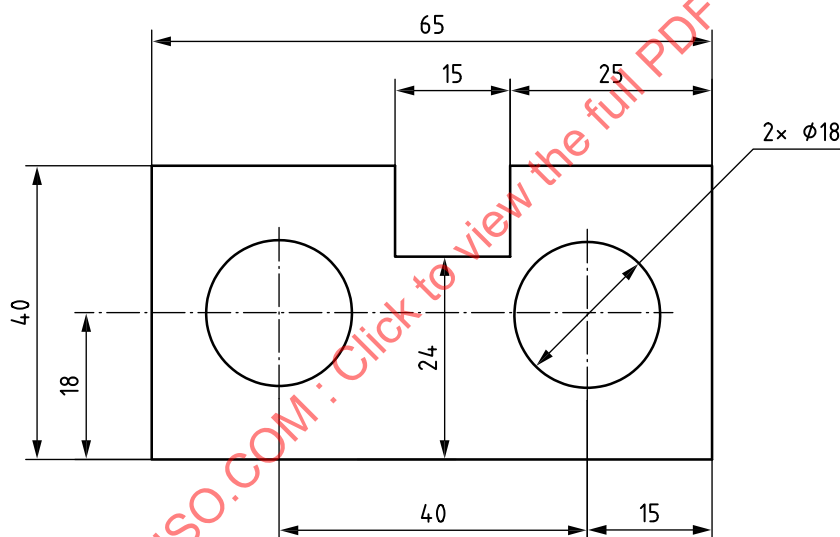


Figure 10

Dimension lines may be shown not in full, when:

- dimensions of diameters are indicated (see [Figure 11](#));
- a part of a symmetrical feature is drawn in a view or section (see [Figures 65](#) and [67](#));
- the reference feature for dimensioning is not on the drawing sheet and there is no need for its presentation (see [Figure 45](#), R140);
- simplified running dimensioning is used [see [Figure 90 b](#)].



Figure 11

5.4 Terminators and origin presentation

5.4.1 Terminators

Terminators shall be shown according to one of the following representations (see [Figure 12](#)):

- a) arrowheads: when an arrowhead is shown, it shall be one of the following types (only one type of arrowhead shall be used on a single drawing or set of drawings):
 - 1) closed 30° filled, [Figure 12 a](#));
 - 2) closed 30° unfilled, [Figure 12 b](#));
 - 3) open 30°, [Figure 12 c](#));
 - 4) open 90°, [Figure 12 d](#));
- b) oblique stroke, [Figure 12 e](#)) and [Figure 12 f](#));
- c) point, [Figure 12 g](#)).

[Figures 12 c](#)) and [Figure 12 d](#)) terminators shall not be used for mechanical engineering purposes.

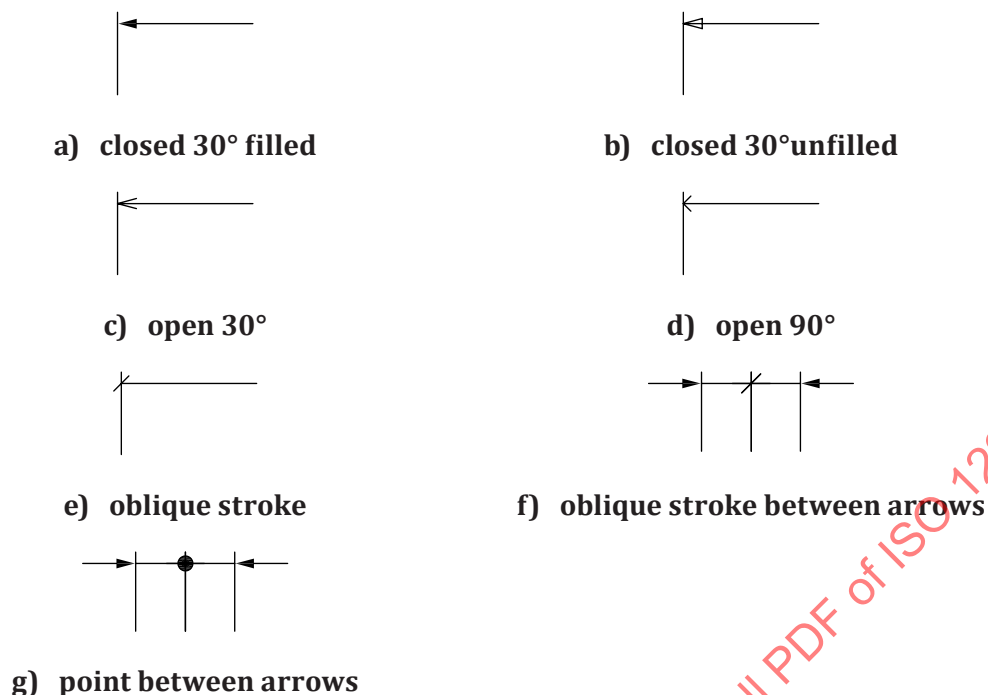


Figure 12

The size ratios of the terminators illustrated in [Figure 12](#) shall be in accordance with [Annex A](#). Where space is available, the arrowhead terminators shall be shown between the extension lines (see [Figure 14](#)). Where space is limited, the arrowhead termination may be

- shown outside of the extension lines on an extended dimension line (see [Figure 26](#), dimension 1,5), or
- substituted with either points or oblique strokes (see [Figure 26](#), dimension 6), or
- substituted by the use of an opposing arrowhead or other terminator from another dimension line (see [Figure 26](#), dimension 3, [Figure 83](#) and [Figure 100](#), dimension 5).

5.4.2 Origin presentation

The origin symbol may be used for

- the origin for running dimensioning (see [8.4](#)), or
- the origin of a coordinate system for coordinate dimensioning (see [8.5](#)).

The origin symbol shall be indicated on the dimension line at the location where a specific dimension or multi dimensions start (see [Figures 13](#) and [96](#)).

The size ratios of the origin circle illustrated in [Figure 13](#) shall be in accordance with [Annex A](#).

NOTE The origin symbol does not change the meaning of dimensional tolerances and does not function as a datum.



Figure 13

5.5 Extension line

Extension lines shall be drawn as continuous narrow lines according to ISO 128-20.

Extension lines should not be drawn between views and should not be drawn parallel to the direction of hatching.

Extension lines shall extend approximately eight times the line width beyond their associated dimension line.

Extension lines should be drawn perpendicular to the corresponding physical length (see [Figures 5, 6, 11, 14](#) and [15](#)).

For circular features, the extension line shall be drawn as a continuation of the feature shape (see [Figure 43](#), $\varnothing 60$).

It is permissible to have a gap, eight times the extension line width, between the feature and the beginning of the extension line (see [Figure 15](#)). Gaps can be used with any terminator.

The centre line or outline of a feature or their extensions may be used in place of an extension line (see [Figure 10](#)).

Where common extension lines are shown, i.e. between repeated features, they should be considered to be coincident (see [Figure 21](#)).

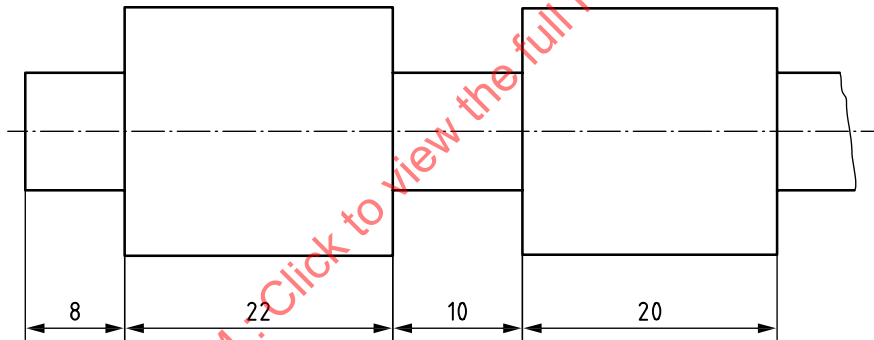


Figure 14

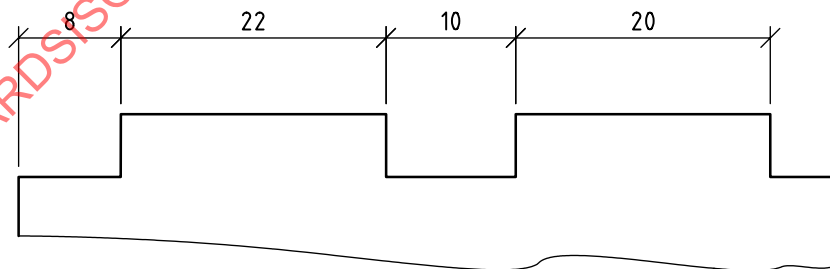


Figure 15

The extension lines may be drawn oblique to the feature but shall be parallel to each other (see [Figure 16](#)).

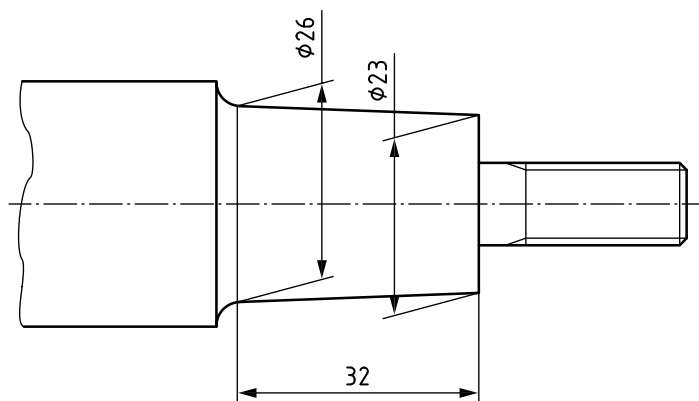


Figure 16

When dimensioning, intersecting projected contours of outlines shall extend approximately eight times the line width beyond the point of intersection (see [Figure 17](#)).

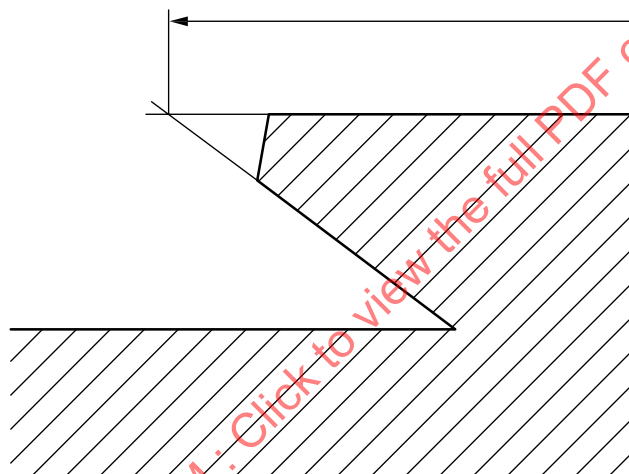


Figure 17

In the case of projected contours of transitions and similar features, the extension lines apply at the point of intersection of the projection lines (see [Figure 18](#)).

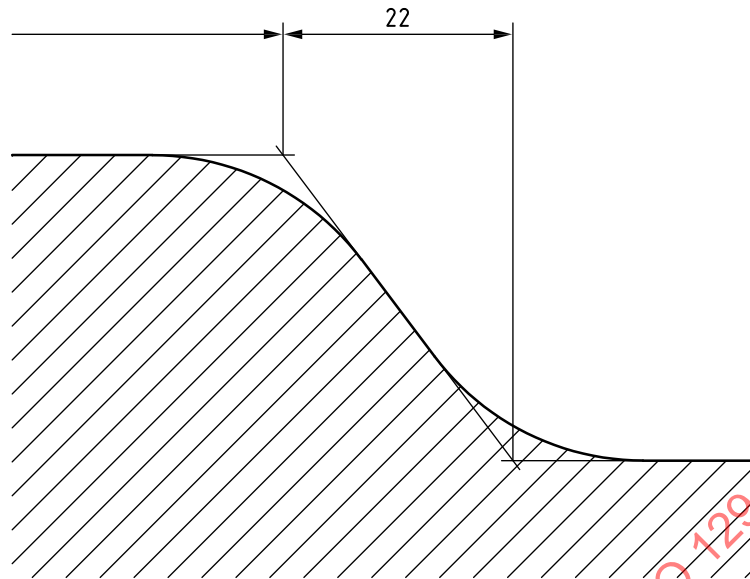


Figure 18

Extension lines may be interrupted if their continuation is unambiguous (see [Figures 19](#) and [20](#)). In the case of angular dimensions, the extension lines are the extensions of the angle legs (see [Figure 20](#)).

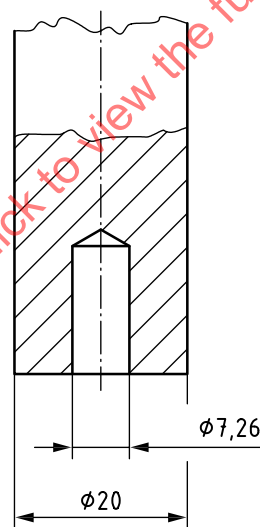


Figure 19

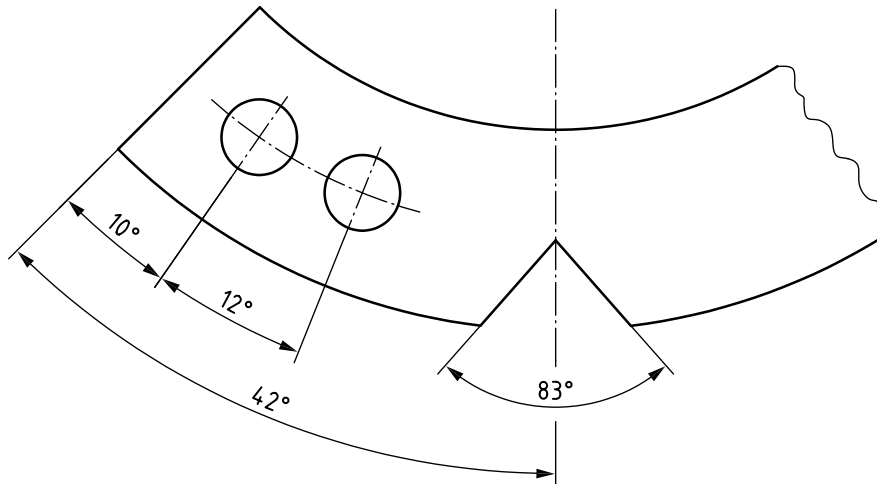
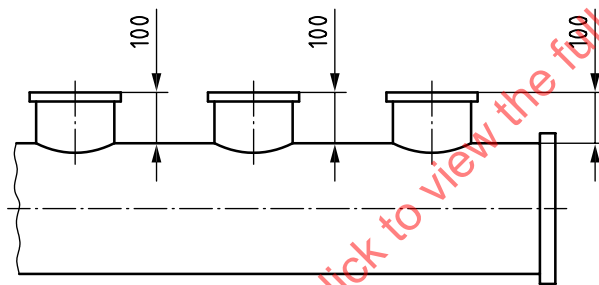
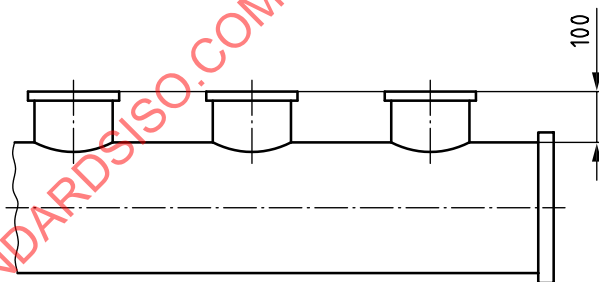


Figure 20

For repeated features, as an alternative to individual dimensions [see Figure 21 a)] or using common extension lines which can be ambiguous [see Figure 21 b)], the repeated feature dimension method “n×” as described in 4.1.2 may be used [see Figure 21 c)].

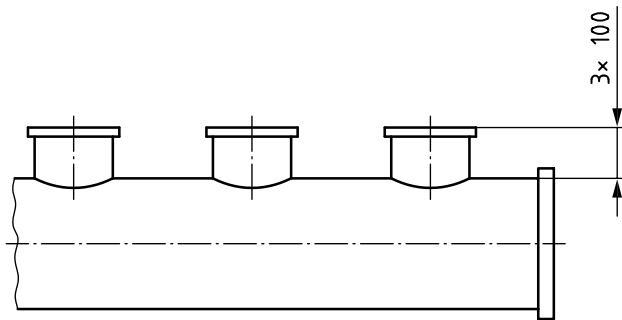


a)



b)

Figure 21 (continued)



c)

Figure 21

5.6 Leader line

Leader lines shall be drawn as continuous narrow lines according to ISO 128-22 and should end with a terminator as defined in 5.4.1. Leader lines may also be used in conjunction with reference lines (see Figure 5).

5.7 Dimensional values

5.7.1 Presentation

To ensure complete legibility on the original drawing, as well as reproductions made from microfilms (see ISO 6428), lettering used for dimensions shall be in accordance with ISO 3098-2:2000, Type B Vertical.

NOTE This lettering results in a character height which is 10× the width of a narrow line. See ISO 128-20.

5.7.2 Placement of dimensional values and symbols

Dimensional values shall be placed parallel to their dimension line. The space between the dimension line and the bottom of the characters and symbols in the dimension shall be a minimum of 2× the line width between the dimension line and the bottom of the characters and symbols in the dimension in accordance with Annex A. The dimensions should be placed above and near the middle of the dimension line. See Figures 22 and 23 and Annex A. For special cases, see 5.7.3.

Dimensional values shall be placed in such a way that they are not crossed by any line. Where this is unavoidable, interrupted extension lines as referenced in 5.5 (Figure 19) shall be used.

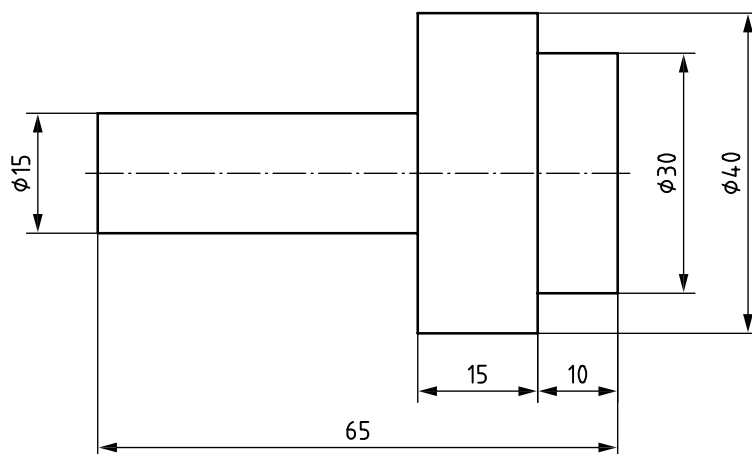


Figure 22

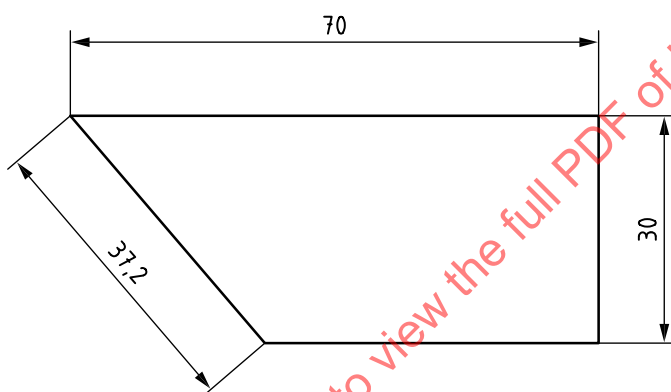


Figure 23

Values of linear dimensions on oblique dimension lines shall be oriented as shown in [Figure 24](#). As stated in [4.1](#), the values shall be indicated so that they can be read from the bottom or right-hand side of the drawing.

Values of angular dimensions shall be oriented as shown in [Figure 25](#). Angular dimensions shall be placed on top of the dimension line and follow the same rule as linear dimensions; see [4.1](#) and [Figure 24](#).

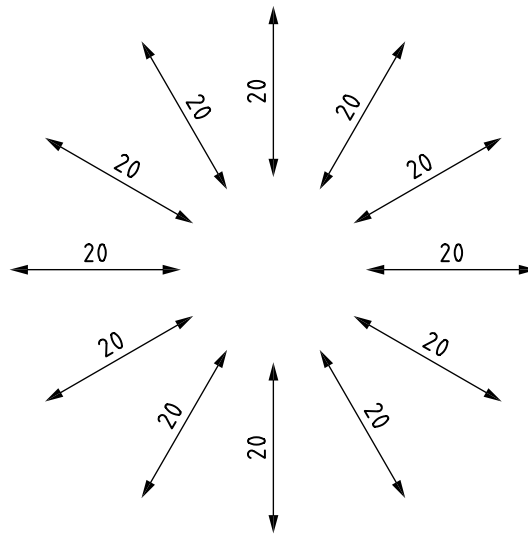


Figure 24

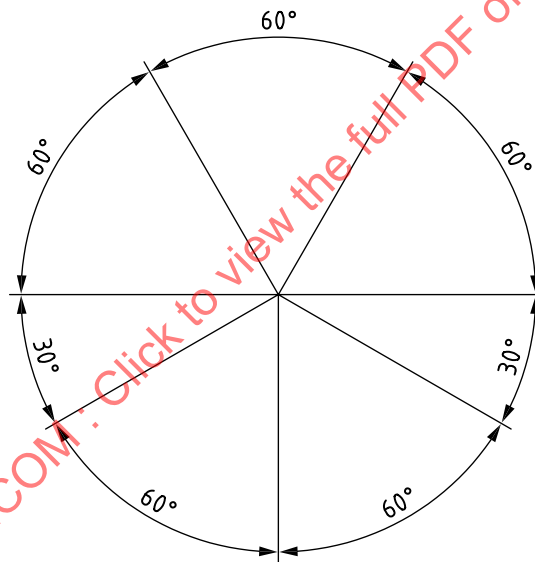


Figure 25

5.7.3 Special placement of dimensional values and symbols

The position of dimensional values may be adapted according to different situations:

- if space is limited, dimensional values shall be placed above the extension of the dimension line beyond one of the terminators (see [Figure 26](#), dimensions 1, 5 and 30°);
- if the dimension line is too short for the dimensional value to be indicated in the usual way between the extension lines, the dimensional values shall be placed on a reference line and attached to the dimension line by a leader line, terminating on the dimension line (see [Figure 26](#), dimensions 2 and 3);
- the dimension line or leader line may be extended and a horizontal reference line added, allowing the dimension value to be positioned horizontally above the reference line (see [Figures 5, 10 and 27](#));
- in running dimensioning, the values shall be indicated near the arrowhead (see [Figures 88 to 90](#)).
- when dimensioning diameters, where there is no ambiguity, a single dimension line may be used, i.e. without an opposing dimension line (see [Figure 27](#), dimension $\varnothing 16$).

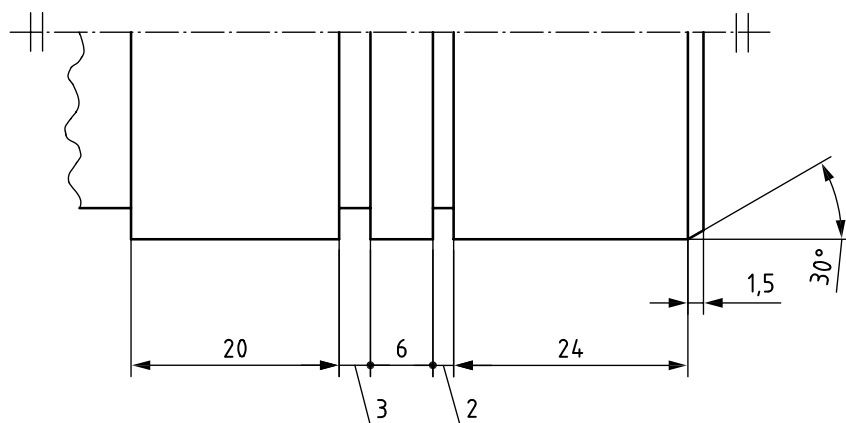


Figure 26

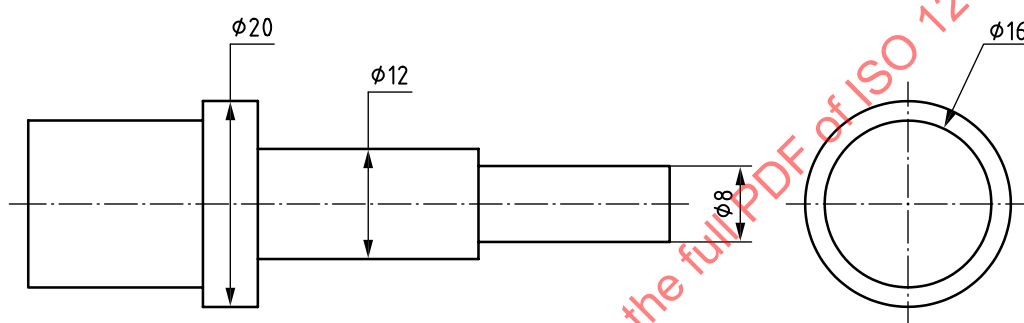


Figure 27

To avoid misinterpretation and improve readability, extension lines and dimension lines may be staggered where many dimensions of the same orientation exist (see [Figure 28](#)). The omission of a portion of the dimension line is unambiguous only for diameters.

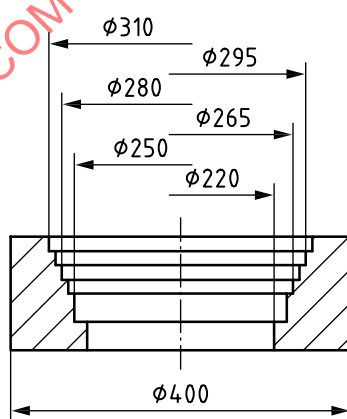


Figure 28

5.8 Alpha numerical characters and symbols representing dimensional values

5.8.1 Alpha numerical characters representing dimensional values

Letters may be used to represent dimensional values and these shall be defined on the same drawing or in associated documentation (see [Figure 29](#)).

Letters on drawings shall be shown according to ISO 3098-2, preferably using upper case, with the exception of when indicating the classes in limits and fits dimensions (see ISO 286-1) and when used for tabulated dimensions. The letters I, O, Q, q, X, Z or letters used for dimensional symbols according to 5.2, i.e. R and t, should not be used to avoid conflicts and avoid misinterpretation.

Greek letters according to ISO 3098-3 may be shown for the presentation of angular dimensions.

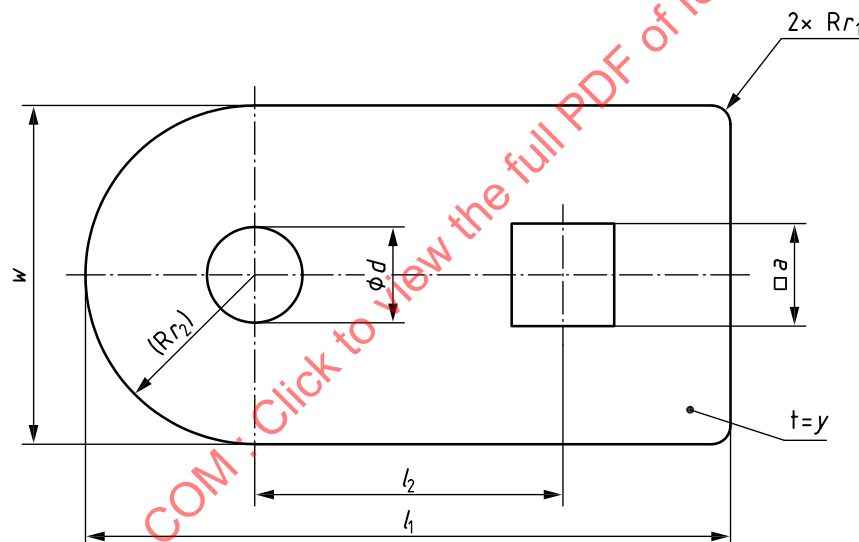
5.8.2 Symbols added to dimensional values

Symbols to dimensional values, e.g. \varnothing for diameter, \frown for arc length, () for auxiliary dimensions and M for metric threads, may be assigned to the dimensional value or the letter representing the dimension. Only one method shall be used on a given drawing (see Figures 29 and 30).

5.9 Tabular dimensioning

This method of dimensioning enables a series of variable common features of a feature or assembly to be presented in tabular form (see Figures 29 and 30).

This method of dimensioning may be used for a family of parts. See Figures 29 and 30.



Part No.	a	d	l_1	l_2	r_1	r_2	w	y
1	12	10	100	50	6	16	32	4
2	16	16	120	64	6	20	40	6
3	20	20	140	78	8	24	48	8

Figure 29

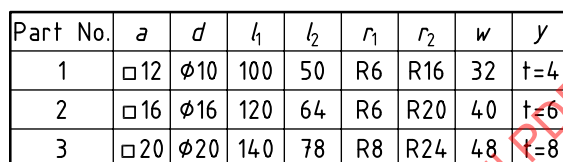


Figure 30

5.10 Complementary indication

- dimensional specification (see [Clause 6](#)),
- information only (see [7.12](#)),
- dimension used for construction (see [7.10](#)), and
- other purposes (e.g. company specific indications such as quality management requirements).

6 Presentation of dimensional tolerances

6.1 General

Depending on the field of application, the tolerances of dimensions may be indicated by

- limit deviations (see [6.2](#)), and
- limits of dimension (see [6.3](#)).

6.2 Limit deviations

a) the dimensional value;

b) the limit deviations.

A space shall separate the dimensional values and the tolerance presentation (see [Figures 1, 31 and 38](#)).

Limit deviations shall be specified by indicating the upper deviation above the lower deviation (see [Figures 31, 32 and 34](#)) or by means of an ISO code (see [Figure 1](#)).

The tolerance limits can be described directly without the presentation of the limit deviations (see [Figure 37](#)).

NOTE The nominal value of the dimension is not identified.

If one of the two limit deviations is zero, this shall be expressed explicitly by the digit zero, shown without a sign (see [Figure 32](#)).

If the tolerance is symmetrical in relation to the dimensional value, the limit deviation shall be indicated only once, preceded by the plus-minus sign (\pm) (see [Figure 33](#)).

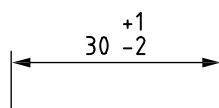


Figure 31

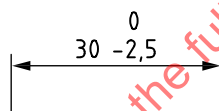


Figure 32

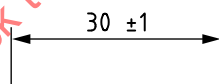


Figure 33

For angular dimensions, the angular dimensional value, as well as the limit deviations, shall be indicated (see [Figures 34 to 37](#)). If the angular dimensional value or the angular limit deviation is expressed in either minutes of a degree or seconds of a minute of a degree, the value of the minute or second should be preceded by 0' or 0'' (see [Figures 34 and 35](#)).

Angular dimensions can be presented using decimal degrees or using degrees, minutes and seconds.

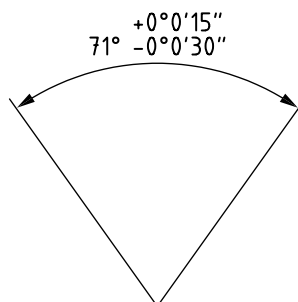


Figure 34

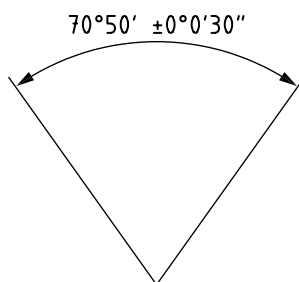


Figure 35

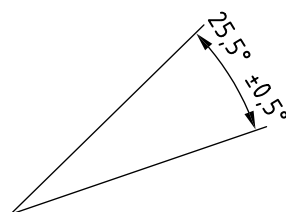


Figure 36

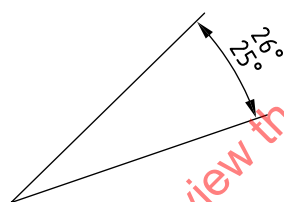


Figure 37

6.3 Limit dimensioning

To limit a dimension in one direction, only the word “min.” or “max.” shall be added after the dimensional value (see [Figure 38](#)).

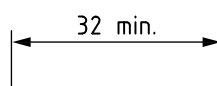


Figure 38

7 Presentation of special dimensions

7.1 Arrangement of graphical and letter symbols with dimensional values

The property indicators shall be used with dimensions to identify the feature characteristics. Where used, the property indicators shall directly precede the dimensional value without space (see [Table 1](#), [Figure 8](#), [Figures 39](#) to [57](#), [Figure 78](#) and [Table A.1](#)).

For chamfers and countersink with a 45° angle, the dimension indications may be simplified by indicating on one dimension line/reference line the extent dimension followed by a space and the multiplication symbol (×) followed by a space and ending with 45°; see [Annex B](#), [Figure B.2](#).

Where a counterbore is dimensioned by using a cylindrical counterbore symbol, the diameter and depth of the counterbore shall be specified below the dimension value of the hole [see Figure 39 a)]. The dimensions presented in Figures 39 a) and b) are equivalent.

Where a countersink is dimensioned by using a countersink symbol, the diameter at the surface and the included angle of the countersink shall be specified below the dimension value of the hole [see Figure 40 a)]. The dimensions presented in Figures 40 a) and b) are equivalent.

Where the depth symbol is presented, the associated value relates to the depth of the full feature, i.e. the cylindrical portion of the hole (see Figure 41) or counterbore (see Figure 39). When dimensioning blind holes, the depth symbol and value may follow the hole dimension (see Figure 41).

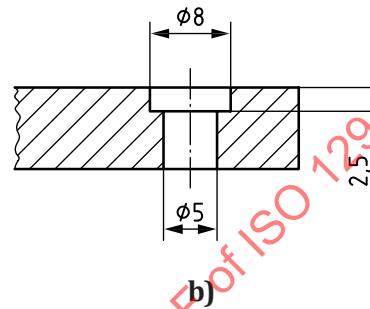
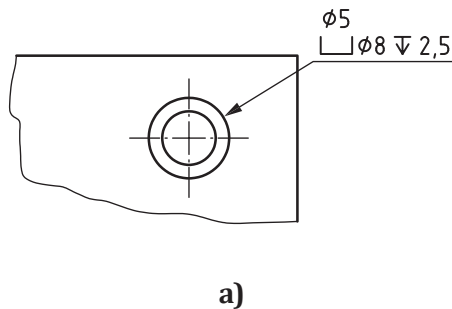


Figure 39

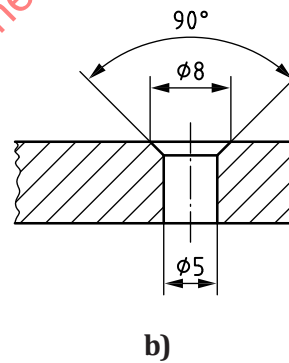
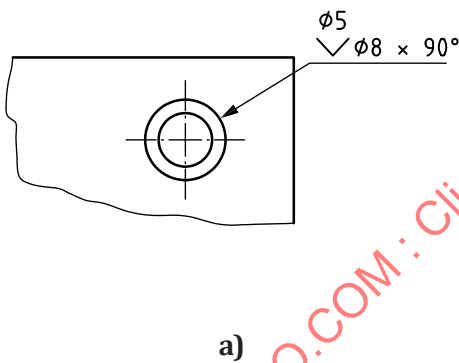


Figure 40

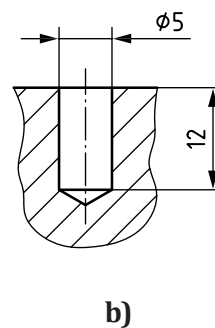
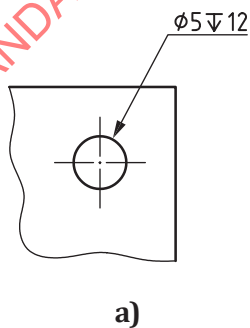


Figure 41

7.2 Diameters

The graphical symbol \varnothing indicates that the cross-section of the feature is a circle. The graphical symbol \varnothing shall precede the dimensional value (see [Figures 42](#) and [43](#)).

The graphical symbol \varnothing shall be indicated when dimensioning the diameter of a circular feature.

Diameters should be indicated when the arc to be dimensioned is greater than 180° (see [Figure 43](#), dimension $\varnothing 60$). The application should dictate whether a radius or diameter dimension is used. In general, a diameter dimension should be used for arcs greater than 180° .

When a diameter is illustrated by one arrowhead, the dimension line shall exceed the centre (see [Figure 43](#), dimension $\varnothing 44$).

If leader lines are used for dimensioning of diameters, see [5.6](#) and [Figures 5](#), [10](#) and [63](#).

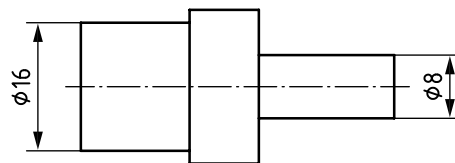


Figure 42

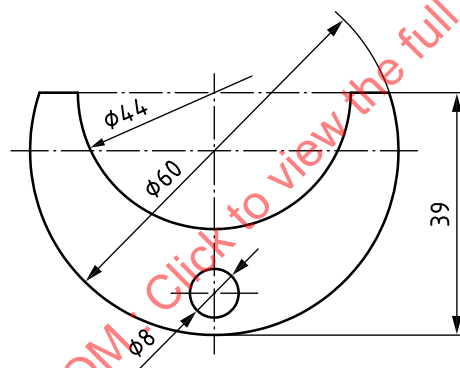


Figure 43

7.3 Radii

7.3.1 General

The letter symbol R indicates that the cross-section of the feature is a portion of a circle. The letter symbol R shall precede the dimensional value (see [Figure 44](#)).

When dimensioning radii, only one terminator shall be used. It shall be indicated at the intersection of dimension line and arc (see [Figure 45](#)). In the case of an arrowhead as terminator and depending on the size of the radius on the drawing, the arrowhead may be either inside or outside the outline or extension line of the feature.

Where the centre of an arc indicated on a drawing falls outside the available space, the dimension line of the radius shall be either broken or staggered according to whether or not it is necessary to locate the centre (see [Figure 45](#)).

Where it is necessary to indicate the centre of a radius for positioning purposes, the centre shall be marked by a cross constructed from solid lines, the dimension of which shall be $10\times$ the line width used (see [Figure 45](#)).

In the case when it is clear and unambiguous, a radius dimension may be applied to an edge (see [Figure 45](#), R0,2).

Where the location of the centre of the radius is not explicitly dimensioned and the contour appears tangent continuous, then the contour is tangent continuous and the centre location is derived from this tangency property.

A radius should be indicated when the arc to be dimensioned is less than 180° (see [Figure 45](#)).

The application should dictate whether a radius or diameter dimension is used. In general, a diameter dimension should be used for arcs greater than 180° .

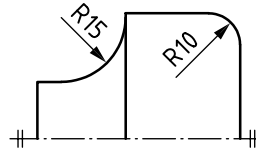


Figure 44

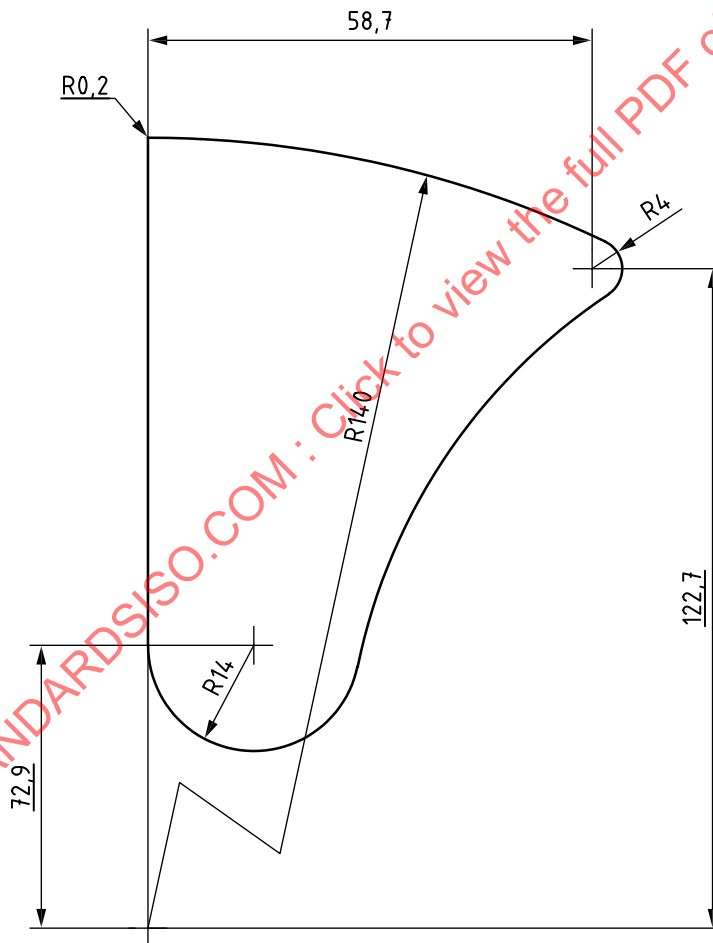


Figure 45

7.3.2 Dimension location of radius centre

If the centre of a radius is not given by the geometry of adjacent features, the dimensions required to define its location shall be indicated (see [Figure 46](#)).

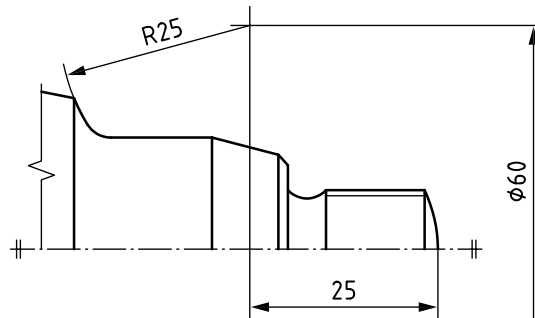


Figure 46

7.3.3 Semicircle features

The radius of a semi-circular feature which connects parallel lines is indicated using one of the following methods depending on the design function:

- where the dimension of the radius can be derived from other dimensions, it may be indicated with a radius arrow and the symbol R without any presentation of the value (see [Figure 47](#));
- NOTE Alternatively, the symbol R can be indicated with a value as an auxiliary dimension, i.e. R(8).
- by specifying the dimension for the location of the centre of the radius and directly specifying the radius value (see [Figure 48](#)).

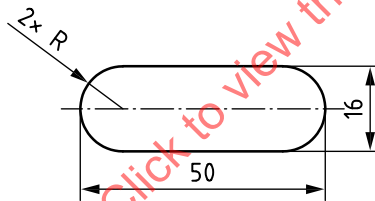


Figure 47

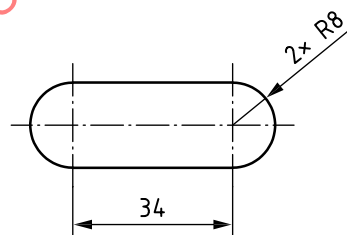


Figure 48

7.3.4 Combined radii presentation

The dimension lines for two or more radii of the same magnitude may be combined (see [Figures 49](#) and [50](#)).

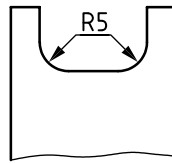


Figure 49

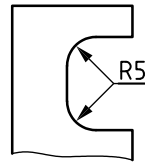


Figure 50

7.4 Spheres

Spherical shapes shall be indicated by the symbols $S\phi$ for diameter and SR for radius. The symbol used shall precede the dimensional value (see [Figures 51](#) and [52](#)).

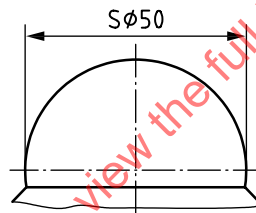


Figure 51

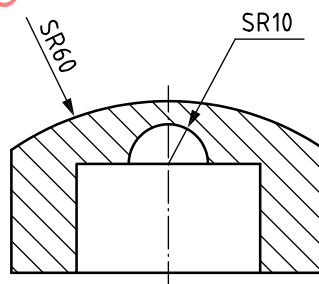


Figure 52

7.5 Between

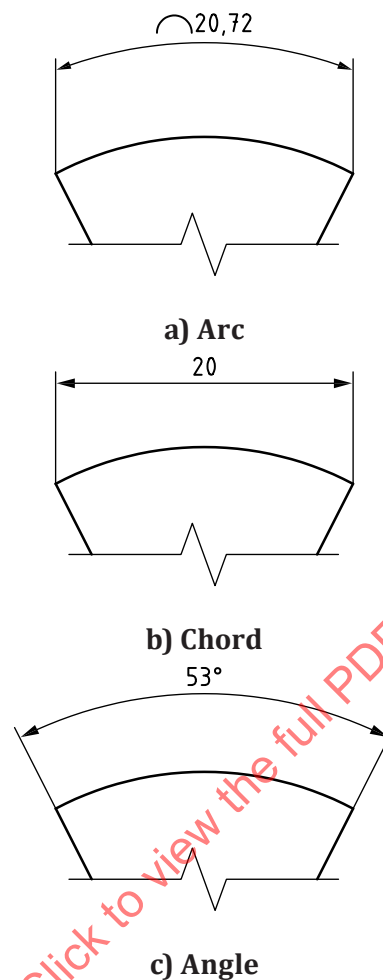
Where the limits of a feature characteristic may be ambiguous, i.e. the extent of surface treatment, the property indicator between symbol (see [5.2](#), [Table 1](#)) and associated annotation may be used to clarify the requirement. In this case, leader lines, reference lines (if required) and letters are presented to identify the extent (start and finish point) of the feature characteristic. The specification of the feature characteristic should be presented on the drawing (near the feature) followed by the first letter, a space, the between symbol, a space then the second letter A ↔ B (see [Figures 54](#) and [81](#)).

7.6 Arcs, chords and angles

The dimensioning of arcs, chords and angles shall be as shown in [Figure 53](#). The graphical symbol of an arc \frown [see [Figure A.1 g](#))] shall precede the dimensional value.

[Figure 53](#) shows the indications of an arc length, chord length and angular distance illustrated for the same part.

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**Figure 53**

In the case of angles less than and including 90° , the extension lines shall be drawn parallel to the bisecting line of the angle. Each arc dimension shall be indicated with its own extension lines.

The extension lines for dimensioning arc or chord length shall point to the centre of the arc. If the relation between the arc length and the dimensional value is ambiguous, it shall be indicated by a leader line and a reference line, terminated by an arrowhead at the arc length to be dimensioned (see [Figure 54](#)).

Alternatively, the application of the between symbol and associated annotation (see [7.5](#)) may also be used to identify the start and finish point of the dimension. In this application, the start and finish point of the arc or chord length are explicitly indicated and dimensioned (see [Figure 54](#)).

Linear or angular dimensions of arcs are indicated on a dimension line between two extension lines (see [Figure 54](#)).

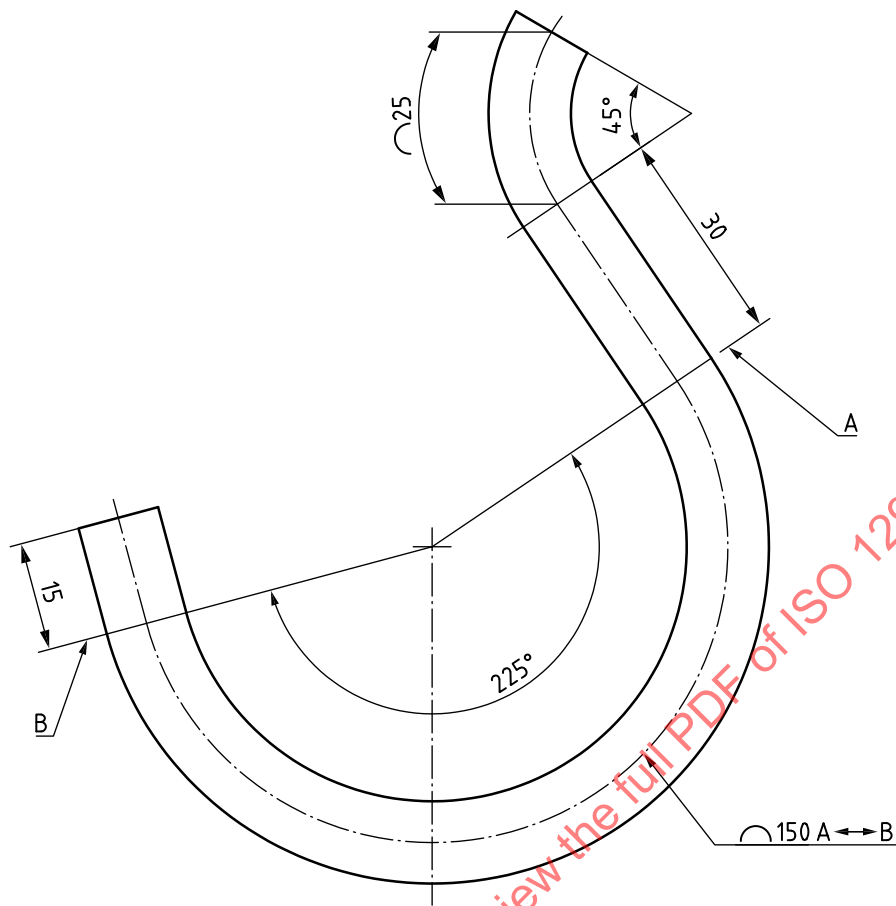


Figure 54

7.7 Squares

The graphical symbol \square shall be indicated where a square feature is shown as a square in the projection plane or at right angle to the projection plane. The graphical symbol \square shall precede the dimensional value. If the tolerances are the same for both sides of the square, the square may be dimensioned by only dimensioning one side of the square (see [Figures 55, 56 and 57](#)).

NOTE The presentation of flat surfaces, [Figures 4, 55 and 56](#), are described in ISO 128-34.

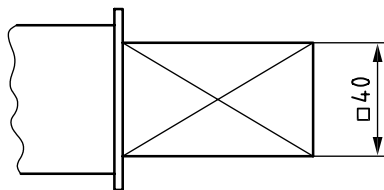


Figure 55

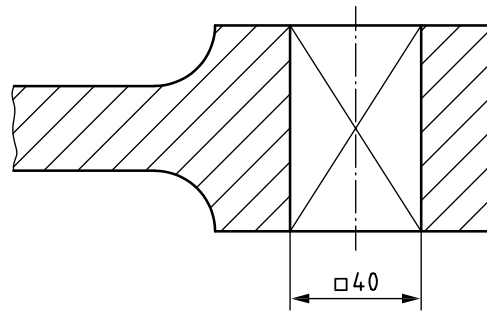


Figure 56

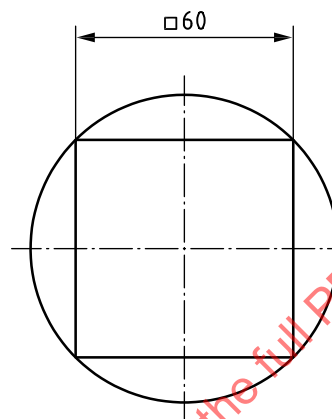


Figure 57

7.8 Equally spaced and repeated features

7.8.1 Equally spaced features

Where features have the same spacing and are uniformly arranged, their dimensioning may be simplified as follows:

Repeated linear and angular spacing may be indicated with the number of spacings and their dimensional value separated by the symbol "×" (see 4.1.2). The number of spacings shall directly precede the symbol × without space and the dimensional value shall be preceded by a space, e.g. 17× 18. If there is any risk of confusion between the length of the space and the number of spacings, one space may additionally be dimensioned as an auxiliary dimension (see 4.1.4, and 7.12 and Figure 58).

The sum of the linear or angular spacing of the indicated features is an auxiliary dimension (see 4.1.4 and 7.12 and Figures 58, 59 and 66). The total representation is to be indicated as the number of spacing multiplied by the dimensional value of the spacings and the sum given in parenthesis preceded by the equal sign. A space should separate the dimensional value and the sum.

Where repeated features are duplicated, the number of groups and symbol "× /" shall precede the number of spacings and their dimensional value as shown in Figure 66.

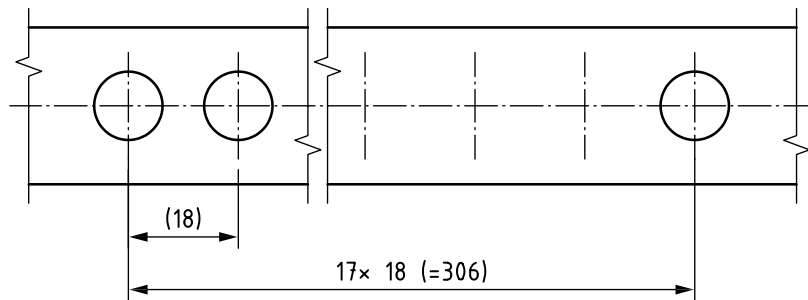


Figure 58

Angular spacing may be dimensioned as shown in [Figure 59](#).

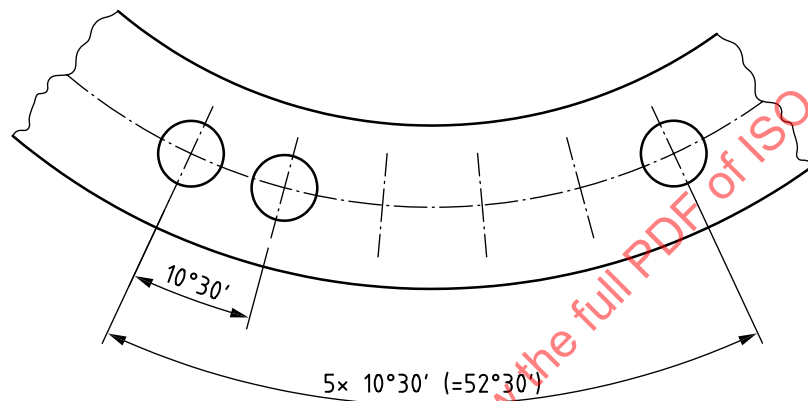


Figure 59

For equally spaced features on a circle, the angular spacing may be omitted where the spacing is self-evident and the presentation does not lead to confusion (see [Figure 60](#)).

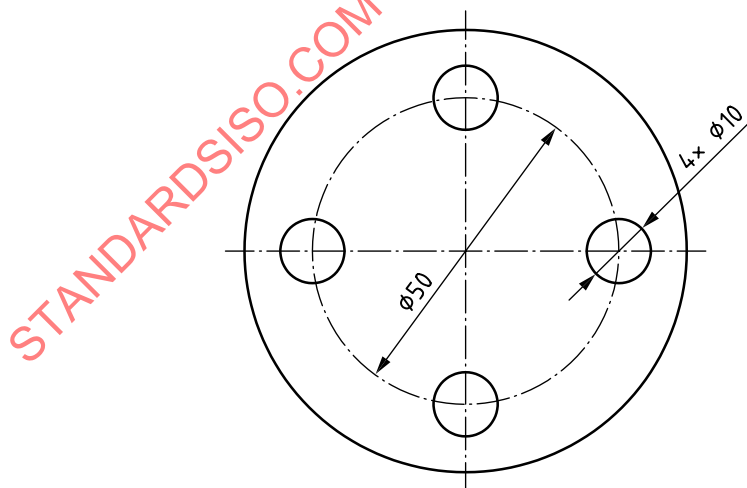


Figure 60

Circular spacings may be dimensioned by indicating the dimensions and the number of features (see [Figure 61](#)).

NOTE See [Annex C](#) for former practice for circular spacings.

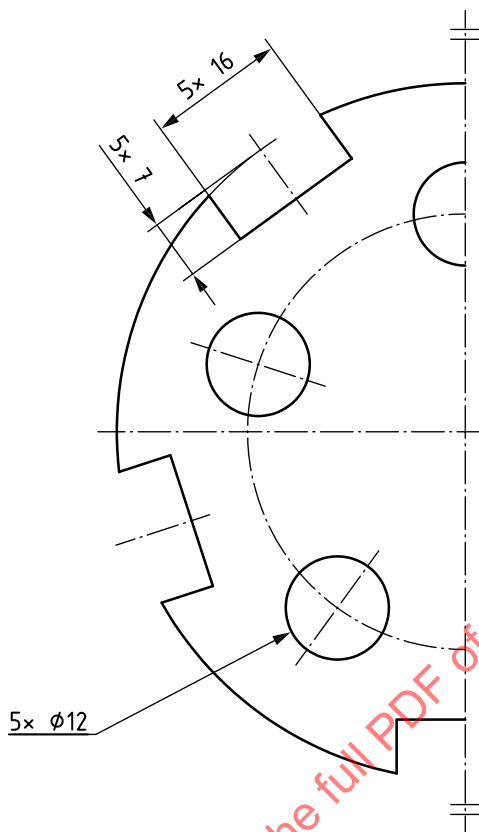


Figure 61

7.8.2 Repeated features

Where clarity is not impaired, features having the same dimensional value may be indicated by that value preceded by the number of features and the symbol “x”. The number of features shall directly precede the symbol “x” without a space and the dimensional value shall be preceded by a space after the symbol “x” (see [Figures 62](#) and [63](#)).

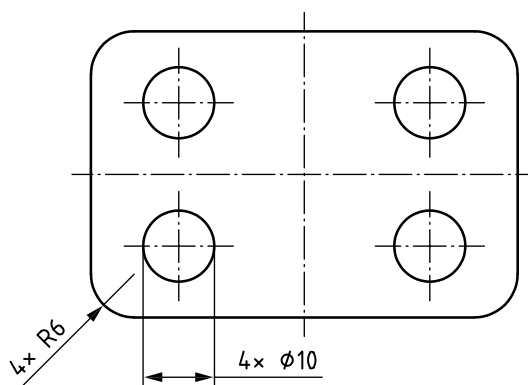


Figure 62

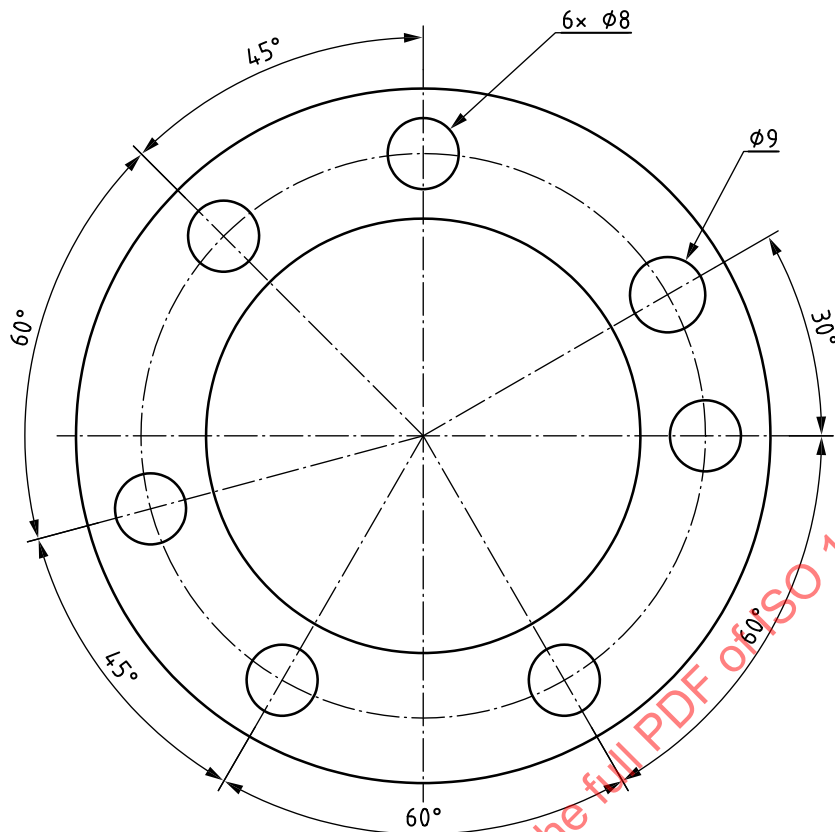
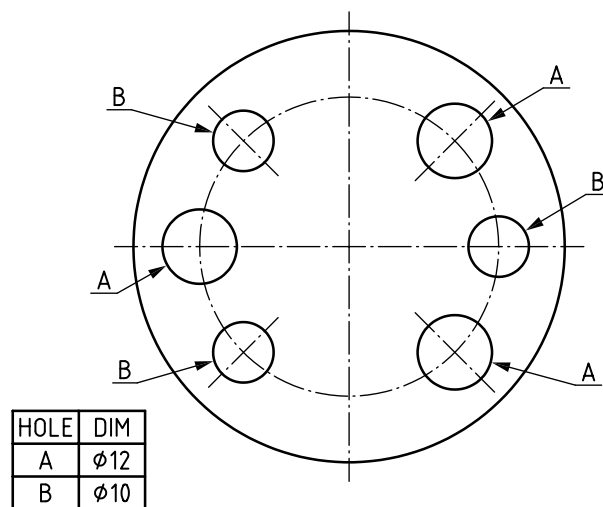


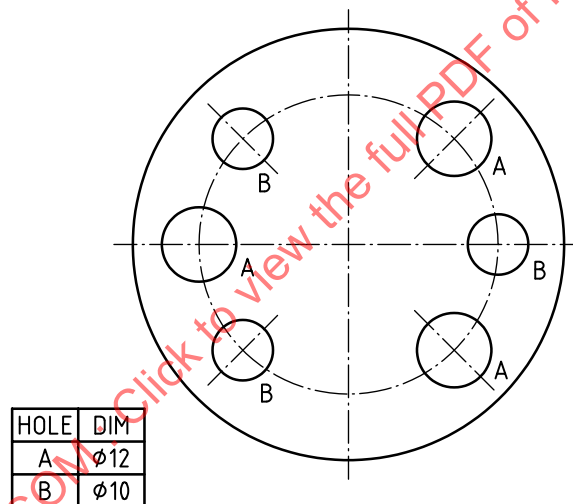
Figure 63

7.8.3 Tabulated repeated features

To avoid repeating the same dimensional value or to avoid long leader lines, reference letters may be used in conjunction with an explanatory table or note (see [Figure 64](#)). The reference letters for the features may be placed on leader lines as shown in [Figure 64 a](#)), or placed adjacent to the features without leader lines as shown in [Figure 64 b](#)).



a)



b)

Figure 64

7.9 Symmetrical workpieces and views

The dimensions of symmetrically arranged features shall be indicated once only (see 4.1.6 and Figures 65, 66 and 67). The total number of repeated dimensions shall be indicated, followed directly (i.e. without a space) by the symbol “x” and followed by the indication of the dimension preceded by a space, e.g. 6x R8.

Usually, the line of symmetry of features shall not be dimensioned (see Figures 65 to 67).

In the case of half or quarter representations, and if also required in the case of full representations, a symmetry symbol (see ISO 128-30) shall be indicated at both ends of the line of symmetry (see Figures 65 to 67).

In the case of half or quarter representations, the dimension lines that need to cross the line of symmetry shall extend past the axis of symmetry; the second termination shall then be omitted (see Figures 65 to 67).

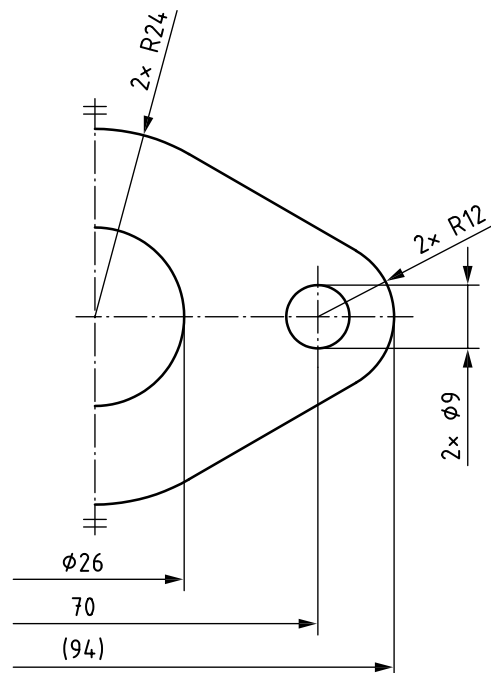


Figure 65

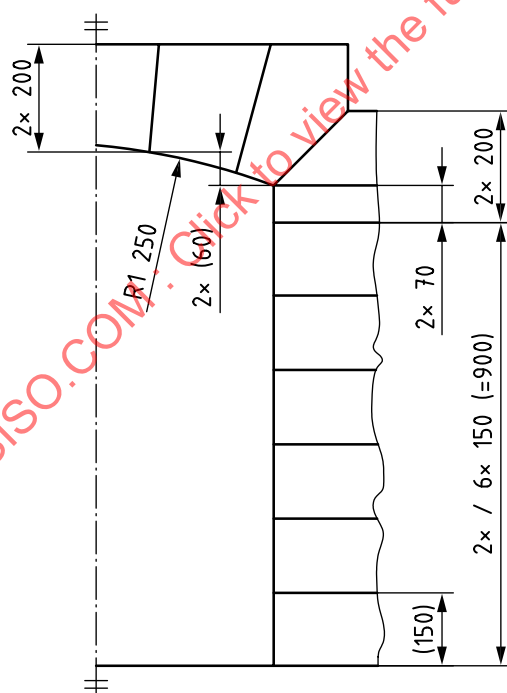


Figure 66

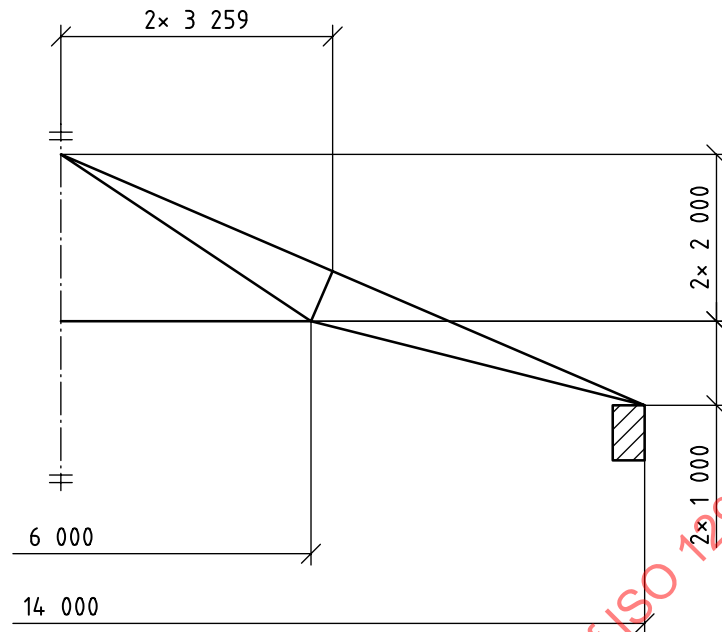


Figure 67

Aside from the presentation of dimensions, other requirements for symmetrical features shall be indicated only once in symmetrical views (e.g. presentations of surface texture, edges of undefined shape and geometrical specifications such as form, orientation and location). The total number of requirements shall be indicated by using the “n×” symbol.

7.10 Presentation of levels

The presentation of levels are generally used in construction type activities and refer to a distance from a known datum (often finished floor level).

Levels on vertical views, sections and cuts shall be indicated by a vertical leader line terminated with an open 90° arrowhead connected with horizontal reference lines, above which the numerical value of level is placed (see [Figure 68](#)). The length of the 90° elements of the arrow head should be at least 10× the line width.

Levels for specified points on horizontal (planes) views and sections shall be indicated by a numerical value of the level placed above a reference line connected to the point indicated by “X” (see [Figure 69](#)). The length of the crossed lines should be at least 20× the line width.

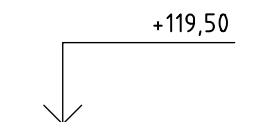


Figure 68

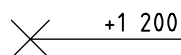


Figure 69

7.11 Dimensions of out-of-scale represented features

The dimensions for out-of-scale represented features shall be marked by underlining the dimensional value with a narrow line according to ISO 128-20 (see 4.1.3 and Figure 70). Out-of-scale represented features should only be used in exceptional cases, e.g. modifications to an existing drawing where recreating the drawing is not practical.

Out-of-scale dimensions shall not be used in 3D models (see ISO 16792).

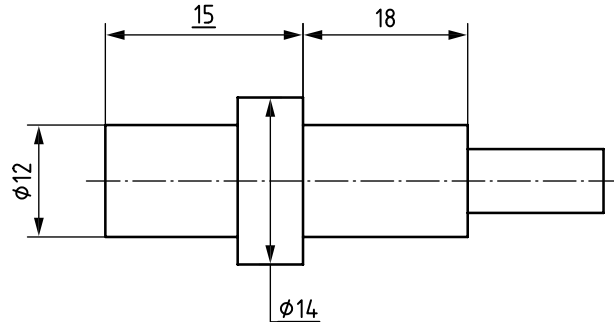


Figure 70

7.12 Auxiliary dimensions

Auxiliary dimensions (see 4.1.4) are presented for information purposes only. Generally, they can be derived from other dimensions (see Figures 65 and 66).

An auxiliary dimension should not be toleranced neither by an individual GPS specification nor by the mean of a general tolerancing.

7.13 Theoretical exact dimensions

When a dimension is considered to be a theoretical exact dimension (see 4.1.5), the dimension value shall be surrounded by a squared box defined by a narrow line as presented in Figure 71. A theoretical exact dimension shall never be toleranced.

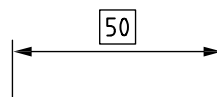


Figure 71

7.14 Dimensioning of curved features

7.14.1 Curved features defined by radii

Dimensioning of curved features defined by radii shall be indicated by a combination of dimensioned arc centres and radii values (see Figures 72 and 73).

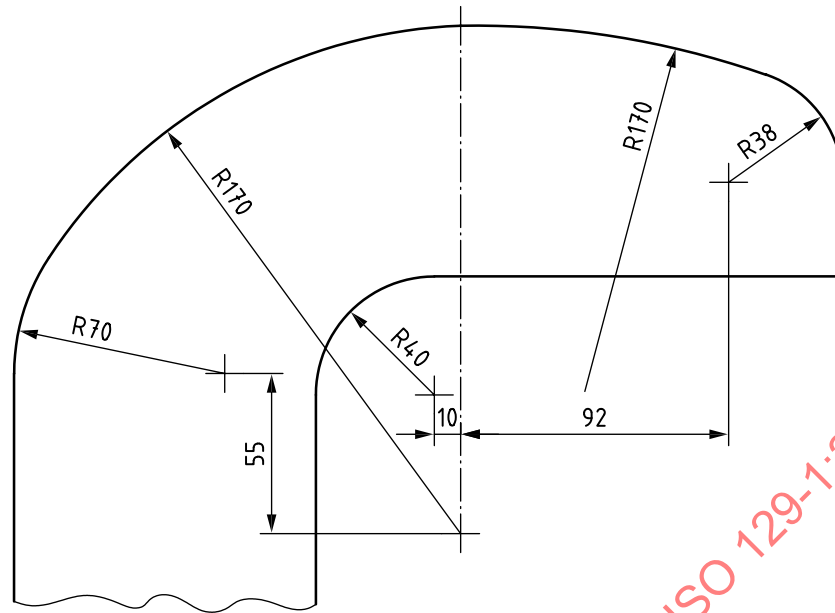


Figure 72

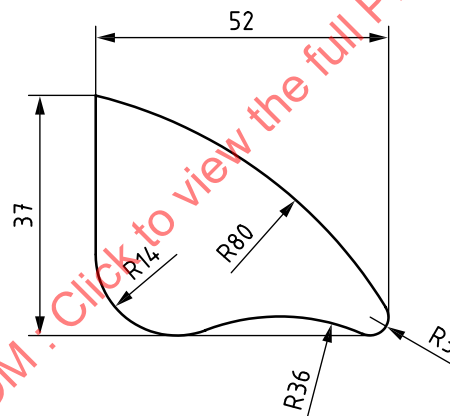


Figure 73

7.14.2 Curved features defined by coordinate dimensions

Dimensioning of curved features using Cartesian or polar coordinates shall be indicated by dimensions to points on the profile (see [Figures 74](#) and [75](#)).

Polar coordinate dimensioning of simplified running dimensions using tabulated indications is shown in [Figure 76](#).

The interpolation of points between the indicated points (e.g. by linear interpolation, spline, etc.) should be specified on the drawing (e.g. by using a flag note or other method) or associated document.

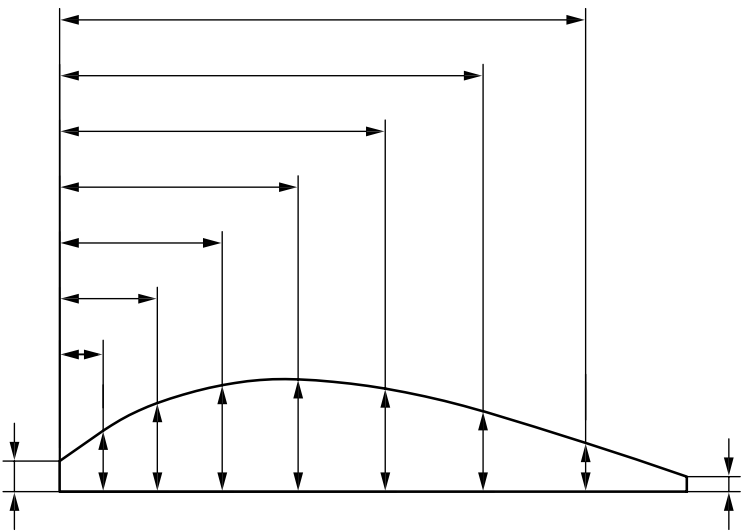


Figure 74

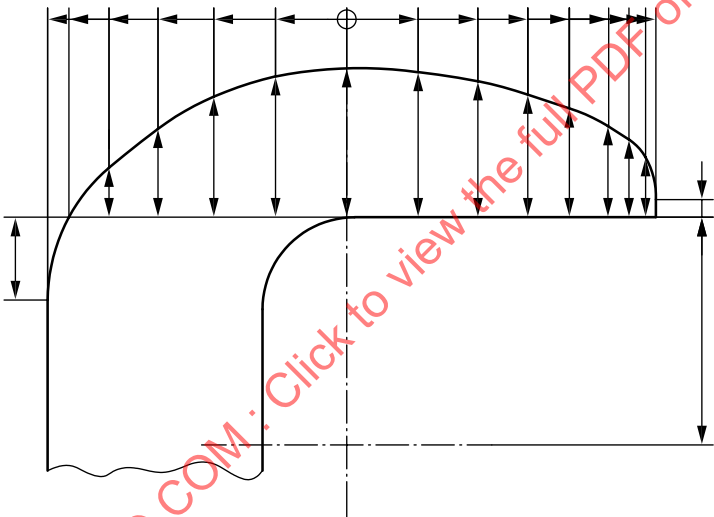
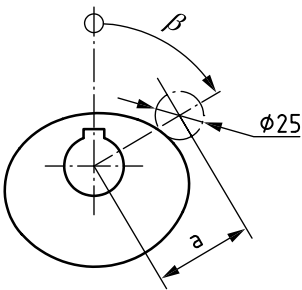


Figure 75



β	0°	20°	40°	60°	80°	100°	120–210°	230°	260°	280°	300°	320°	340°
a	50	52.2	57	63.5	70	74.5	76	75	70	65	59.5	55	52

Figure 76

7.15 Dimensioning of developed views

If it is necessary to indicate for information, the initial outline of a finished workpiece (e.g. the length of a workpiece before bending) may be presented by long dashed double-dotted narrow lines according to ISO 128-24:2014, type 05.01 and dimensioned as auxiliary dimensions; see 4.1.4, 7.12 and Figure 77 a).

Where the initial outline is not represented, the symbol for developed length may be used to indicate this dimension [see Figure 77 b) and c)].

The developed length symbol and dimension may be shown as an auxiliary dimension when appropriate [see Figure 77 c)].

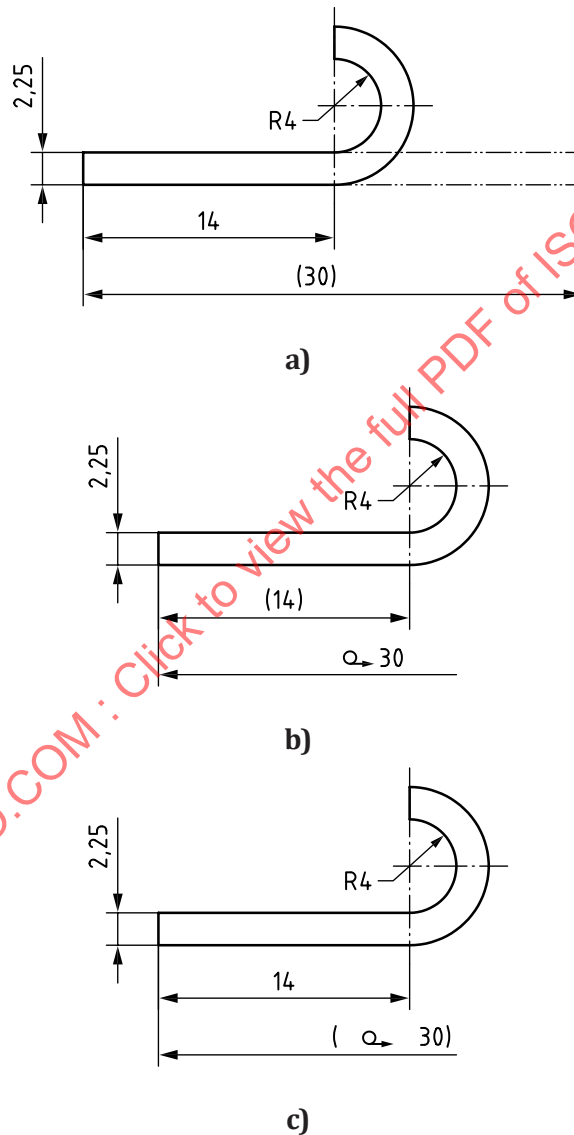


Figure 77

7.16 Dimensioning of thin parts

7.16.1 Thickness indication

The thickness of a part may be indicated by the symbol "t=" followed by the thickness dimension attached to one surface with a leader line terminated with a point [see Figures 78 a) and b)].

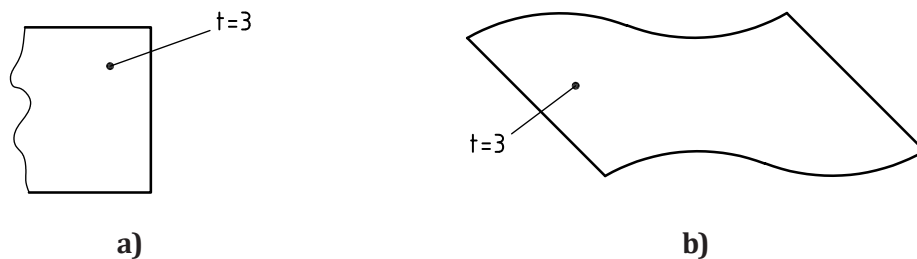


Figure 78

7.16.2 Surface indication

When thin parts according to ISO 128-50 are dimensioned, a surface indicator symbol shall be added to the wide line representing the section to indicate which surface is being dimensioned (see [Figures 79](#) and [80](#)). This symbol is composed of a short line segment which represents the non-dimensioned or non-modelled surface(s). When the surface indicator is composed of two short line segments, then the dimension applies to the median surface.

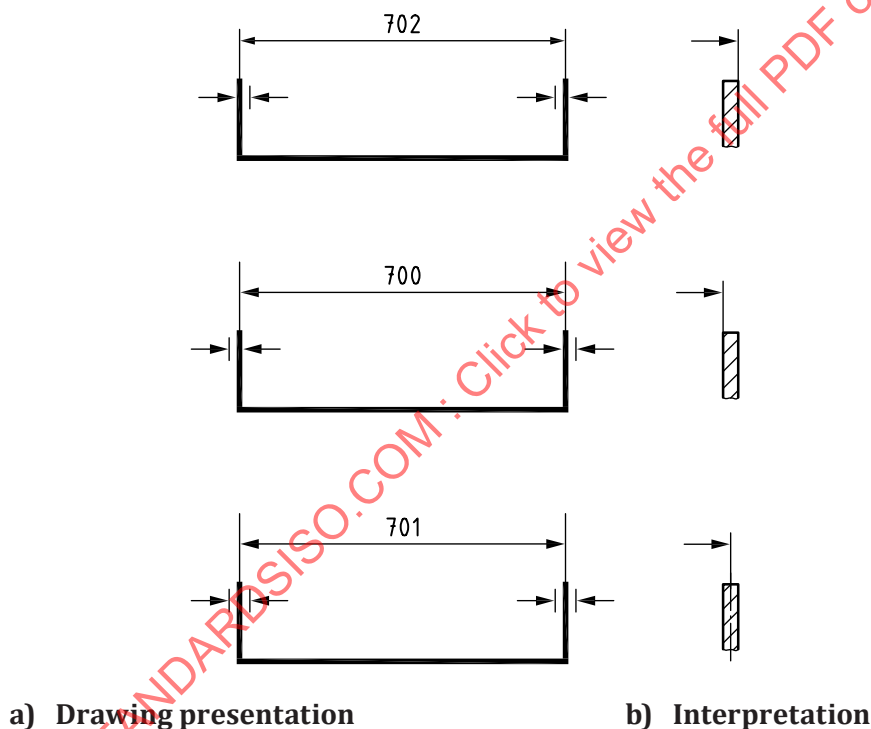


Figure 79

The symbology as specified above may be straight forwardly applied to curved surfaces. When a surface indicator symbol is indicated on a curved surface, it applies to the whole surface and not the individual feature where it is attached (see [Figure 80](#)).

For the dimensioning of the whole surface, consideration should be given to using the “Between” symbol and associated annotation if there is any ambiguity; see [7.5](#), [Table 1](#) and [Figures 54](#) and [81](#) for examples.

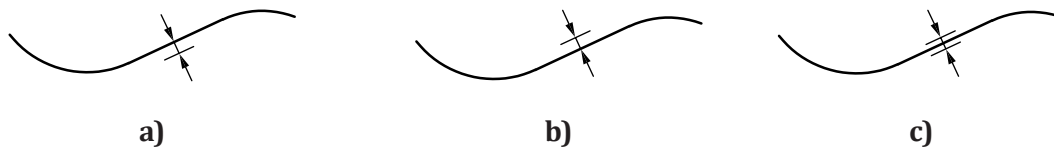


Figure 80

7.17 Dimensioning of restricted areas

7.17.1 General Rules

When dimensioning a restricted area of a surface to indicate a condition or specification, the area and its location shall be presented as a long dashed dotted wide line in accordance with ISO 128-24:2014, type 04.2.

7.17.2 Dimensioning of restricted areas on surfaces of revolution

Where the location and extent of a requirement applies to a restricted portion of a feature, appropriate dimensioning is necessary (see [Figure 81](#)). The line indicating the area shall be drawn adjacent and parallel to the surface at a short distance from it.

When the requirement applies to the entire circumference of the surface, only the length of the area needs to be indicated, and it shall be shown only once (see [Figure 81](#)).

If there is any ambiguity in specifying the restricted area, the use of the “Between” symbol and associated annotation should be considered [see [Z5](#), [Table 1](#) and [Figure 81](#) b)].

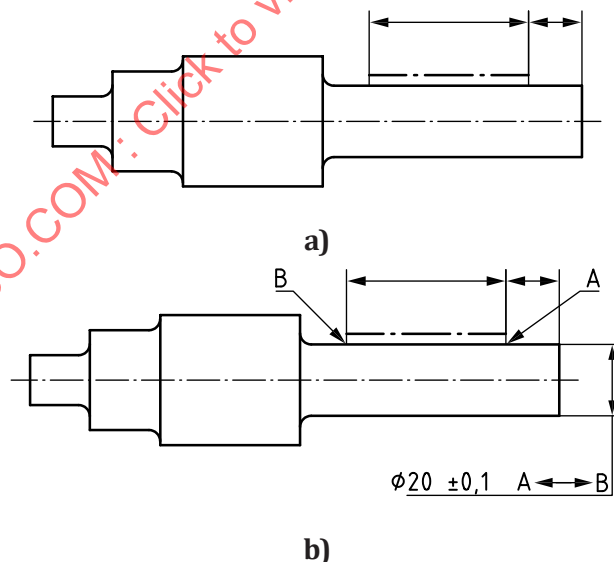


Figure 81

When the requirement applies to a restricted area of the cylindrical feature, the angular extent shall be dimensioned in a separate view (see [Figure 82](#)).

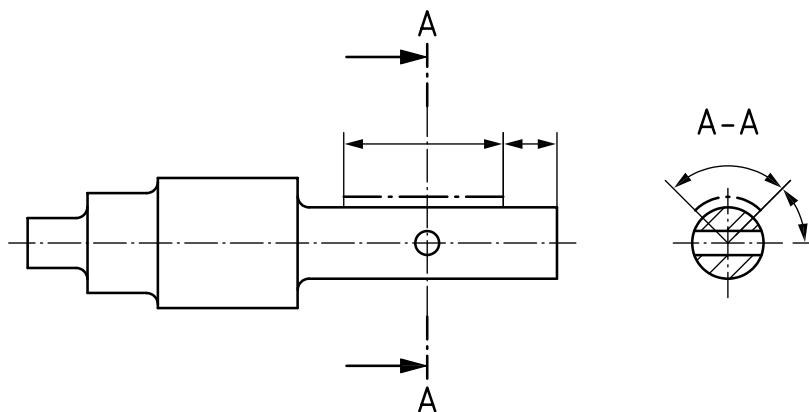


Figure 82

7.17.3 Dimensioning of restricted areas on other than surfaces of revolution

The extents of the area shall be dimensioned as needed based on the shape. The outline of the area is depicted and the area should be emphasized, e.g. by hatching (see [Figure 83](#)).

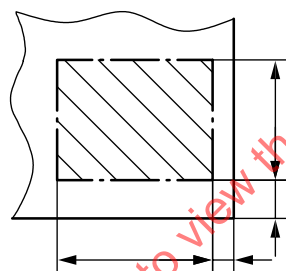


Figure 83

Where the drawing clearly shows the extent and location of the indicated restricted area, dimensioning of the restricted area is not necessary (see [Figure 84](#)).

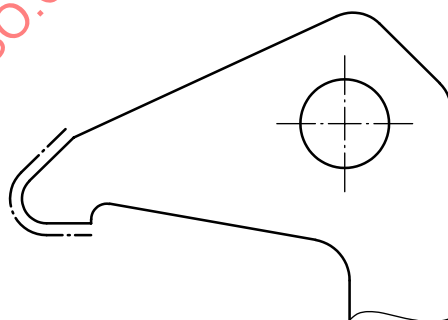


Figure 84

If there is any ambiguity in specifying the restricted area, the use of the “Between” symbol and associated annotation should be considered (see [7.5](#), [Table 1](#) and [Figure 81 b](#)).

NOTE For further specification of restricted areas, see ISO 1101 and ISO 14405-1.

8 Arrangements of dimensions

8.1 General

The arrangement of dimensions on a drawing shall indicate clearly the design purpose. Generally, the arrangement of dimensions is the result of a combination of various design requirements.

Dimension lines shall be arranged as parallel, chain or running dimensioning or in combination.

8.2 Chain dimensioning

When using chain dimensioning, chains of single dimensions are arranged in a row (see [Figure 85](#)).

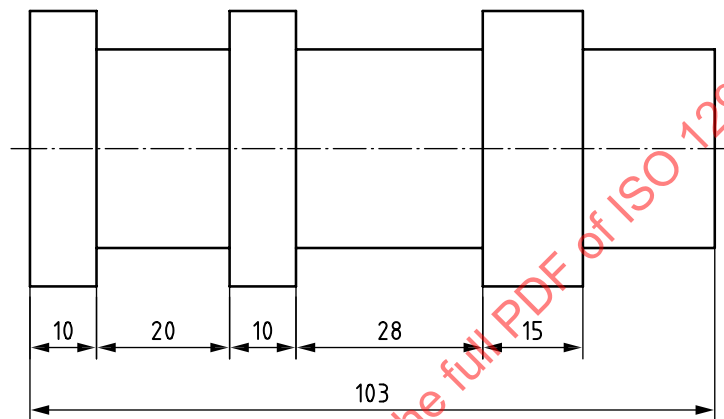


Figure 85

8.3 Parallel dimensioning

When using parallel dimensioning, the dimension lines are drawn parallel in one, two or three orthogonal directions or concentrically (see [Figures 86](#) and [87](#)).

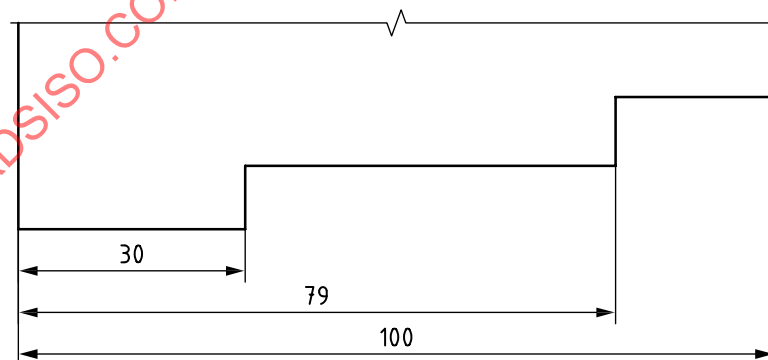


Figure 86

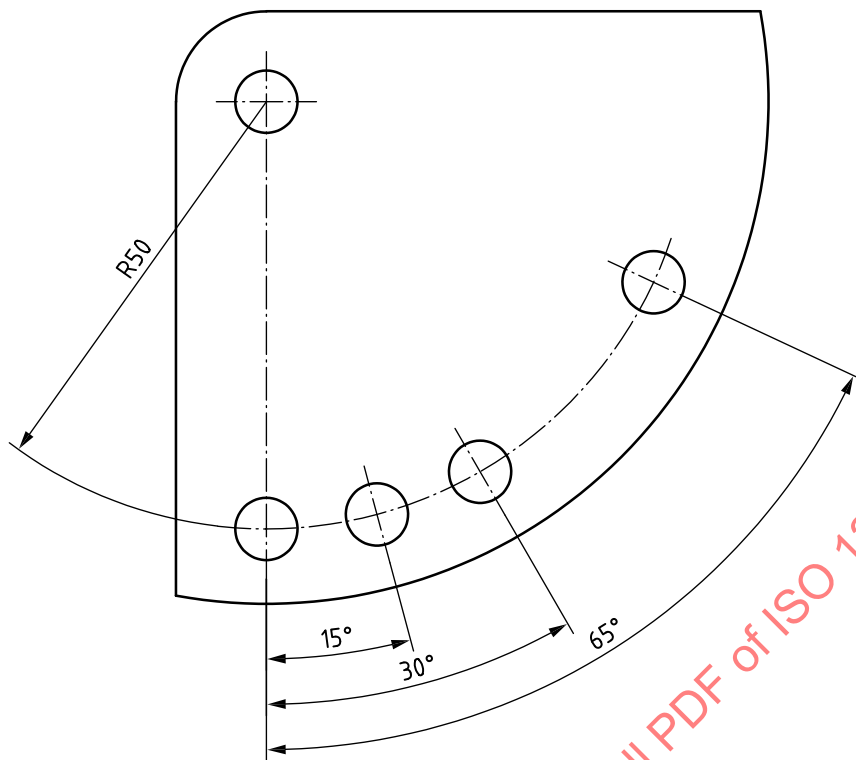


Figure 87

8.4 Running dimensioning

8.4.1 General

Running dimensioning is simplified parallel dimensioning. The origin(s) of the dimension line(s) are indicated in accordance with 5.4.2 (see Figures 88 to 92).

Dimensional values are placed near the terminator, remote from the origin, and may be either

- in line with the corresponding extension line [see Figures 88, 89, 90 a) and 92], or
- above and clear of the dimension line (see Figure 91).

An alternate representation of running dimensions may be used where

- the start of running dimensioning shall be indicated by using the origin symbol in an appropriate location (see Figures 88 and 89), and
- the dimension values are shown on abbreviated dimension lines, where only one arrow is used directed to the feature to which the dimension value applies [see Figure 90 b)].

Where there is no ambiguity, running dimensions may be simplified with the dimensions placed on a common reference line (see Figure 93).

8.4.2 Unidirectional and bidirectional running dimensions

Unidirectional running dimensioning uses one origin and one set of dimension lines aligned in the same direction (see Figure 88).

Bidirectional running dimensioning uses one origin and two sets of dimension lines aligned in opposite directions (see Figure 89).

Unidirectional and bidirectional running dimensioning in more than one orientation can be indicated on a drawing [see [Figures 90 a\)](#) and [b\)](#), [91](#) and [92](#)].

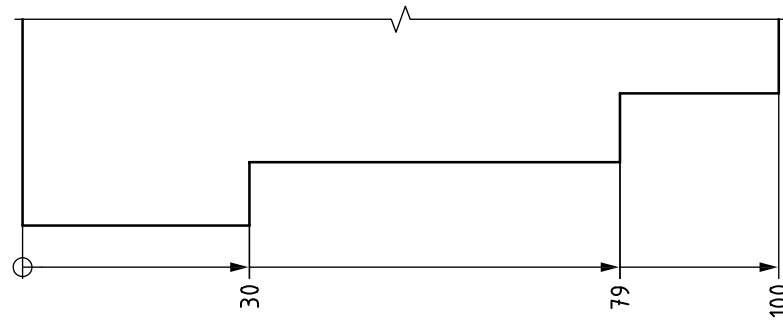


Figure 88

NOTE The use of the origin symbol does not imply a datum; consequently, there are no dimensioning differences between [Figures 86](#) and [88](#).

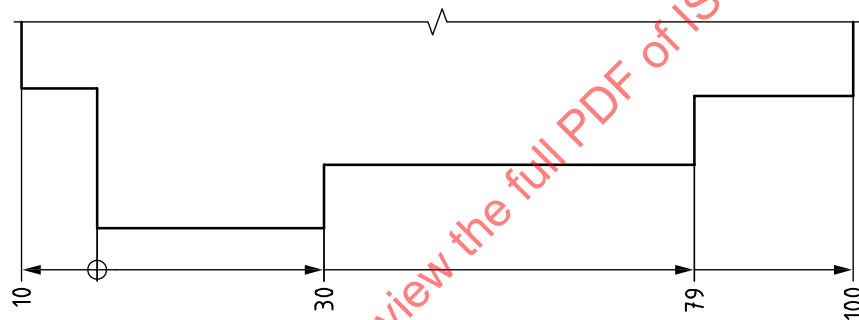
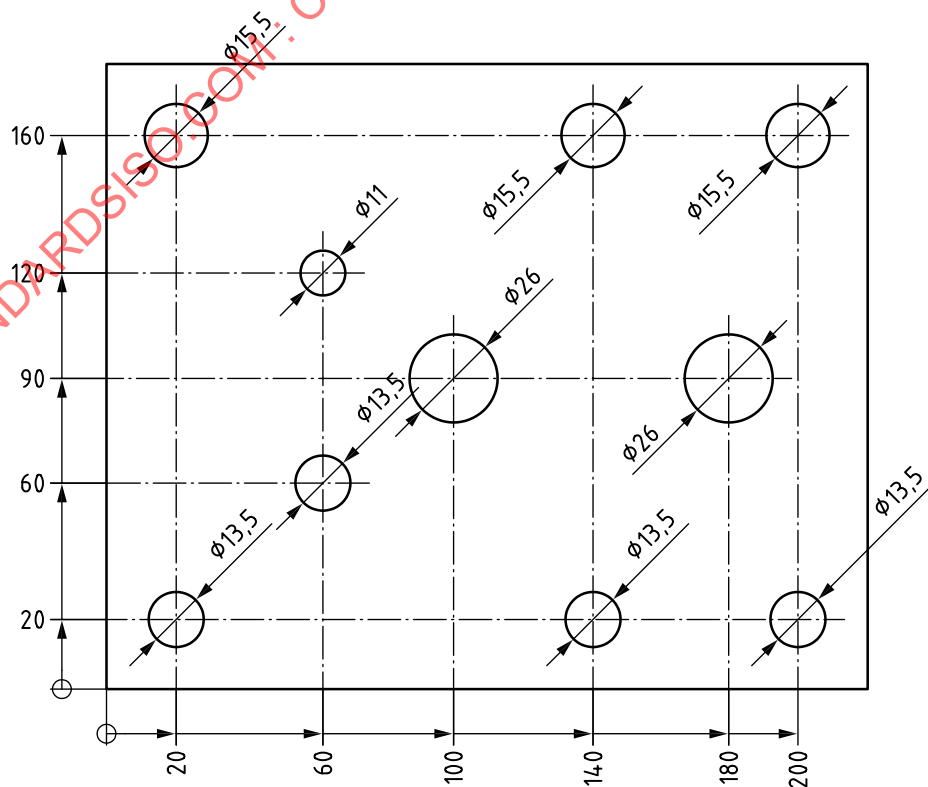
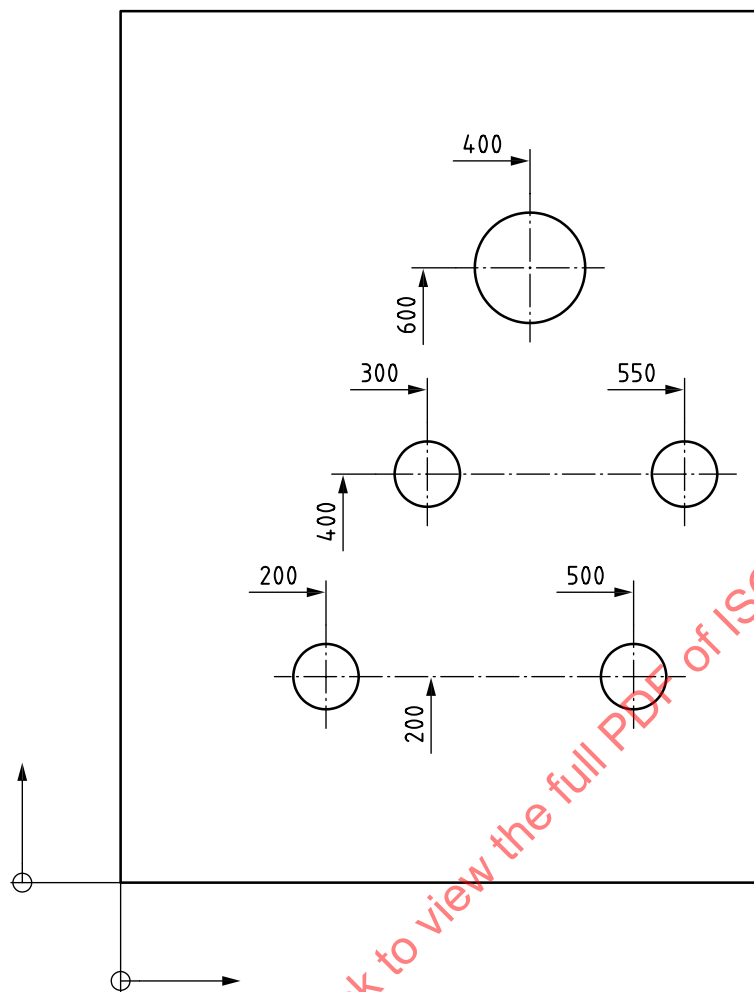


Figure 89



a)



b)

Figure 90

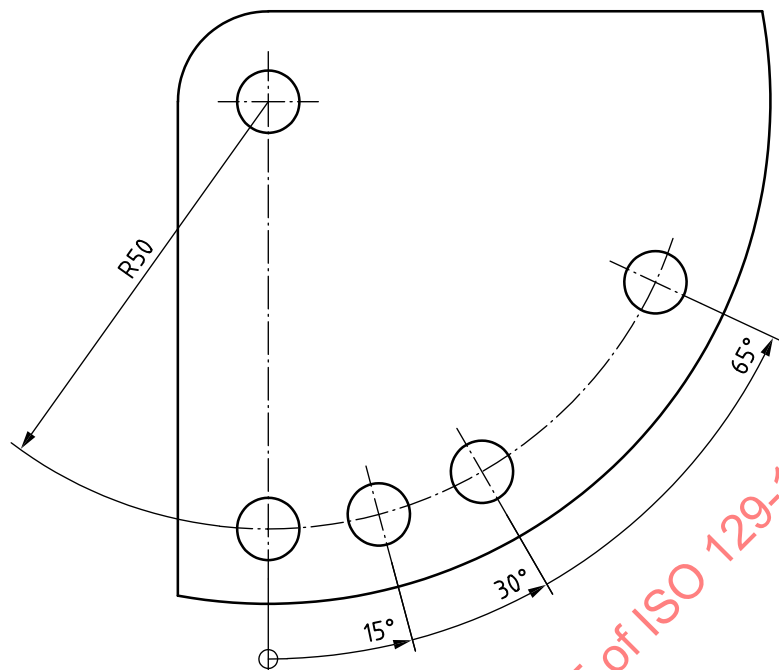


Figure 91

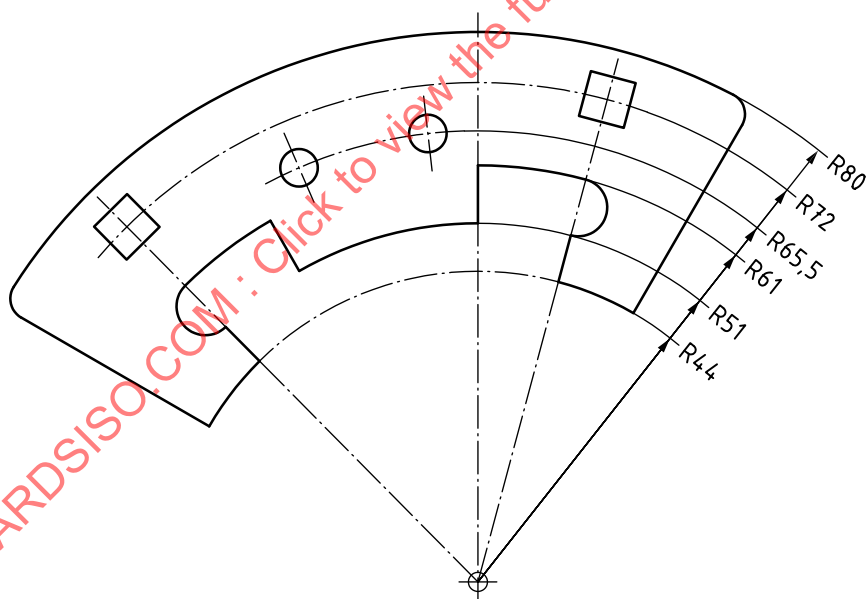


Figure 92

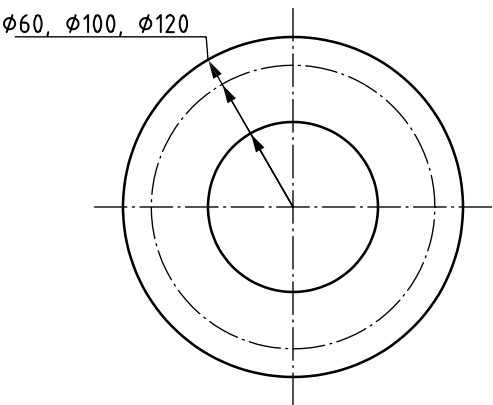


Figure 93

8.5 Coordinate dimensioning

8.5.1 Cartesian coordinate dimensioning

Cartesian coordinates are defined starting from the origin by linear dimensions in orthogonal directions (see Figures 94 and 96). Neither dimension lines nor extension lines are drawn.

The positive and negative directions of the coordinate axes are shown in Figure 95. The dimensional values indicated in the negative directions shall have negative signs.

The origin used for coordinate dimensioning shall be indicated (see Figures 94 and 96).

The coordinates may be indicated by a reference letter which appears in a table together with the value of the coordinate (see Figure 94) or by the direct presentation of the coordinates (see Figure 96). The reference letters or the coordinate value may be placed adjacent to the coordinate location or indicated using a leader line. Designations for position may be numerical or alphanumerical.

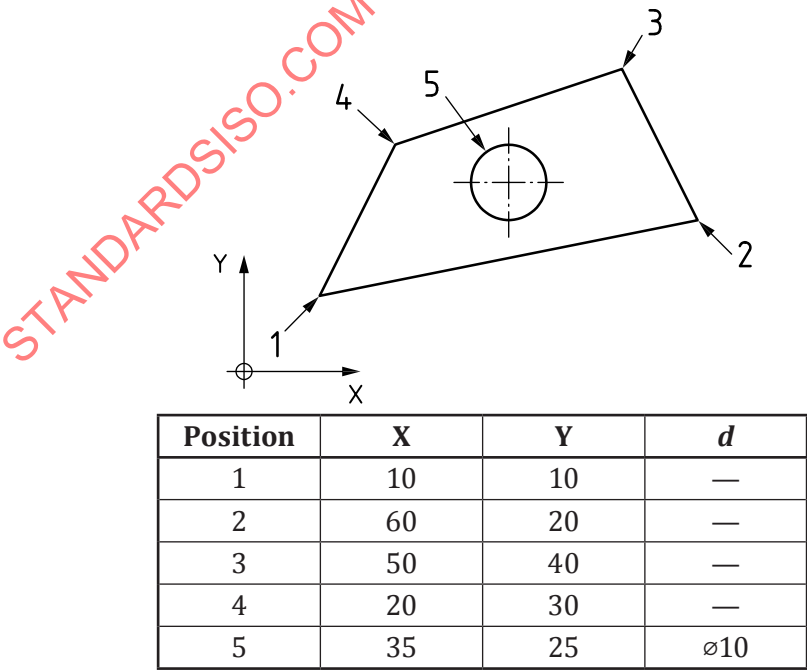


Figure 94

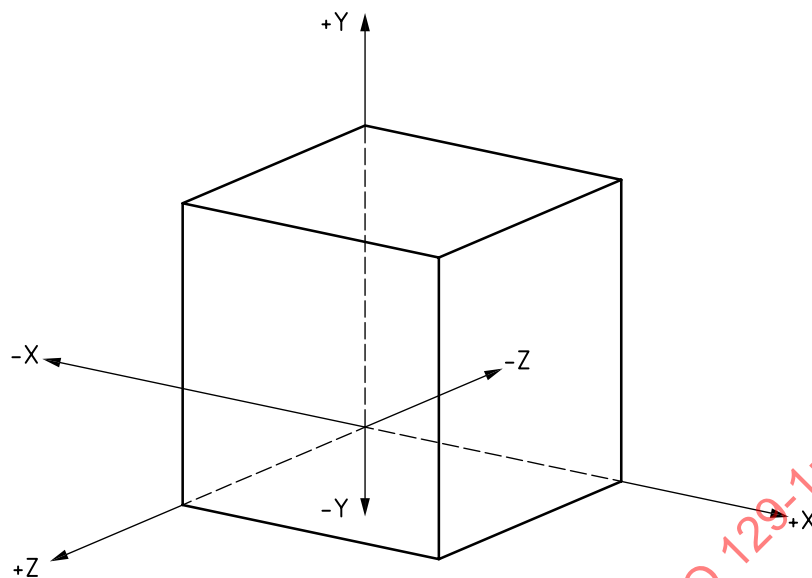


Figure 95

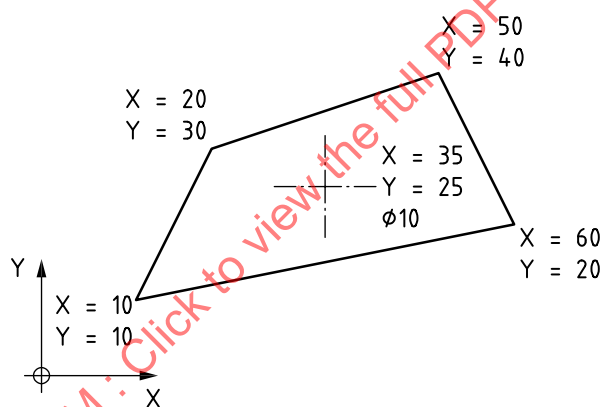
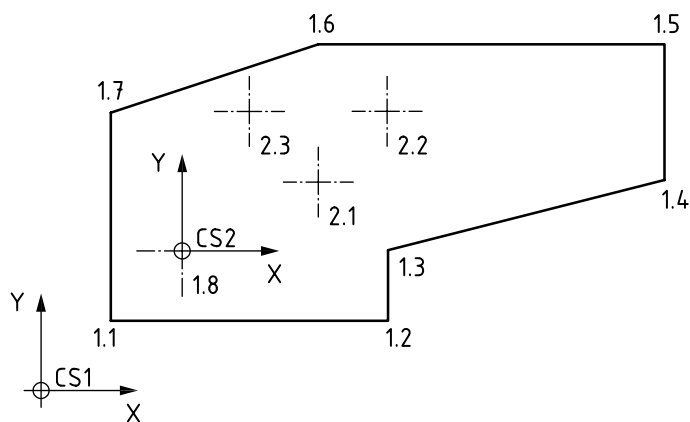


Figure 96

The main coordinate system may have subsystems. If this is the case, the coordinate system number and the specific positions shall be numbered continuously by Arabic numbers. A point shall be used as a separation symbol (see [Figure 97](#)).



Coordinate system number	Position	X	Y	d
1	1.1	10	10	—
1	1.2	50	10	—
1	1.3	50	20	—
1	1.4	80	30	—
1	1.5	80	50	—
1	1.6	30	50	—
1	1.7	10	40	—
1	1.8	20	20	ø10
2	2.1	20	10	ø5
2	2.2	30	20	ø10
2	2.3	10	20	ø5

Figure 97

8.5.2 Polar coordinate dimensioning

Polar coordinates are defined starting from the origin of the radius and angle. They shall always be indicated counter-clockwise relative to the polar axis. The point may be indicated by 90° crossed narrow lines (see [Figure 98](#)). The length of the crossed lines should be at least 20× the line width.