Technical drawings — Dimensioning — General principles, definitions, methods of execution and special indications

1 Scope and field of application

This International Standard establishes the general principles of dimensioning applicable in all fields (i.e., mechanical, electrical, civil engineering, architecture, etc.). It is possible that in some specific technical areas, the general rules and conventions will not cover all the needs of specialized practices adequately. In such cases additional rules may be laid down in standards specific to these areas. However, the general principles of this International Standard shall be followed to facilitate the international exchange of drawings and to ensure the coherence of drawings in a comprehensive system relating to several technical fields.

The figures, as shown in this International Standard, merely illustrate the text and are not intended to reflect actual usage. The figures are consequently simplified to indicate only the relevant general principles applicable in any technical area.

2 References

ISO 128, *Technical drawings — General principles of presentation.*

ISO 406, *Technical drawings — Linear and angular tolerancing — Indications on drawings.*

ISO 1660, *Technical drawings — Dimensioning and tolerancing of profiles.*

ISO 2595, *Building drawings — Dimensioning of production drawings — Representation of manufacturing and work sizes.*

ISO 3040, *Technical drawings — Dimensioning and tolerancing cones.*

ISO 3098/1, *Technical drawings — Lettering — Part 1: Currently used characters.*

ISO 6428, *Technical drawings — Requirements for microcopying.*

3 General principles

3.1 Definitions

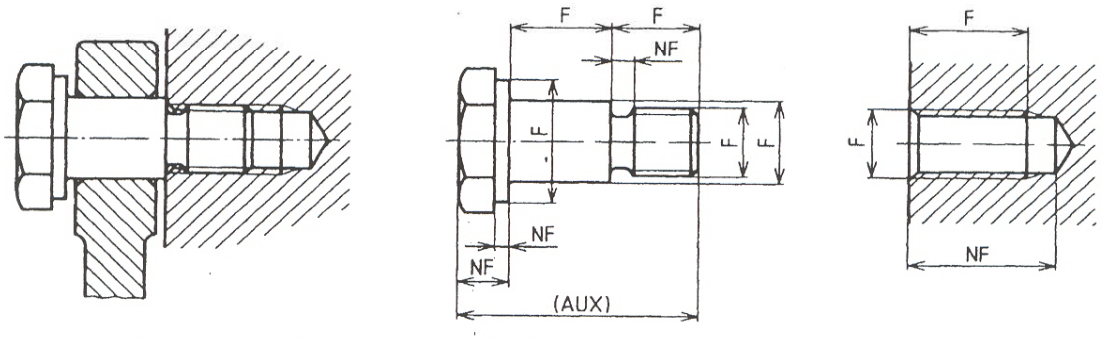
For the purposes of this International Standard, the following definitions apply.

3.1.1 dimension: A numerical value expressed in appropriate units of measurement and indicated graphically on technical drawings with lines, symbols and notes.

Dimensions are classified according to the following types:

3.1.1.1 functional dimension: A dimension that is essential to the function of the piece or space. (See "F" in figure 1.)

3.1.1.2 non-functional dimension: A dimension that is not essential to the function of the piece or space. (See "NF" in figure 1.)



a) Design requirement b) Shoulder screw c) Threaded hole

Figure 1 — Functional, non-functional and auxiliary dimensions

3.1.1.3 **auxiliary dimension**: A dimension given for information purposes only. It does not govern production or inspection operations and is derived from other values shown on the drawing or in related documents. An auxiliary dimension is given in parentheses and no tolerance applies to it. (See "AUX" in figure 1.)

3.1.2 **feature**: An individual characteristic such as a flat surface, a cylindrical surface, two parallel surfaces, a shoulder, a screw thread, a slot, a profile, etc.

3.1.3 **end product**: The complete part ready for assembly or service or a configuration produced from a drawing specification. An end product may also be a part ready for further processing (for example, the product of a foundry or forge) or a configuration needing further processing.

3.2 Application

3.2.1 All dimensional information necessary to define a part or component clearly and completely shall be shown directly on a drawing unless this information is specified in associated documentation.

3.2.2 Each feature shall be dimensioned once only on a drawing.

3.2.3 Dimensions shall be placed on the view or section that most clearly shows the corresponding features.

3.2.4 Each drawing shall use the same unit (for example, millimetres) for all dimensions but without showing the unit symbol. In order to avoid misinterpretation, the predominant unit symbol on a drawing may be specified in a note.

Where other units have to be shown as part of the drawing specification (for example, N·m for torque or kPa for pressure), the appropriate unit symbol shall be shown with the value.

3.2.5 No more dimensions than are necessary to define a part or an end product shall be shown on a drawing. No feature of a part or an end product shall be defined by more than one dimension in any one direction. Exception may, however, be made

a) where it is necessary to give additional dimensions at intermediate stages of production (for example, the size of a feature prior to carburizing and finishing);

b) where the addition of an auxiliary dimension would be advantageous.

3.2.6 Production processes or inspection methods should not be specified unless they are essential to ensure satisfactory functioning or interchangeability.

3.2.7 Functional dimensions should be shown directly on the drawing wherever possible (see figure 2).

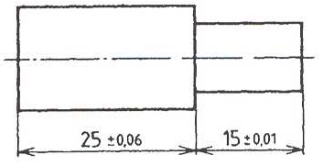


Figure 2 — Functional dimensioning

Occasionally indirect functional dimensioning is justified or necessary. In such cases, care shall be exercised so that the effect of directly shown functional dimensioning is maintained. Figure 3 shows the effect of acceptable indirect functional dimensioning that maintains the dimensional requirements established by figure 2.

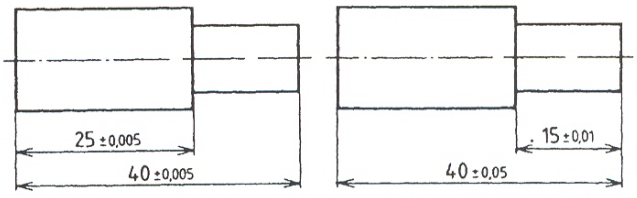


Figure 3 — Indirect functional dimensioning

3.2.8 The non-functional dimensions should be placed in a way which is most convenient for production and inspection.

4 Method of dimensioning

4.1 Elements of dimensioning

The elements of dimensioning include the projection line, dimension line, leader line, dimension line termination, the origin indication, and the dimension itself. The various elements of dimensioning are illustrated in figures 4 and 5. (See ISO 128.)

4.2 Projection lines, dimension lines and leader lines

Projection lines, dimension lines and leader lines are drawn as thin continuous lines as shown in ISO 128 and as illustrated in figures 4 and 5.

4.2.1 Projection lines shall extend slightly beyond the respective dimension line (see figures 4 and 5).

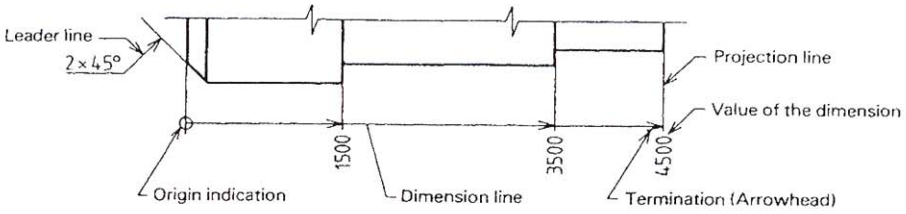


Figure 4

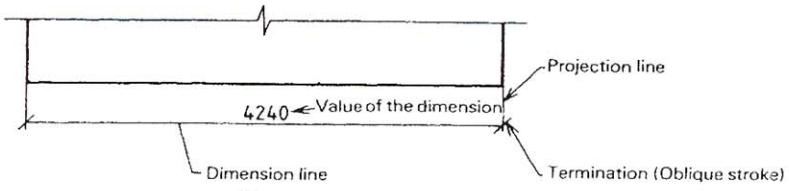


Figure 5

4.2.2 Projection lines should be drawn perpendicular to the feature being dimensioned. Where necessary, however, they may be drawn obliquely, but parallel to each other (see figure 6).

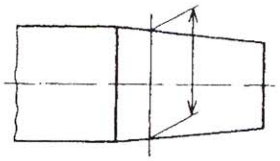


Figure 6

4.2.3 Intersecting construction and projection lines shall extend slightly beyond their point of intersection (see figure 7).

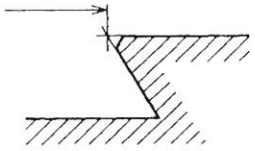


Figure 7

4.2.4 In general, projection lines and dimension lines should not cross other lines unless this is unavoidable (see figure 8).

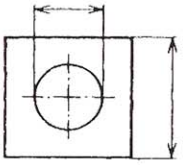


Figure 8

4.2.5 A dimension line shall be shown unbroken where the feature to which it refers is shown broken (see figure 9), except as indicated in 4.4.1, method 2.

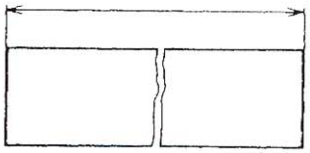


Figure 9

4.2.6 Intersecting projection and dimension lines should be avoided. Where unavoidable, however, neither line shall be shown with a break (see figure 10).

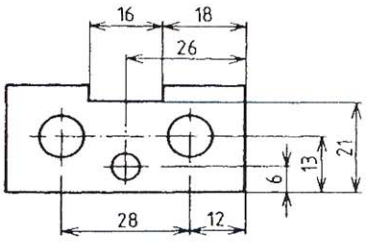


Figure 10

4.2.7 A centreline or the outline of a part shall not be used as a dimension line but may be used in place of a projection line (see figure 10).

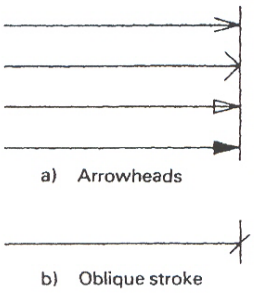
4.3 Terminations and origin indication

Dimension lines shall show distinct terminations (i.e., either arrowheads or oblique strokes), or, where applicable, an origin indication.

4.3.1 Two dimension line terminations (see figure 11) and an origin indication (see figure 12) are specified in this International Standard. They are

a) the arrowhead, drawn as short lines forming barbs at any convenient included angle between 15° and 90°. The arrowhead may be open, closed, or closed and filled in [see figure 11 a)].

b) the oblique stroke, drawn as a short line inclined at 45° [see figure 11 b)].



a) Arrowheads

b) Oblique stroke

Figure 11

c) the origin indication, drawn as a small open circle of approximately 3 mm in diameter.

Figure 12

4.3.2 The size of the terminations shall be proportionate to the size of drawing on which they are used but not larger than is necessary to read the drawing.

4.3.3 One style of arrowhead termination only shall be used on a single drawing. However, where space is too small for an arrowhead, the oblique stroke or a dot may be substituted (see figure 24).

4.3.4 Arrowhead terminations shall be shown within the limits of the dimension line where space is available (see figure 13). Where space is limited, the arrowhead termination may be shown outside the intended limits of the dimension line that is extended for that purpose (see figure 14).

Figure 13

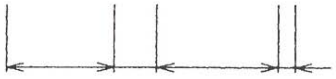


Figure 14

4.3.5 Only one arrowhead termination, with its point on the arc end of the dimension line, shall be used where a radius is dimensioned (see figure 15). The arrowhead termination may be either on the inside or on the outside of the feature outline (or its projection line) depending upon the size of the feature.

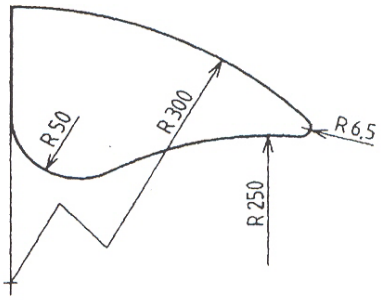


Figure 15 — Radius dimensioning

4.4 Indicating dimensional values on drawings

Dimensional values shall be shown on drawings in characters of sufficient size to ensure complete legibility on the original drawing as well as on reproductions made from microfilms.

They shall be placed in such a way that they are not crossed or separated by any other line on the drawing.

4.4.1 Values shall be indicated on a drawing according to one of the following two methods. Only one method should be used on any one drawing.

Method 1

Dimensional values shall be placed parallel to their dimension lines and preferably near the middle, above and clear of the dimension line (see figure 16).

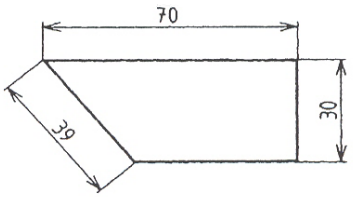


Figure 16

An exception may be made where superimposed running dimensions are used (see 5.2.2).

However, values shall be indicated so that they can be read from the bottom or from the right-hand side of the drawing. Values on oblique dimension lines shall be oriented as shown in figure 17.

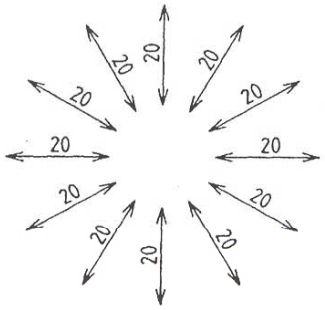


Figure 17

Angular dimensional values may be oriented either as in figure 18 or figure 19.

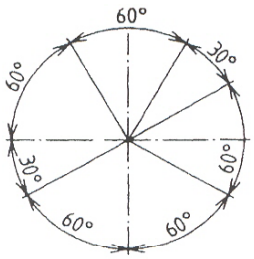


Figure 18

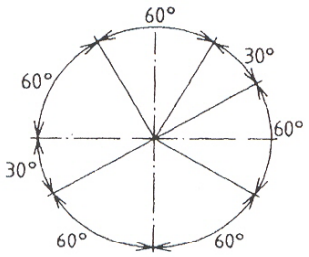


Figure 19

Method 2

Dimensional values shall be indicated so that they can be read from the bottom of the drawing sheet. Non-horizontal dimension lines are interrupted, preferably near the middle so that the value can be inserted (see figures 20 and 21).

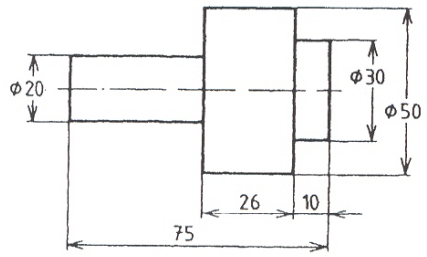


Figure 20

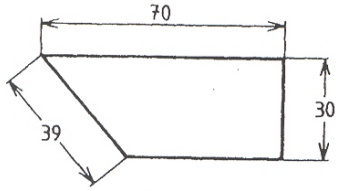


Figure 21

Angular dimensional values may be oriented either as in figure 19 or figure 22.

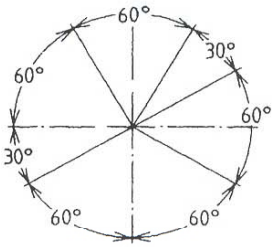


Figure 22

4.4.2 The positioning of dimensional values frequently needs adapting to different situations. Therefore, for example, values can be

a) closer to a termination to avoid having to follow a long dimension line where only part of the dimension line needs to be shown (see figure 23).

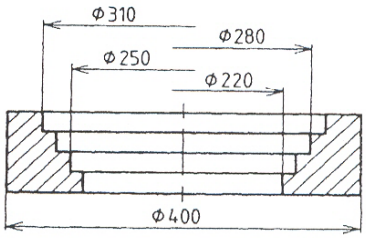


Figure 23

b) above the extension of the dimension line beyond one of the terminations if space is limited (see figure 24).

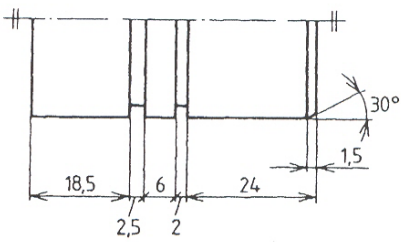


Figure 24

c) at the end of a leader line which terminates on a dimension line that is too short for the dimensional value to be indicated in the usual way (see figure 24).

d) above a horizontal extension of a dimension line where space does not allow placement at the interruption of a non-horizontal dimension line (see figure 25).

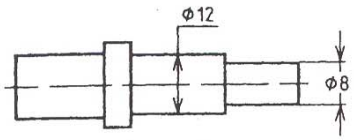


Figure 25

4.4.3 Values for dimensions out-of-scale (except where break lines are used) shall be underlined with a straight thick line (see figure 26).

NOTE — Dimensions out-of-scale can result from a feature size modification where the modification does not warrant an extensive drawing revision to correct the feature scale.

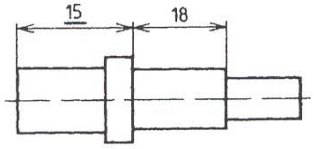


Figure 26

4.4.4 The following indications are used with dimensions to show applicable shape identification and to improve drawing interpretation. The diameter and square symbols may be omitted where the shape is clearly indicated. The applicable indication (symbol) shall precede the value for the dimension (see figures 27 to 31).

Φ: Diameter
R: Radius
□: Square
SR: Spherical radius
SΦ: Spherical diameter

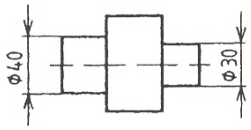


Figure 27

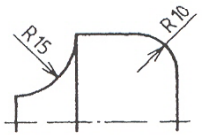


Figure 28

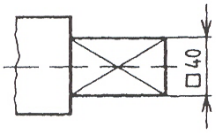


Figure 29

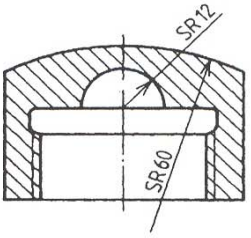


Figure 30

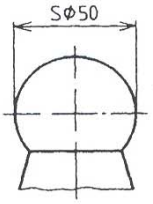


Figure 31

5 Arrangement and indication of dimensions

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

5.1 Chain dimensioning

Chains of single dimensions (see figure 32) should be used only where the possible accumulation of tolerances does not impinge on the functional requirements of the part. Any termination may be used for chain dimensioning except the 90° arrowhead [see figure 11a)].

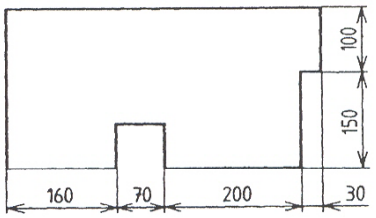


Figure 32 — Chain dimensioning

5.2 Dimensioning from a common feature

This method of dimensioning is used where a number of dimensions of the same direction relate to a common origin.

Dimensioning from a common feature may be executed as parallel dimensioning or as superimposed running dimensioning.

5.2.1 Parallel dimensioning is the placement of a number of single dimension lines parallel one to another and spaced out so that the dimensional value can easily be added in (see figures 33 and 41).

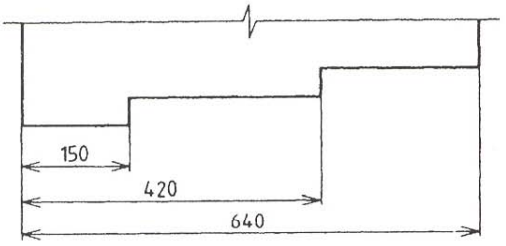


Figure 33 — Parallel dimensioning

5.2.2 Superimposed running dimensioning is simplified parallel dimensioning and may be used where there are space limitations and where no legibility problems would occur (see figures 34 and 35).

The origin indication (see figure 12) is placed appropriately and the opposite ends of each dimension line shall be terminated only with an arrowhead.

Dimensional values may be placed, where there is no risk of confusion, either

— near the arrowhead, in line with the corresponding projection line (see figure 34), or

— near the arrowhead, above and clear of the dimension line (see figure 35).

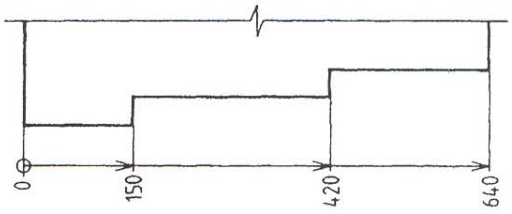


Figure 34

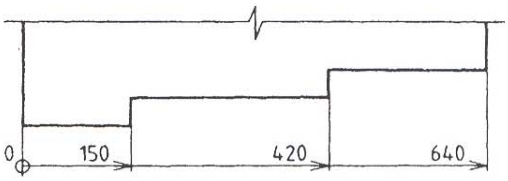


Figure 35

5.2.3 It may be advantageous to use superimposed running dimensioning in two directions. In such a case, the origins may be as shown in figure 36.

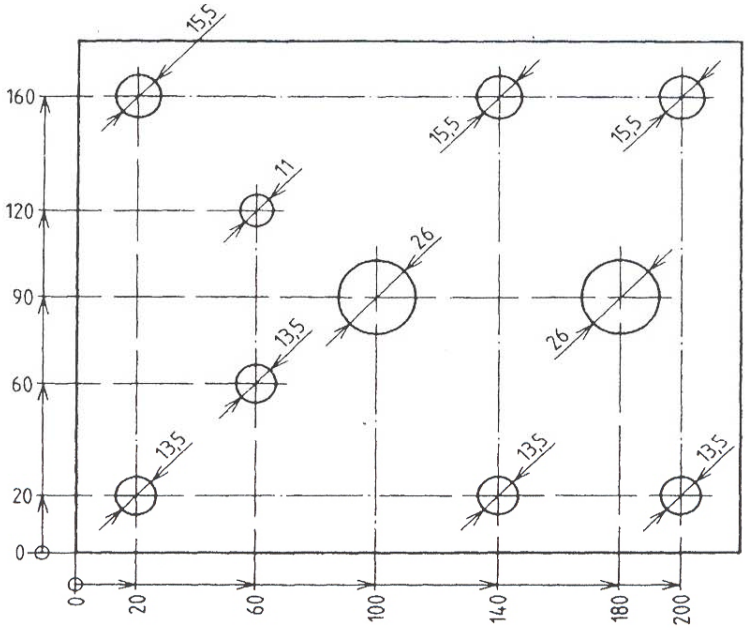
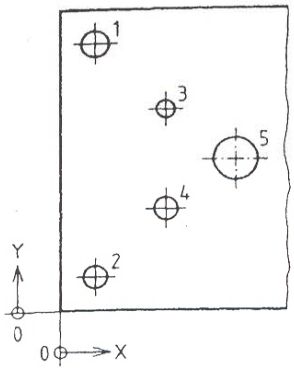


Figure 36

5.3 Dimensioning by coordinates

5.3.1 It may be useful, instead of dimensioning as shown in figure 36, to tabulate dimensional values as shown in figure 37.



	X	Y	Φ
1	20	160	15,5
2	20	20	13,5
3	60	120	11
4	60	60	13,5
5	100	90	26
6			
7			
8			
9			
10			

Figure 37

5.3.2 Coordinates for intersections in grids on block plans (site plans) are indicated as shown in figure 38.

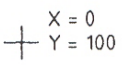


Figure 38

Coordinates for arbitrary points of reference without a grid shall appear adjacent to each point (see figure 39) or in tabular form (see figure 40).

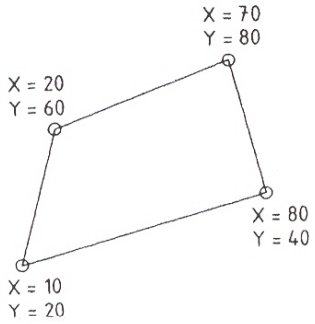
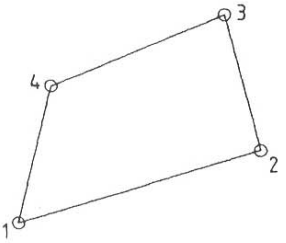


Figure 39



	X	Y
1	10	20
2	80	40
3	70	80
4	20	60

Figure 40

5.4 Combined dimensioning

Single dimensions, chain dimensioning and dimensioning from a common feature may be combined on a drawing, if necessary. See figures 41 and 42.

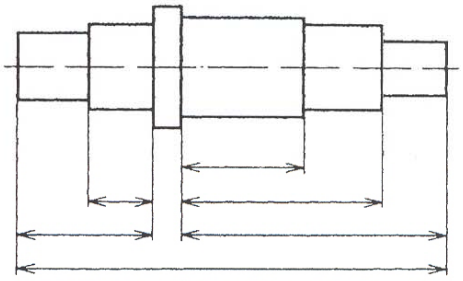


Figure 41

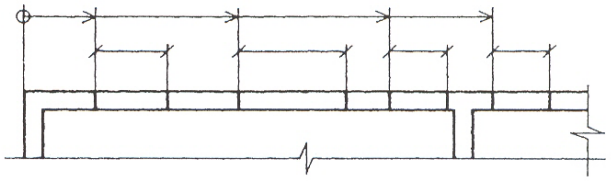


Figure 42

6 Special indications

6.1 Chords, arcs, angles and radii

6.1.1 The dimensioning of chords, arcs and angles shall be as shown in figure 43.

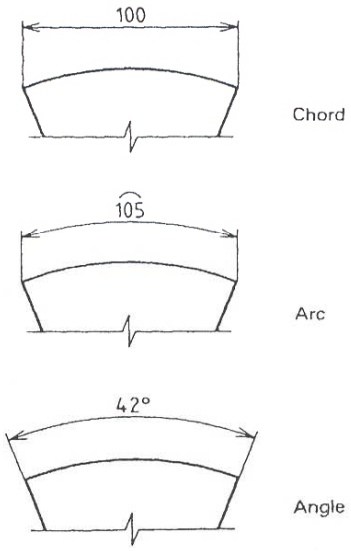


Figure 43

6.1.2 Where the centre of an arc falls outside the limits of the space available, the dimension line of the radius shall be broken or interrupted according to whether or not it is necessary to locate the centre (see figure 15).

6.1.3 Where the size of the radius can be derived from other dimensions, it shall be indicated with a radius arrow and the symbol R without an indication of the value (see figure 44).

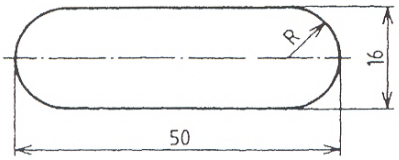


Figure 44

6.2 Equidistant features

Where equidistant features or uniformly arranged elements are part of the drawing specification, dimensioning may be simplified as follows.

6.2.1 Linear spacings may be dimensioned as shown in figure 45. If there is any possibility of confusion between the length of the space and the number of spacings, one space shall be dimensioned as shown in figure 46.

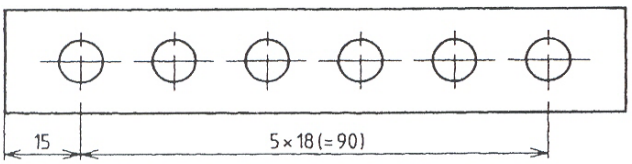


Figure 45

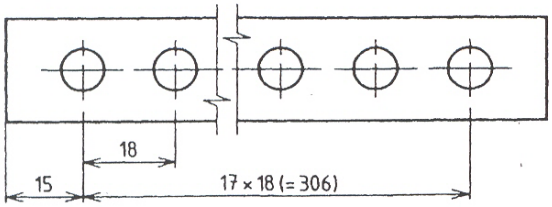


Figure 46

6.2.2 Angular spacings of holes and other features may be dimensioned as shown in figure 47.

The angles of the spacings may be omitted if their number is evident without confusion (see figure 48).

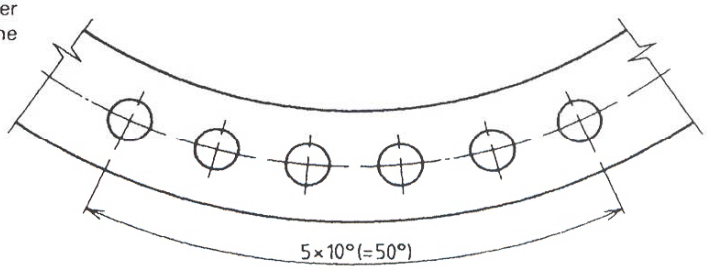


Figure 47

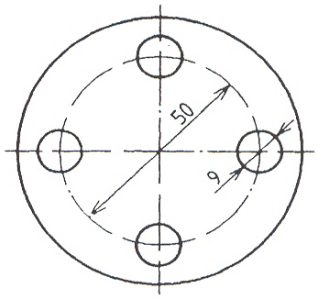


Figure 48

6.2.3 Circular spacings may be dimensioned indirectly by giving the number of elements as shown in figure 49.

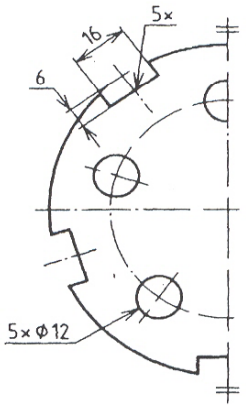


Figure 49

6.3 Repeated features

If it is possible to define a quantity of elements of the same size so as to avoid repeating the same dimensional value, they may be given as shown in figures 50 and 51.

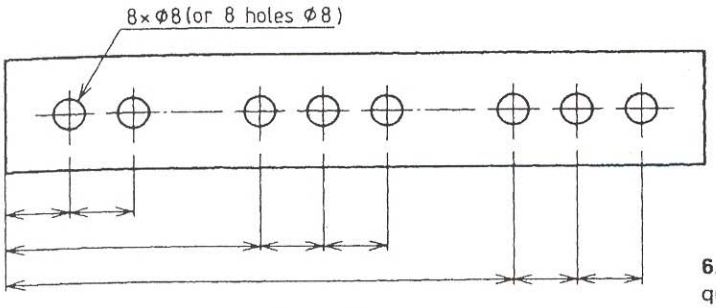


Figure 50

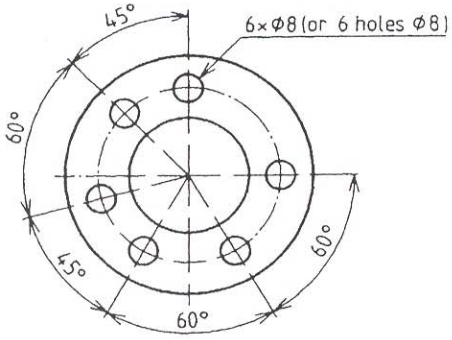


Figure 51

6.4 Chamfers and countersinks

6.4.1 Chamfers shall be dimensioned as shown in figure 52. Where the chamfer angle is 45°, the indications may be simplified as shown in figures 53 and 54.

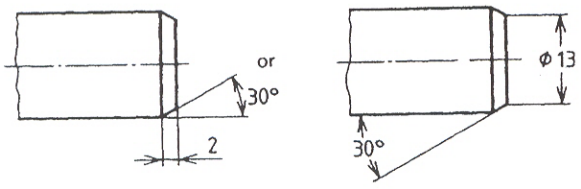


Figure 52 — Chamfers dimensioned

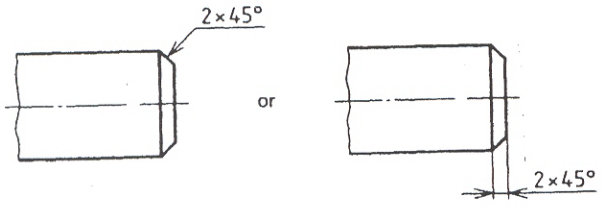


Figure 53 — 45° chamfers simplified

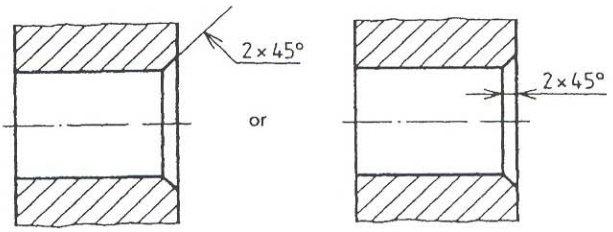


Figure 54 — Internal chamfers

6.4.2 Countersinks are dimensioned by showing either the required diametral dimension at the surface and the included angle, or the depth and the included angle (see figure 55).

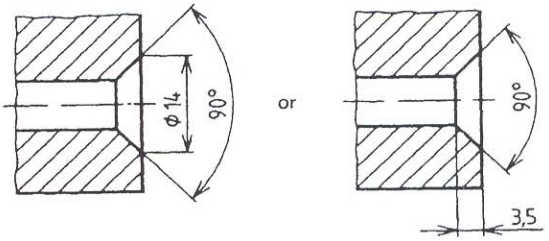


Figure 55 — Countersinks

6.5 Other indications

6.5.1 Where necessary, in order to avoid repeating the same dimensional value or to avoid long leader lines, reference letters may be used in connection with an explanatory table or note (see figure 56). Leader lines may be omitted.

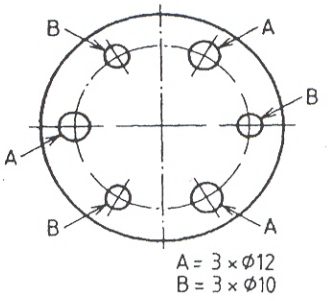


Figure 56

6.5.2 In partially drawn views and partial sections of symmetrical parts, the dimension lines that need to cross the axis of symmetry are shown extended slightly beyond the axis of symmetry; the second termination is then omitted (see figure 57).

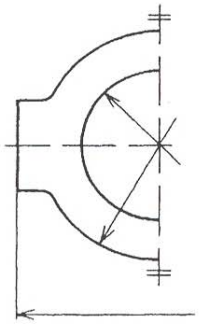


Figure 57

6.5.3 Where several parts are drawn and dimensioned in an assembly, the groups of dimensions related to each part should be kept as separate as possible (see figure 58).

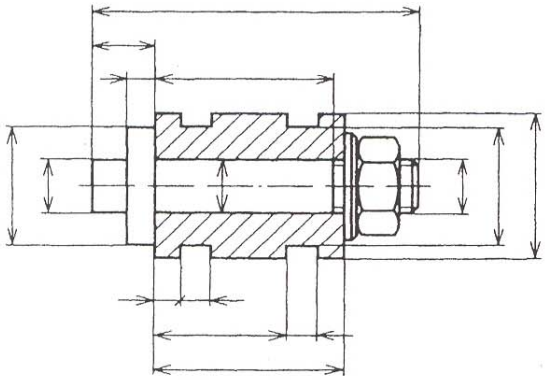


Figure 58 — Dimensioning an assembly

6.5.4 Sometimes it is necessary to dimension a limited area or length of a surface to indicate a special condition. In such instances, the area or length and its location are indicated by a long thick chain line, drawn adjacent and parallel to the surface and at a short distance from it.

If the special requirement is applied to an element of revolution, the indication shall be shown on one side only (see figure 59).

Where the location and extent of the special requirement requires identification, the appropriate dimensioning is necessary. However, where the drawing clearly shows the extent of the indication, dimensioning is not necessary (see figure 60).

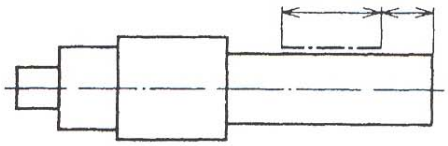


Figure 59

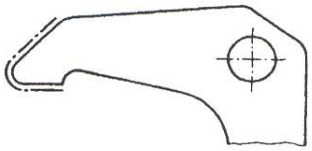


Figure 60

7 Indication of levels

7.1 General

Levels shall be expressed in appropriate units from a predetermined base-zero level.

7.2 Levels on vertical views and sections

7.2.1 The predetermined base-zero level on vertical views and sections shall be indicated with a closed arrowhead with barbs at an included angle of 90°. The arrowhead shall point to a horizontal line, shall be half filled in, and shall be connected to a horizontal leader line by means of a short thin line (see figure 61).

Figure 61

7.2.2 If it is required to indicate the altitude of the base-zero level, the base-zero level symbol is modified to include 0,000 directly above and the actual altitude directly below the horizontal leader line (see figure 62).

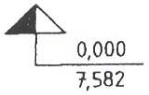


Figure 62

7.2.3 Subsequent levels are indicated in vertical views and sections with an arrowhead with barbs at an included angle of 90° pointing to the respective level and attached to a short thin vertical line. The vertical line is connected, at right angles, to a horizontal leader line above which is placed the appropriate level dimension (see figure 63).

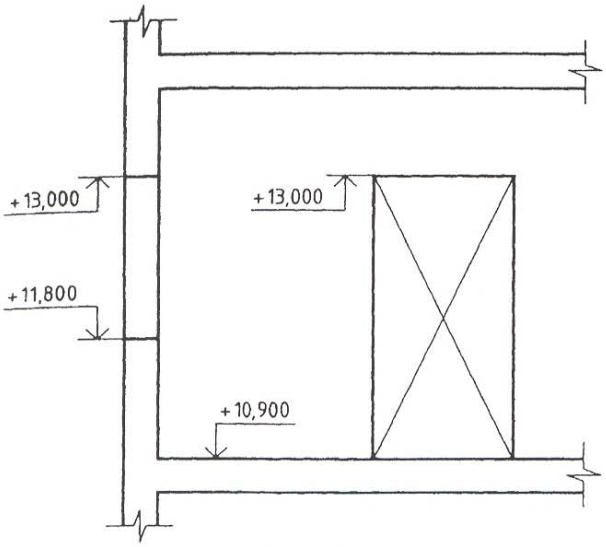


Figure 63

7.3 Levels on horizontal (plan) views and sections

7.3.1 The numerical value of the level for a point (a specific location) shall be placed above the leader line that is connected to an "X". The "X" is used to indicate the exact position of a particular point (see figure 64).

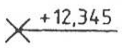


Figure 64

If the specific location point is defined by two intersecting outlines, the "X" shall be replaced with a circle and the numerical value of the elevation shall be located above the leader line that is extended from the circle on the same side of the outline as the surface associated with the elevation (see figure 65).

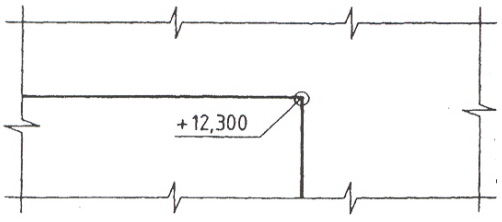
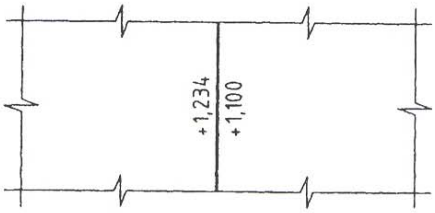


Figure 65

7.3.2 The numerical value of an elevation of an outline shall be located adjacent to it and on the same side of it as the surface associated with the elevation (see figure 66).

Example



Meaning

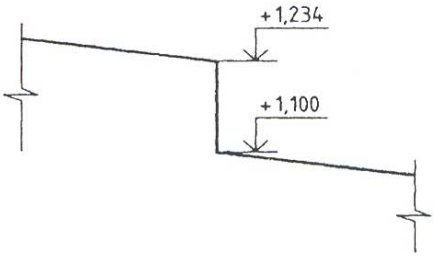


Figure 66

7.4 Levels on site layout

7.4.1 Levels on ground preparation drawings and site plans shall be given as follows:

Original ground level to be used	+0,000
New ground level	+0,000
Original ground level no longer valid	(+0,000)

7.4.2 Levels for contour lines shall be located on the upper side of the contour line and shall be given as follows:

Contour line 49,000

Original contour line no longer valid

7.4.3 Elevation datums to be used when setting out dimensions shall be shown as follows:

⊕ FIX +0,000