

BS 8888:2013



BSI Standards Publication

Technical product documentation and specification

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Summary of pages

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Foreword

Publishing information

This British Standard is published by BSI and came into effect on 31 December 2013. It was prepared by Subcommittee TDW/4/8, *BS 8888 – Technical product specification*, under the authority of Technical Committee TDW/4, *Technical product realization*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 8888:2011, which is withdrawn.

Information about this document

This edition of the standard is a full revision. It introduces relevant international standards published since the 2011 edition. It also incorporates more fully than previous editions some of the fundamental requirements of the key international standards relevant to the preparation of technical product specifications, such as BS EN ISO 1101 and BS EN ISO 5459. It is hoped that UK industry will find this edition of BS 8888 more user-friendly than previous editions. It aims to help organizations better understand and implement the full complement of International Standards developed by ISO/TC 213, *Geometrical product specifications and verification*, and ISO/TC 10, *Technical product documentation*.

Relationship with other publications

The function of BS 8888 is to draw together, in an easily accessible manner, the full complement of international standards relevant to the preparation of technical product specifications. However, it is not the intention for BS 8888 to be a “stand-alone” standard. TDW/4 is responsible for a suite of related national standards, including the various parts of BS 8887, BS 8889¹⁾ and PD 68888, a new training document.

BS 8888 was taken up by the Ministry of Defence in 2006 as part of its DEF-STAN for defence project specification.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

In addition, information boxes provide additional informative material that might otherwise have appeared in informative annexes, but was felt to be best placed in the main body of text.

All dimensions shown in the figures in this British Standard are in millimetres.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

¹⁾ In development.

Section 1: Scope

1.1 Scope

This British Standard implements the ISO system for technical product documentation and specification.

The ISO system is defined in a large number of interlinked and related international standards which are referenced in this British Standard.

The purpose of this British Standard is to facilitate the use of the ISO system by providing:

- an index to the international standards which make up the ISO system, referencing them according to their area of application;
- key elements of the ISO standards to facilitate their application;
- references to additional British and European Standards where they provide information or guidance over and above that provided by ISO standards; and
- commentary and recommendations on the application of the standards where this is deemed useful.

The requirements refer to International and European Standards which have been implemented as British Standards, either in the BS EN, BS EN ISO, BS ISO series or as International Standards renumbered as British Standards.

Annex A (normative) contains a list of normative references, indispensable for the application of this British Standard.

Annex B (informative) contains a list of informative references.

Annex C (informative) gives examples of geometrical tolerances and requirements associated with them.

Annex D (normative) contains requirements for enhanced security.

1.2 Normative references

The documents listed in Annex A, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

1.3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS EN ISO 10209 and BS EN ISO 14660-1 apply, together with the following.

1.3.1 date of issue

point in time at which the technical product specification is officially released for its intended use

NOTE 1 The date of issue is important for legal reasons, e.g. patent rights, traceability.

NOTE 2 For the implications of the date of issue, see 4.2.

1.3.2 ISO GPS system

geometrical product specification and verification system developed in ISO by ISO/TC 213

1.3.3 technical product documentation (TPD)

means of conveying all or part of a design definition or specification of a product

1.3.4 technical product specification (TPS)

technical product documentation comprising the complete design definition and specification of a product for manufacturing and verification purposes

NOTE A TPS, which might contain drawings, 3-D models, parts lists or other documents forming an integral part of the specification, in whatever format they might be presented, might consist of one or more TPDs.

Section 2: Standards underpinning BS 8888

2.1 General

The following documents shall be applied as “global” standards in support of BS 8888.

ISO/IEC Guide 98-3 *Guide to the expression of uncertainty in measurement (GUM)*

ISO/IEC Guide 99 *International vocabulary of metrology – Basic and general concepts and associated terms (VIM)*

The principles in Section 3 shall always be applied where conformity with BS 8888 is claimed.

Section 3: Symbols and abbreviations

3.1 Symbols and abbreviations

3.1.1 General

Abbreviations (text equivalents) used in a TPS shall be the same in the singular and plural. Full stops shall not be used, except where the abbreviation forms a word (e.g. NO. as an abbreviation for “number”).

NOTE Where possible, abbreviations should be avoided (see 3.1.2).

Symbols used for physical quantities and units of measurement shall conform to the following standards, as appropriate.

BS EN ISO 80000-1	<i>Quantities and units – Part 1: General</i>
BS EN ISO 80000-2	<i>Quantities and units – Part 2: Mathematical signs and symbols to be used in the natural sciences and technology</i>
BS EN ISO 80000-3	<i>Quantities and units – Part 3: Space and time</i>
BS EN ISO 80000-4	<i>Quantities and units – Part 4: Mechanics</i>
BS EN ISO 80000-5	<i>Quantities and units – Part 5: Thermodynamics</i>
BS EN ISO 80000-6	<i>Quantities and units – Part 6: Electromagnetism</i>
BS ISO 80000-7	<i>Quantities and units – Part 7: Light</i>
BS EN ISO 80000-8	<i>Quantities and units – Part 8: Acoustics</i>
BS EN ISO 80000-9	<i>Quantities and units – Part 9: Physical chemistry and molecular physics</i>
BS EN ISO 80000-10	<i>Quantities and units – Part 10: Atomic and nuclear physics</i>
BS EN ISO 80000-11	<i>Quantities and units – Part 11: Characteristic numbers</i>
BS EN ISO 80000-12	<i>Quantities and units – Part 12: Solid state physics</i>
BS EN 80000-13	<i>Quantities and units – Part 13: Information science and technology</i>
BS EN 80000-14	<i>Quantities and units – Part 14: Telebiometrics related to human physiology</i>

3.1.2 Standard symbols and abbreviations

COMMENTARY ON 3.1.2

In the existing environment of outsourcing across national borders, every effort is being made to make the use of GPS (geometrical product specification) independent of language through the adoption of standard symbology. It is for this reason that the continued use of abbreviations is deprecated.

Where particular specification requirements cannot be expressed using the available GPS system, full text description shall be employed.

NOTE 1 It is suggested that, where such a requirement occurs frequently, this be drawn to the attention of the relevant ISO committee through the appropriate BSI Technical Committee.

For diagrams used in technical applications, a library of harmonized graphical symbols has been developed with close cooperation between ISO and IEC. This is published in the following series of standards and these shall be applied wherever practicable to improve the universal applicability of the TPS.

- BS ISO 14617-1 *Graphical symbols for diagrams – Part 1: General information and indexes*
- BS ISO 14617-2 *Graphical symbols for diagrams – Part 2: Symbols having general application.*
- BS ISO 14617-3 *Graphical symbols for diagrams – Part 3: Connections and related devices*
- BS ISO 14617-4 *Graphical symbols for diagrams – Part 4: Actuators and related devices*
- BS ISO 14617-5 *Graphical symbols for diagrams – Part 5: Measurement and control devices*
- BS ISO 14617-6 *Graphical symbols for diagrams – Part 6: Measurement and control functions.*
- BS ISO 14617-7 *Graphical symbols for diagrams – Part 7: Basic mechanical components*
- BS ISO 14617-8 *Graphical symbols for diagrams – Part 8: Valves and dampers*
- BS ISO 14617-9 *Graphical symbols for diagrams – Part 9: Pumps, compressors and fans*
- BS ISO 14617-10 *Graphical symbols for diagrams – Part 10: Fluid power converters*
- BS ISO 14617-11 *Graphical symbols for diagrams – Part 11: Devices for heat transfer and heat engines*
- BS ISO 14617-12 *Graphical symbols for diagrams – Part 12: Devices for separating purification and mixing*

Symbols appropriate to TPS are provided and detailed throughout the suite of documents cross-referenced from this British Standard and these shall be used where appropriate.

NOTE 2 It is strongly recommended that abbreviations not be used.

Where, in particular technical fields, certain abbreviations are in common use and generally understood, it is accepted that these may continue to be used, but new abbreviations shall not be introduced.

NOTE 3 Former practice has resulted in certain abbreviations becoming accepted as symbols and these should not be considered to provide precedence for the proliferation of abbreviations.

Section 4: Principles of specification

4.1 General principles of specification

4.1.1 A TPS shall document the criteria that the manufactured product has to satisfy.

NOTE 1 The TPS might include requirements of individual manufactured components, where necessary.

NOTE 2 The TPS might include additional information required for the manufacture, verification, maintenance and disposal of the product.

NOTE 3 Criteria might include requirements relating to the appearance, transportation, storage, maintenance, assembly, disassembly, recycling and disposal of the product, as well as its performance and reliability in use.

Sizes, geometrical relationships and tolerances which are necessary for the correct functioning or location of a component or assembly shall be specified through the use of datums, dimensions and tolerances.

NOTE 4 Selection of datum features which are not related to the function or location of a component or assembly results in the need for tighter tolerances.

4.1.2 A TPS shall provide sufficient information to avoid ambiguity of interpretation.

NOTE A TPS is not complete if there is more than one possible interpretation of the specification.

4.1.3 A TPS shall provide sufficient information for the product to be manufactured, but shall not unnecessarily constrain manufacturing methods.

NOTE A particular manufacturing process which has been tested and approved for the production of a safety-critical component is an example of a situation where there is a requirement to specify the manufacturing method.

4.1.4 A TPS shall provide sufficient information for the verification of each element of the specification, but shall not unnecessarily constrain verification methods.

4.1.5 A TPS shall provide all the information necessary for the manufacture and verification of the product, or state where that information can be found.

NOTE 1 This might be achieved through the use of notes and references to other standards or documents.

NOTE 2 Requirements not specified in the TPS cannot be enforced.

4.1.6 Where a TPS includes requirements relating to several stages of completion of the product, it shall indicate which stage each indication refers to, unless it is the finished product.

4.2 Date of issue principle

A TPS shall always be interpreted according to those versions of standards which governed its interpretation on its date of issue.

NOTE What is not specified in a TPS at the date of issue cannot be required.

4.3 Reference condition principle

Unless otherwise stated, all geometrical properties and tolerances for a workpiece given in a TPS shall be considered to apply at 20 °C.

NOTE 1 See BS EN ISO 1.

Unless otherwise stated, the workpiece shall be considered to have infinite stiffness, and all geometrical properties and tolerances given in a TPS shall be

considered to apply in the absence of deformation from any external forces (including gravity).

NOTE 2 This is of particular importance when aligning and/or measuring large and/or flexible constructions. See 5.3.2.

4.4 Interpretation

A TPS shall indicate which standards, or systems of standards, govern its interpretation.

When the presentation of data in a TPS conforms to the British and ISO standards identified in BS 8888, a reference to BS 8888 itself shall be sufficient to indicate that these standards apply to the specification. Such a reference shall take the following form.

CONFORMS TO BS 8888

NOTE 1 This note may be placed in the title block, in a drawing note, or elsewhere within the drawing frame.

NOTE 2 The phrase “presentation of data” refers to layout of drawing borders and title blocks, layout of views and projections, format of letters, numbers, dimensions and tolerances, use of different line types and thicknesses, etc.

When the geometry of a workpiece is defined according to the requirements of ISO GPS (see 7.1), which are documented in standards such as BS EN ISO 5459 and BE EN ISO 1101, a reference to BS EN ISO 8015 is sufficient to indicate that all ISO GPS standards apply to the interpretation of that specification. Such a reference shall take the following form.

TOLERANCING ISO 8015

NOTE 3 This note may be placed in the title block, in a drawing note, or elsewhere within the drawing frame. This note is required in addition to any reference to BS 8888.

This marking is a BS 8888 requirement, and not a requirement of BS EN ISO 8015. This is necessary to avoid possible misinterpretation of which system of standards govern the interpretation of a TPS.

4.5 Decimal principle

Non-indicated decimals shall be taken as zeroes.

NOTE 1 0,2 is the same as 0,200 000 000 000 000 000 000 000 000 ... etc.

NOTE 2 10 is the same as 10,000 000 000 000 000 000 000 000 000 ... etc.

4.6 Rigid workpiece principle

By default, a workpiece shall be considered as having infinite stiffness and all GPS specifications shall apply in the free state, undeformed by any external forces, including the force of gravity. Any additional or other conditions that apply shall be defined in the drawing.

NOTE See, for example, BS ISO 10579.

4.7 Representation of features

Conventions used for the representation of features shall conform to the following standards, as appropriate.

BS EN ISO 4063	<i>Welding and allied processes – Nomenclature of processes and reference numbers</i>
BS EN ISO 5261	<i>Technical drawings – Simplified representation of bars and profile sections</i>
BS EN ISO 5845-1	<i>Technical drawings – Simplified representation of the assembly of parts with fasteners – Part 1: General principles</i>
BS EN ISO 6410-1	<i>Technical drawings – Screw threads and threaded parts – Part 1: General conventions</i>
BS EN ISO 6410-2	<i>Technical drawings – Screw threads and threaded parts – Part 2: Screw thread inserts</i>
BS EN ISO 6410-3	<i>Technical drawings – Screw threads and threaded parts – Part 3: Simplified representation</i>
BS EN ISO 6411	<i>Technical drawings – Simplified representation of centre holes</i>
BS EN ISO 6413	<i>Technical drawings – Representation of splines and serrations</i>
BS ISO 13715	<i>Technical drawings – Edges of unidentified shape – Vocabulary and indications</i>
BS EN ISO 15785	<i>Technical drawings – Symbolic presentation and indication of adhesive, fold and pressed joints</i>
BS EN 22553	<i>Welded, brazed and soldered joints – Symbolic representation on drawings</i>

NOTE The BS ISO 128 series of standards covers the general subject of feature representation.

Section 5: Fundamental concepts

5.1 Properties

A TPS defines various properties and requirements. Some properties or requirements may be defined for an entire workpiece (e.g. a material specification), some for part of a workpiece (e.g. a particular surface treatment), and some for individual features on a workpiece (e.g. a size requirement). Properties or requirements may also be defined for a process or procedure.

Properties which may be specified include:

- size;
- location;
- orientation;
- form;
- surface texture;
- surface imperfections;
- properties of edges;
- material;
- coatings and finishes;
- hardness;
- chemical composition;
- treatments which are to be applied to the workpiece;
- processing requirements;
- recycling requirements;
- packaging requirements;
- handling requirements.

Properties of size, location, orientation and form may be defined solely with toleranced dimensions (see Section 7), but this results in ambiguous specifications which are open to a wide range of interpretations.

For an unambiguous definition of the size, location, orientation and form of features on the workpiece, the ISO system of Geometrical Product Specification shall be used (see Section 7). This utilizes datums and geometrical tolerances to minimize ambiguity.

5.2 Features

A workpiece shall be considered as made up of a number of features limited by natural boundaries. By default, every specification requirement for a feature or relation between features shall apply to the entire feature and each specification requirement shall apply only to one feature or one relation between features.

NOTE This default can only be overridden by explicit indications on the drawing. The system for classifying features is outlined in the following information box.

Classification of features

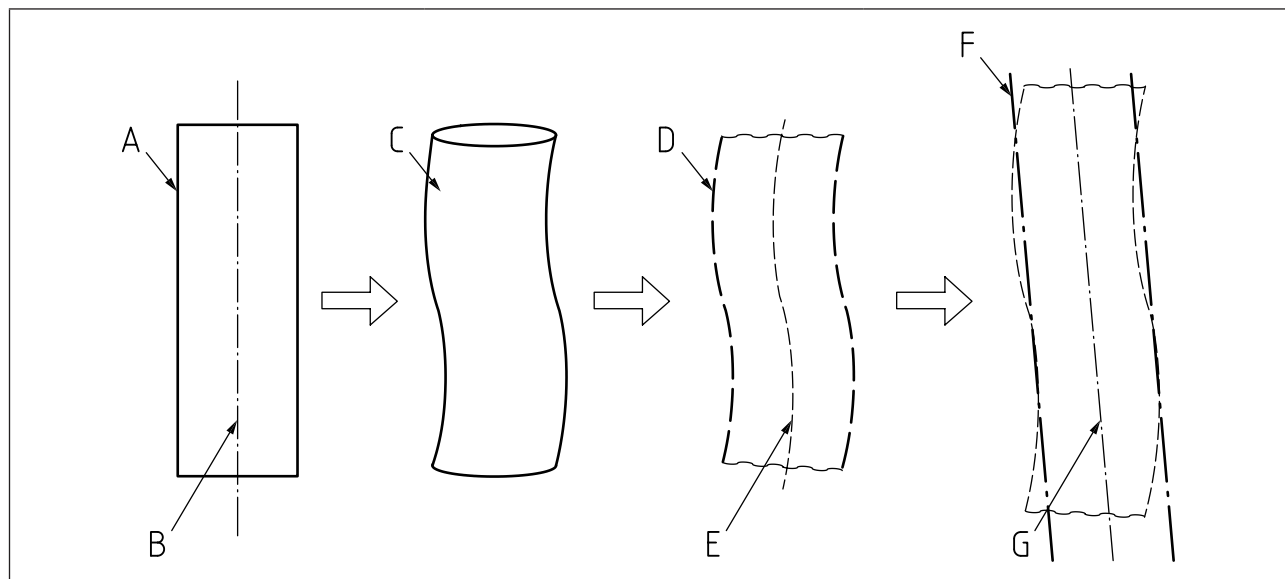
ISO GPS defines several different types of feature. The main types of features are:

- a) integral features: features which consist of, or represent, surfaces on the workpiece;
- b) features of size: integral features which have a size characteristic and can consist of:
 - 1) two parallel opposed planes;
 - 2) a cylinder;
 - 3) a sphere;
 - 4) two non-parallel planes (a wedge);
 - 5) a cone; and
 - 6) a torus;
- c) derived features: theoretical features, such as axes or median lines, which are derived from a feature of size (axis or median line, median plane or median surface, and centre points).

ISO GPS also defines a number of different “worlds” or “states” that features can exist in. In some “worlds” the features exist in an ideal form, such as in the specification, while in other states they exist in a non-ideal form, such as surfaces on the manufactured workpiece.

NOTE 1 See Figure 1.

Figure 1 Interrelationship of the geometrical feature definitions



Key

A	Nominal integral feature	D	Extracted integral feature	G	Associated derived feature
B	Nominal derived feature	E	Extracted derived feature		
C	Real feature	F	Associated integral feature		

Nominal features

In the “world” of the specification, features are represented in an ideal state. These features have ideal form, and ideal relationships with each other. Features in this world are known as nominal features.

Real features

In the “world” of the manufactured workpiece (the physical world), features are non-ideal, and are known as real features.

Extracted features

In the “world” of verification, a feature is represented by a set of data obtained by sampling the workpiece with measuring instruments. This set of data represents the non-ideal real feature, and is known as an extracted feature.

NOTE 2 The extracted feature is used when determining whether a tolerance requirement has been met.

Associated features

In the “world” of verification, an ideal feature may be “fitted” to, or associated with, either the real feature or the extracted feature. This ideal feature is known as an associated feature.

NOTE 3 The associated feature is used when determining the orientation of size measurements, or when defining a datum. A range of different association methods may be used.

5.3 Interpretations of limits of size for a feature-of-size

5.3.1 General

BS EN ISO 14405-1 states that the default definition of a size tolerance is the “two-point” definition. This means that size limits only apply to any “two-point” size measurement of a feature. Therefore, the size limits do not control the form deviations of the feature. For example:

- the size limits on a cylindrical feature do not control its roundness or straightness;
- the size limits on a feature consisting of two parallel, opposed planes do not control the flatness of the two planes.

Form deviations can be controlled by:

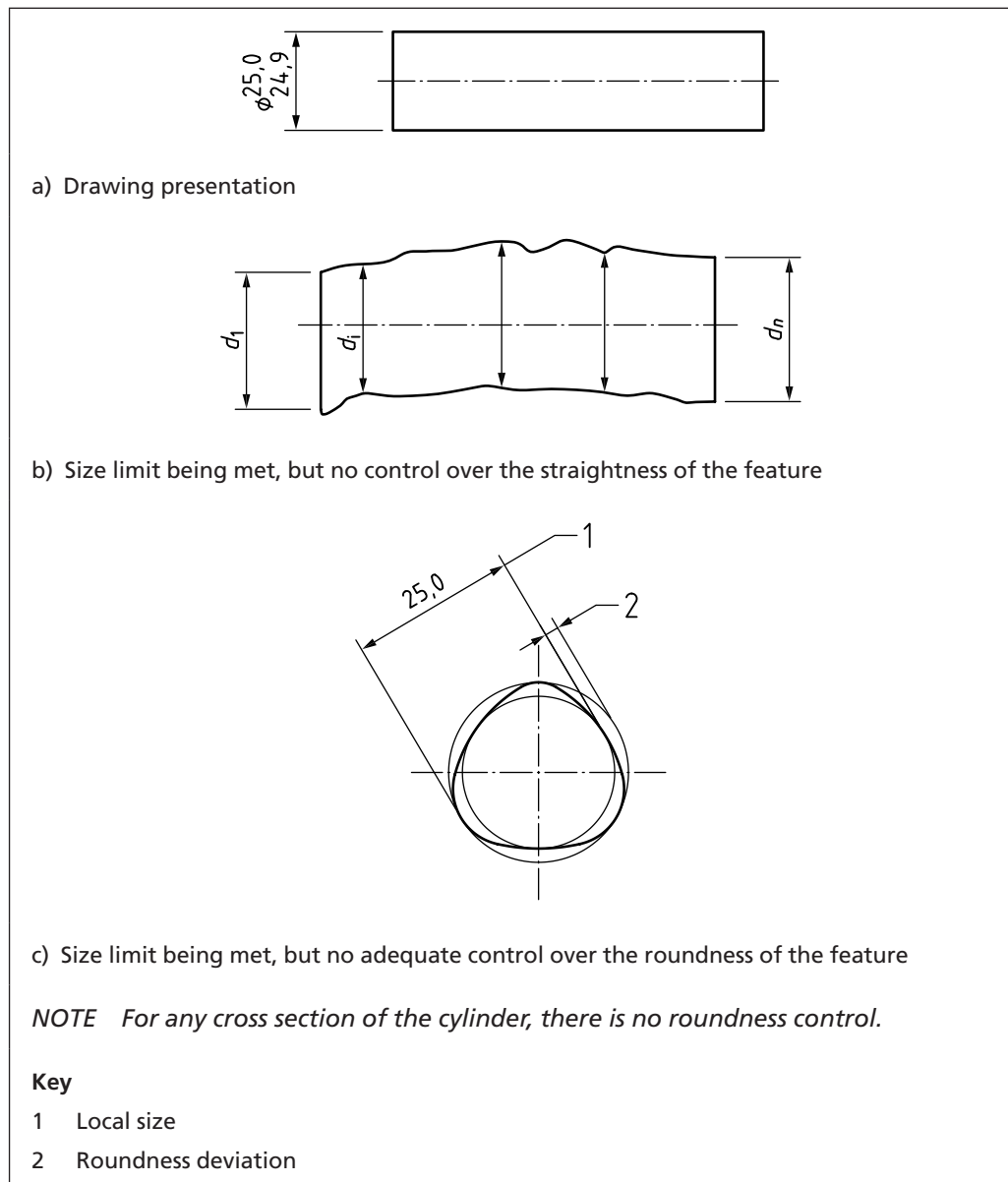
- individually specified geometrical tolerances;
- general geometrical tolerances; or
- the use of the envelope requirement (where the maximum material limit of size defines an envelope of perfect form for the relevant surfaces, see BS EN ISO 14405-1).

Limits of size for an individual feature-of-size shall be interpreted according to the principles and rules defined in the following standards.

NOTE Figure 2 gives examples of how size limits could be interpreted where no form control is defined and the specification is incomplete.

BS EN ISO 8015	<i>Geometrical product specifications (GPS) – Fundamentals – Concepts, principles and rules</i>
BS EN ISO 14405-1	<i>Geometrical product specifications (GPS) – Dimensional tolerancing – Part 1: Linear sizes (ISO 14405-1:2010)</i>
BS EN ISO 14660-1	<i>Geometrical product specifications (GPS) – Geometrical features – Part 1: General terms and definitions.</i>
BS EN ISO 14660-2	<i>Geometrical product specifications (GPS) – Geometrical features – Part 2: Extracted median line of a cylinder and a cone, extracted median surface, local size of an extracted feature</i>

Figure 2 Possible interpretations of size limits where no form control is defined and the specification is incomplete



5.3.2 Limits of size with mutual dependency of size and form

Some national standards apply, or have applied, the envelope requirement to all features-of-size by default. As the envelope requirement has been the default, they have not used a symbol to indicate this requirement; rather, they use a note to indicate when this is not required. This system of tolerancing is sometimes described as the principle of dependency, or the application of the Taylor Principle.

Standards which apply, or have applied, the envelope requirement by default include BS 308 and ASME Y14.5 [1] (the requirement that there is an envelope of perfect form corresponding to the Maximum Material Size of the feature is defined as Rule #1 in ASME Y14.5).

BS EN 22768-2 includes an option for marking drawings to indicate that the envelope requirement applies to all features of size on the drawing, but this marking is neither widely used nor well understood and is not recommended. Use of BS EN 22768-2 is in any case inadvisable.

BS EN ISO 14405-1 allows the default interpretation of size requirements to be changed for an TPS. A number of different possibilities are available, including the option of making the envelope requirement the default interpretation of size for the entire specification.

If the default interpretation of size is to be changed for a TPS, the following indication shall appear in or near the title block of each drawing.

SIZE ISO 14405

followed by the relevant modifier.

For example, if the envelope requirement is to be made the default interpretation of size requirements for the entire TPS, the indication shall be:

SIZE ISO 14405 $\textcircled{\text{E}}$

NOTE It is recommended that a note on the drawing be used in addition to the ISO 14405 reference, for clarity.

5.3.3 Implied dimensions

The following rules shall govern the use and interpretation of implied annotation on engineering drawings.

NOTE A dimension may be implied and not indicated on a drawing in the following circumstances, so long as there is no risk of misinterpretation.

- a) Where two features are aligned, there is no requirement to indicate a linear dimension of 0 or an angular dimension of 0°.
- b) Where two features are parallel to each other, there is no requirement to indicate an angular dimension of 0° or 180°.
- c) Where two features are at 90° to each other, there is no requirement to indicate an angular dimension of 90°.
- d) Where several features are equispaced around a pitch circle (see BS ISO 129-1), there is no requirement to indicate an angular dimension, although it might be advisable to do so. Terms such as “equispaced”, “equally spaced”, etc., shall not be used.
- e) Where not otherwise indicated, holes are considered as through holes.
- f) If the features concerned have their locations and/or orientations controlled through the use of geometrical tolerances, then the implied dimensions shall be taken as theoretically exact dimensions (TEDs; see BS EN ISO 1101).
- g) If the features concerned have their locations and/or orientations controlled through the use of +/- or limit tolerances, then the implied dimensions shall also be toleranced. In the absence of other indications, they shall be subject to a general tolerance, or else the TPS would remain incomplete.

Tolerances shall never be implied, and shall always be indicated.

Datums shall never be implied, and shall always be indicated.

Section 6: Dimensioning

6.1 Dimensioning methods

6.1.1 Presentation rules

Dimensioning shall conform to BS ISO 129-1.

NOTE 1 The dimensioning of mechanical engineering drawings will be specified in BS ISO 129-2, which is currently in preparation, while the dimensioning of shipbuilding drawings is specified in BS ISO 129-4.

Only the dimensions which are necessary to unambiguously define the nominal geometry of the product shall be specified.

NOTE 2 The dimensions shown should be for the purposes of describing the function, production or verification of the product.

Each feature or relation between features shall be dimensioned only once.

Unless otherwise specified, dimensions shall be indicated for the finished state of the dimensioned feature. However, it might be necessary to give additional dimensions at intermediate stages of production if they are shown on the same drawing (e.g. the size of a feature prior to carburizing and finishing).

All dimensional information shall be complete and shown directly on a drawing, unless this information is specified in related associated documentation.

All dimensions, graphical symbols and annotations shall be indicated such that they can be read from the bottom or right-hand side (main reading directions) of the drawing.

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

Lettering on drawings shall be in accordance with BS EN ISO 3098.

There shall be only one lettering height for dimension and tolerance indication for a specific drawing.

A space shall separate the elements of the dimension indicator.

NOTE 2 The dimension value and the lower deviation should be at the same distance from the dimension line.

All dimensions shall be toleranced, either via a general tolerance or by direct indication of tolerance or limit indications, except the following cases:

- a) MIN, see 6.1.7.4;
- b) MAX, see 6.1.7.4;
- c) auxiliary dimension, see 6.1.14;
- d) theoretically exact dimension (TED) (see BS EN ISO 1101).

When tolerance limits are indicated in a vertical orientation (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, e.g.:

$$2 \times 55^{+0,2}_{-0,15}$$

$$2 \times 55^0_{-0,15}$$

If two deviations relating to the same dimension have to be shown, both shall be expressed to the same number of decimal places (see Figure 3), except if one of

the deviations is zero. This shall also be applied if the limits of size are indicated (see Figure 4).

Figure 3 **Example: expression of two deviations to the same number of decimal places**

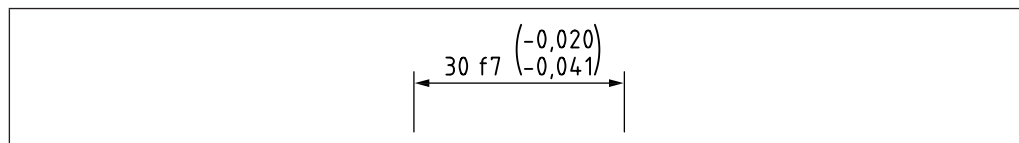
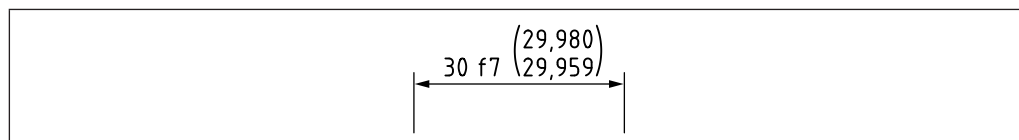
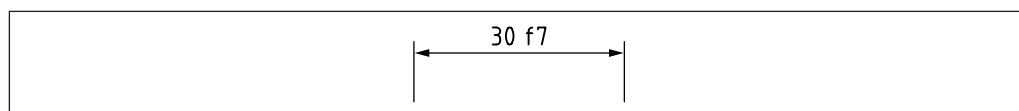


Figure 4 **Example: expression of two limits of size to the same number of decimal places**



NOTE 3 For dimensions displayed in accordance with BS EN ISO 286-1, it is not necessary to express the values of the deviations unless they are needed (see Figure 5).

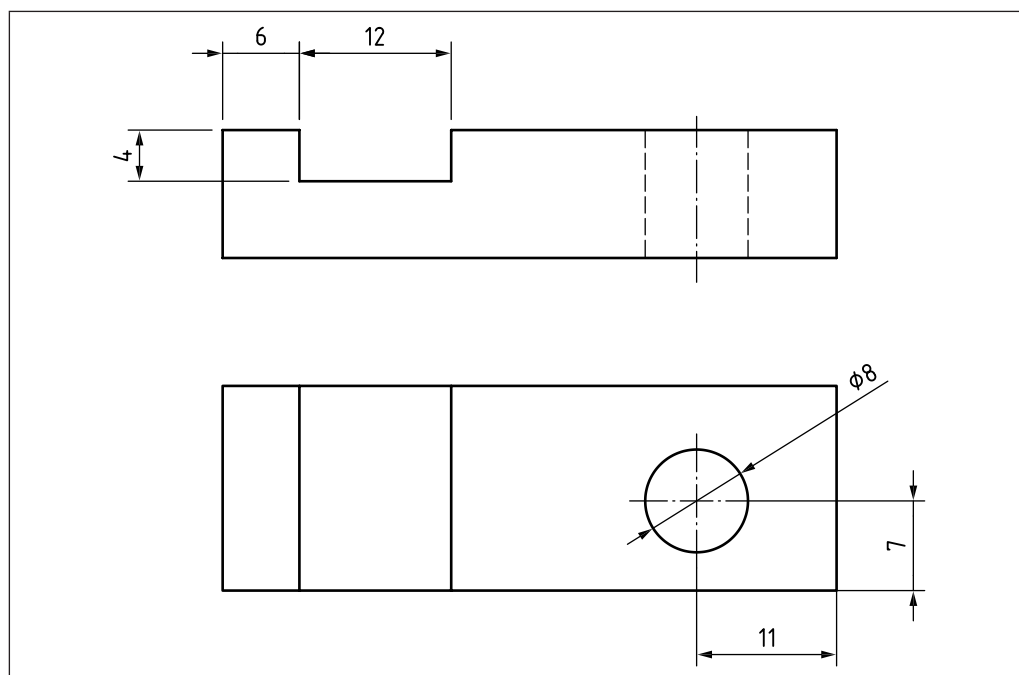
Figure 5 **Example: expression of deviations from dimensions displayed in accordance with BS EN ISO 286-1**



6.1.2 Positioning of dimensions

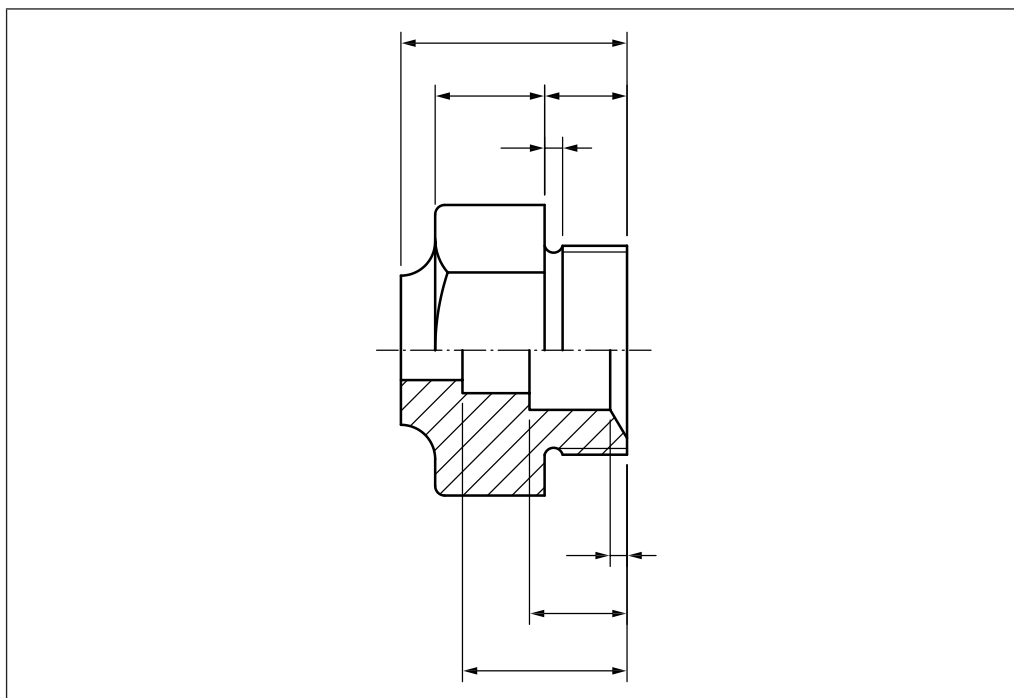
Dimensions shall be placed on that view or section which shows the relevant feature(s) most clearly (see Figure 6).

Figure 6 **Positioning of dimensions**



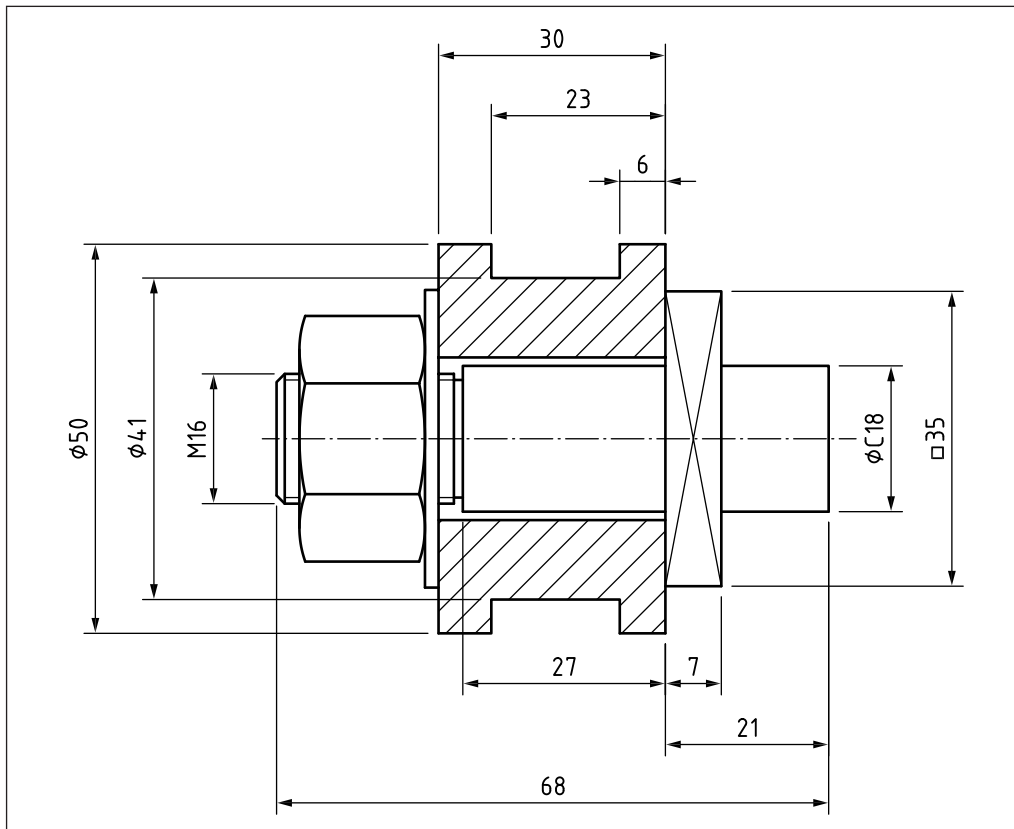
Dimensions for internal features and dimensions for external features shall, where possible, be arranged and indicated in separate groups of dimensions to improve readability (see Figure 7).

Figure 7 Arrangement and indication of dimensions internal and external features



Where several features or objects are depicted in close proximity, their relative dimensions shall be grouped together, separately, for ease of reading (see Figure 8).

Figure 8 Grouping of relative dimensions of features or objects in close proximity



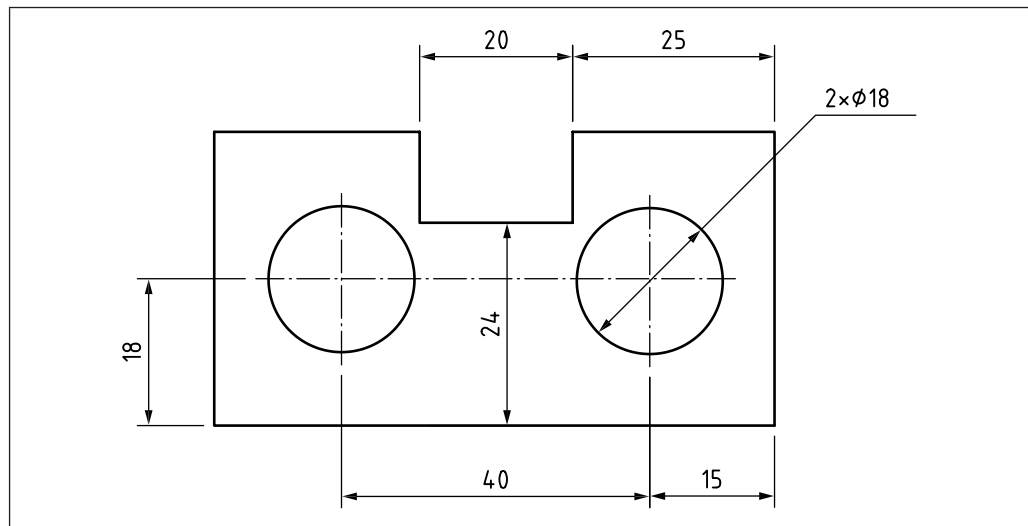
Whenever possible, dimensions shall not be placed within the contour of the depicted item.

Dimension lines of holes may be indicated oblique through the centre of the hole (see Figure 11).

Intersection of dimension lines with any other line should be avoided, but where intersection is unavoidable they shall be shown unbroken (see Figure 8).

The centre line or outline of a feature or their extensions may be used in place of an extension line (see Figure 11). However, a centre line or the outline of a feature shall not be used as a dimension line.

Figure 11 Dimension lines of holes



6.1.4.3 Extension lines

Extension lines shall be drawn as continuous narrow lines in accordance with BS ISO 128-20.

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

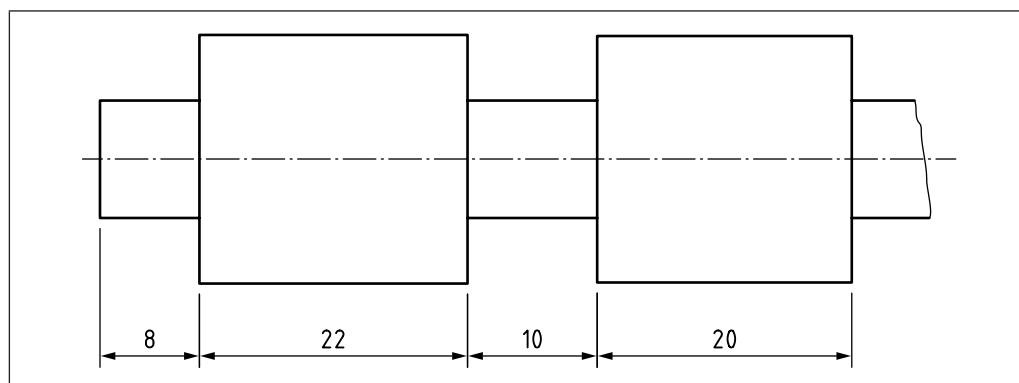
Extension lines shall extend approximately eight times the line width beyond their associated dimension line.

Extension lines should be drawn perpendicular to the corresponding physical length (see Figure 12, Figure 13 and Figure 16).

For circular features the extension line shall be drawn as a continuation of the feature shape (see Figure 55).

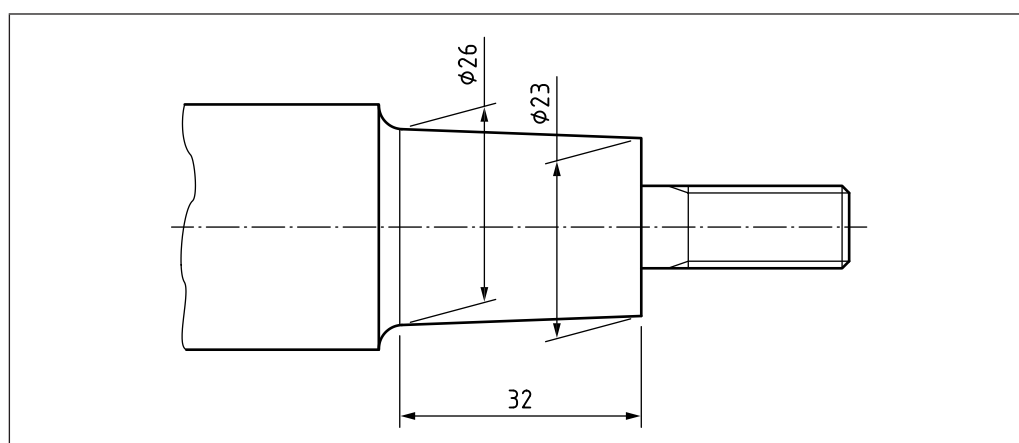
NOTE It is advisable to have a gap between the feature and the beginning of the extension line (see the information box in 6.2.1).

Figure 12 Extension lines



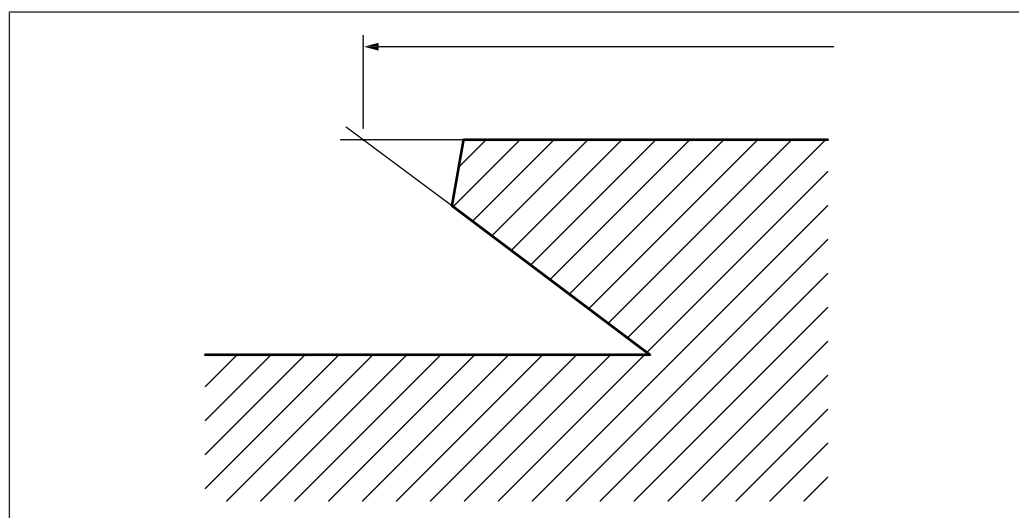
The extension lines may be drawn oblique to the feature but shall be parallel to each other (see Figure 13).

Figure 13 Oblique extension lines



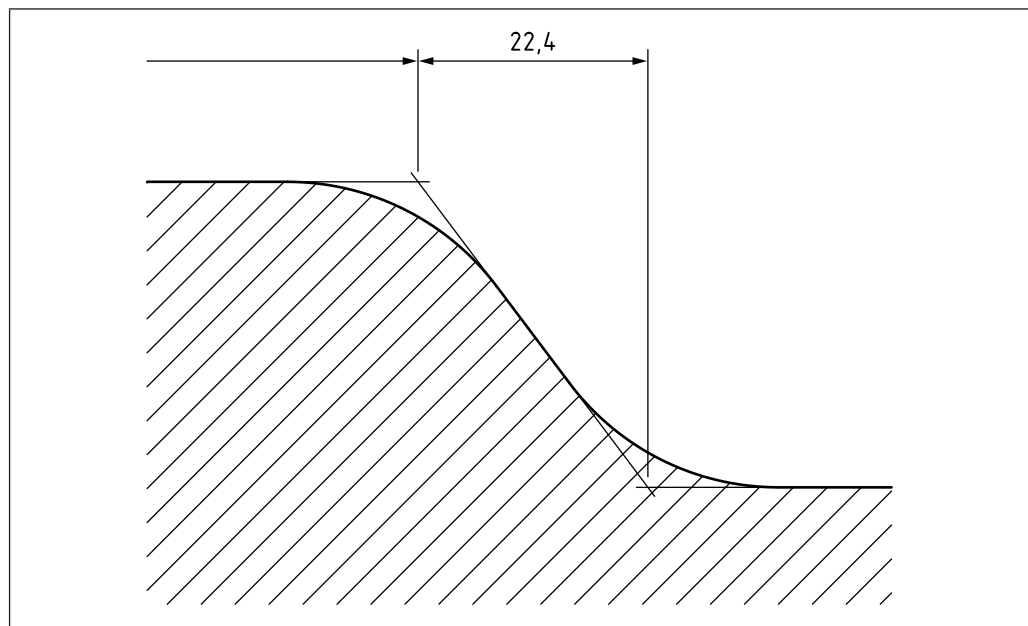
Intersecting projected contours of outlines shall extend approximately eight times the line width beyond the point of intersection (see Figure 14).

Figure 14 Intersection of projected contours of outlines



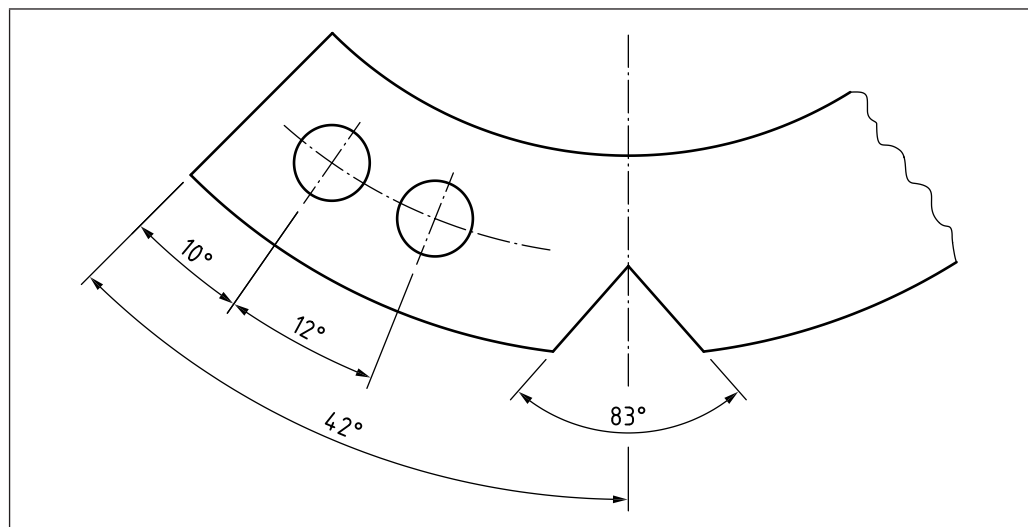
In the case of projected contours of transitions and similar features, the extension lines shall apply at the point of intersection of the projection lines (see Figure 15).

Figure 15 Intersection of projected contours of transitions and similar features



In the case of angular dimensions, the extension lines shall be the extensions of the angle legs (see Figure 16).

Figure 16 Extension lines of angular dimensions



6.1.5 Leader line

Leader lines shall be drawn in accordance with BS ISO 128-22.

6.1.6 Dimensional values

6.1.6.1 Indication

Dimensional values shall be indicated on drawings in characters of sufficient size to ensure complete legibility on the original drawing, as well as on reproductions made from microfilms (see BS EN ISO 6428).

NOTE Lettering ISO 3098-BVL (Type B, Vertical, Latin) is recommended.

6.1.6.2 Positions of dimensional values

Dimensional values shall be placed parallel to their dimension line and near the middle of and slightly above that line (see Figure 17 and Figure 18).

Dimensional values shall be placed in such a way that they are not crossed or separated by any line.

Figure 17 Position of dimensional values

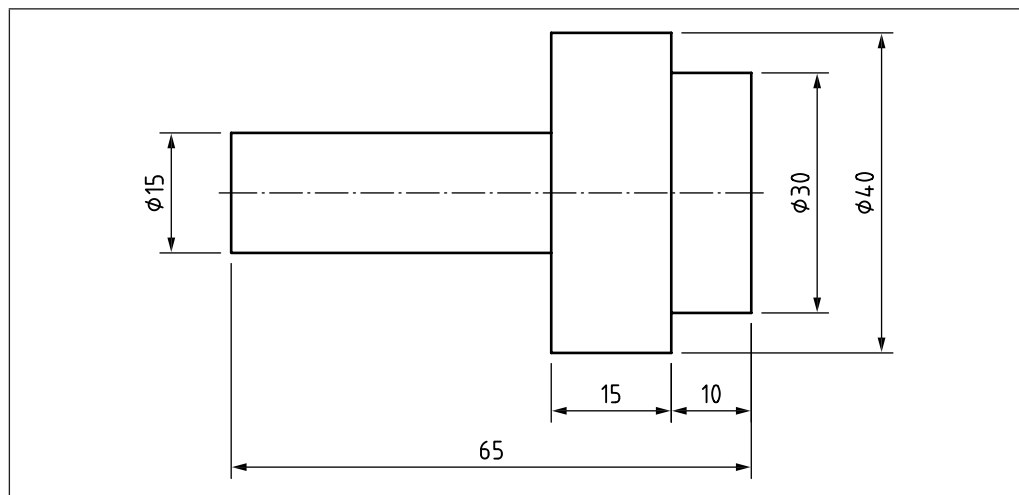
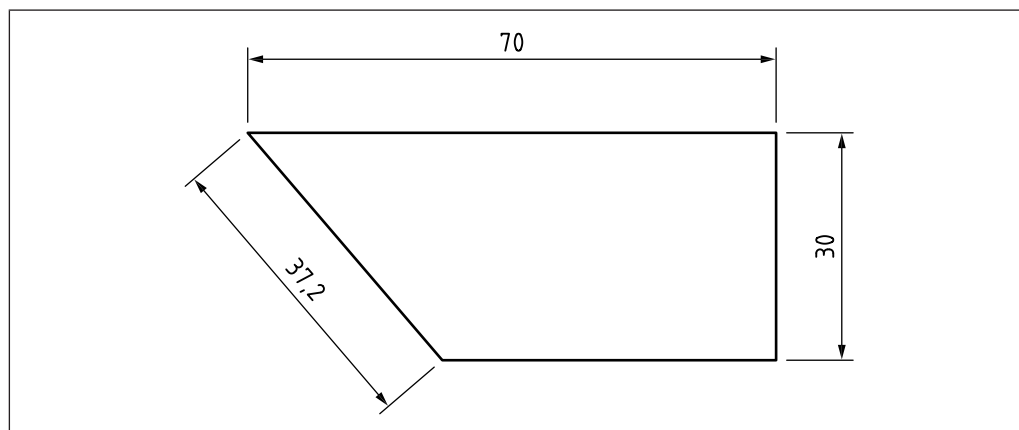


Figure 18 Position of dimensional values



Values of linear dimensions on oblique dimension lines shall be oriented as shown in Figure 19. 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 20. Angular dimensions shall be placed on top of the dimension line and follow the same rule as linear dimensions (see Figure 19).

Figure 19 Orientation of linear dimensions

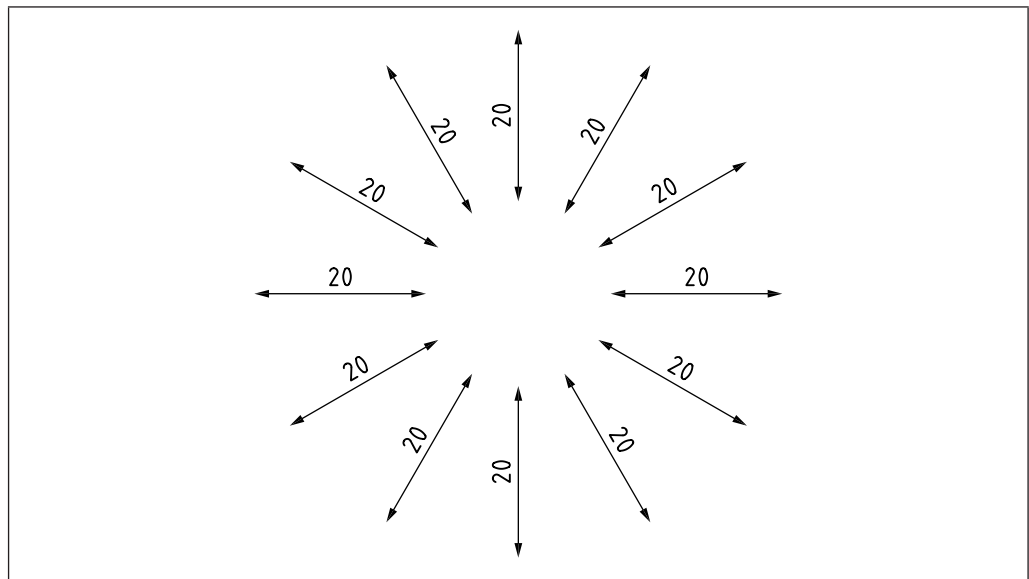
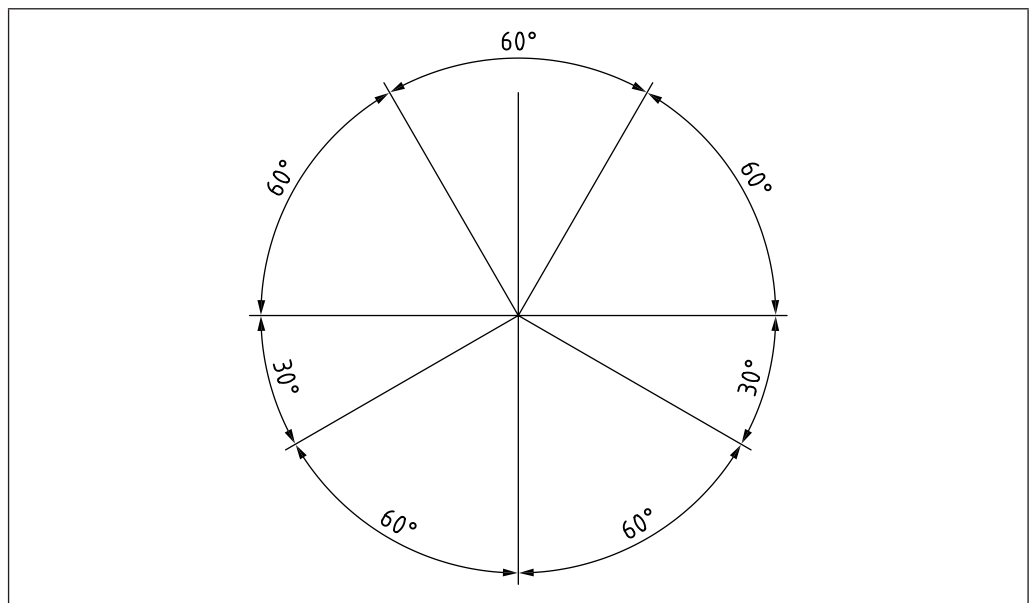


Figure 20 Orientation of angular dimensions



6.1.7 Indication of tolerances

6.1.7.1 General

Dimensional tolerancing for mechanical engineering shall be in accordance with BS EN ISO 14405. BS EN ISO 14405 may also be applied to fields other than mechanical engineering. Some of these rules are summarized here for information.

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

- general tolerances (see 6.1.7.2);
- limit deviations (see 6.1.7.3);
- limits of dimension (see 6.1.7.4).

All tolerances shall apply to the represented state of the feature in the technical drawing.

6.1.7.2 General tolerances

When general tolerances are controlled by another document or method, the reference shall be indicated on the drawing.

6.1.7.3 Limit deviations

The components of a toleranced dimension shall be indicated in the following order (see Figure 21 to Figure 29):

- the dimensional value;
- the limit deviations.

A space shall separate the dimensional values and the tolerance indication, e.g.:

- $55 \pm 0,2$;
- 30 min ;
- $\varnothing 10 \text{ h}7$.

Limit deviations shall be indicated by indicating the upper deviation above the lower deviation (see Figure 21 and Figure 22).

If one of the two limit deviations is zero, this shall be expressed explicitly by the digit zero shown without sign (see Figure 22).

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 23).

Figure 21 Components of a toleranced dimension

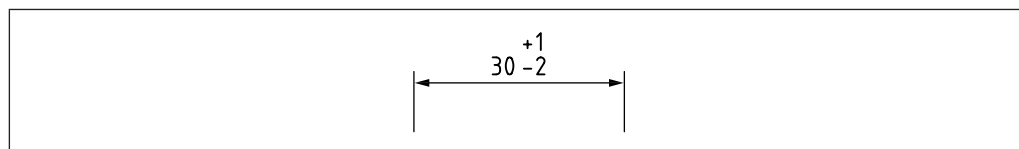


Figure 22 Components of a toleranced dimension

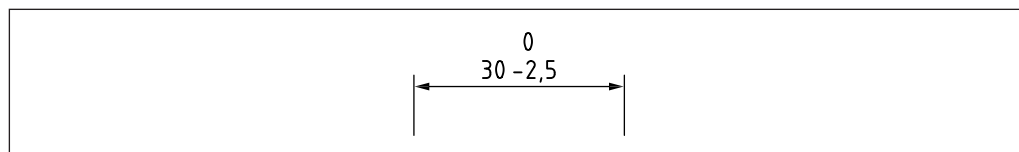
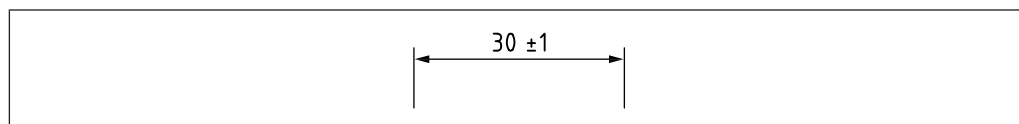


Figure 23 Components of a toleranced dimension

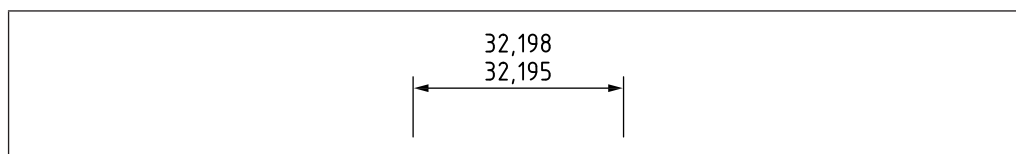


6.1.7.4 Limit dimensioning

6.1.7.4.1 Maximum and minimum limit dimensions

The limits of dimensions shall be indicated by a maximum and a minimum dimension (see Figure 24). The larger dimension shall be placed above the smaller dimension.

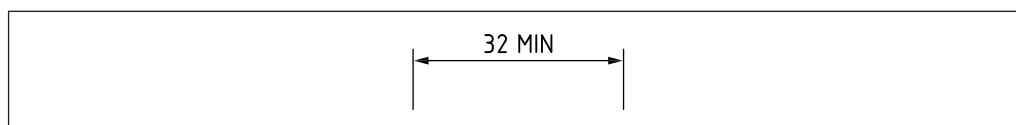
Figure 24 Limits of dimensions



6.1.7.4.2 Single limit dimensions

To limit the dimension in one direction only, the word "MIN" or "MAX" shall be added after the dimensional value (see Figure 25).

Figure 25 Single limit dimension



6.1.8 Indications of special dimensions: Arrangement of graphical and letter symbols with dimensional values

The following symbols shall be used with dimensions to identify the feature characteristics. The following symbols shall directly precede the dimensional value without space (see Figure 26 to Figure 30).

- $\varnothing$ Diameter
- R Radius
- $\square$ Square
- S $\varnothing$ Spherical diameter
- SR Spherical radius
- $\frown$ Arc length
- $t=$ Thickness of thin objects
- $\Downarrow$ Depth
- $\sqcup$ Cylindrical counterbore
- ∇ Countersink

Figure 26 Indications of special dimensions: Radius

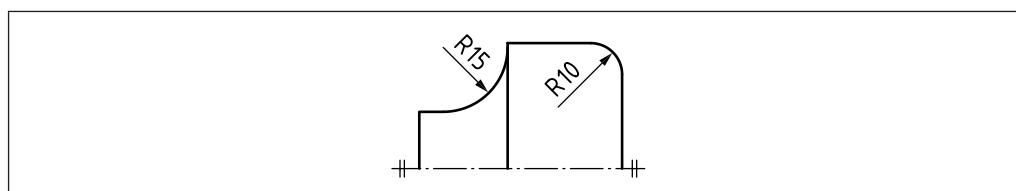


Figure 27 Indications of special dimensions: Square

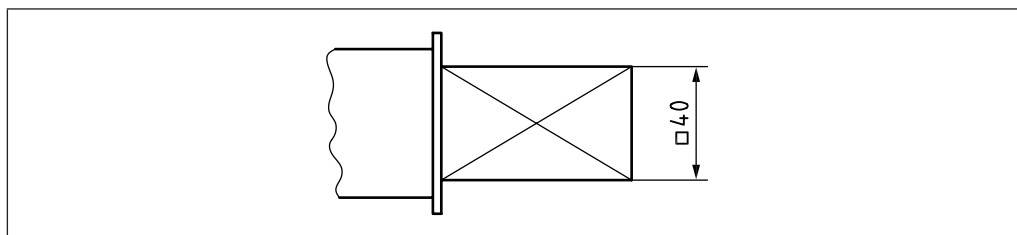


Figure 28 Indications of special dimensions: Spherical diameter

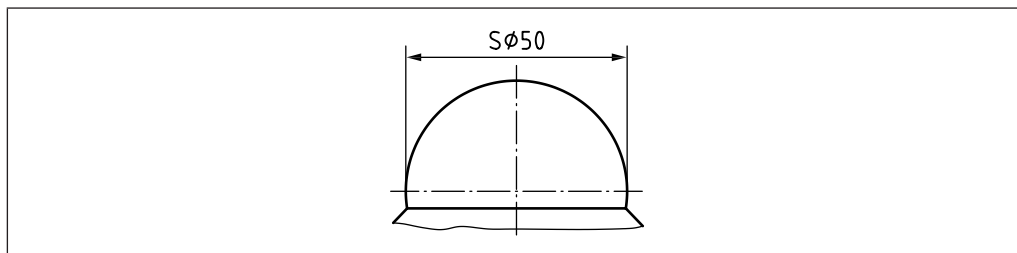


Figure 29 Indications of special dimensions: Spherical radius

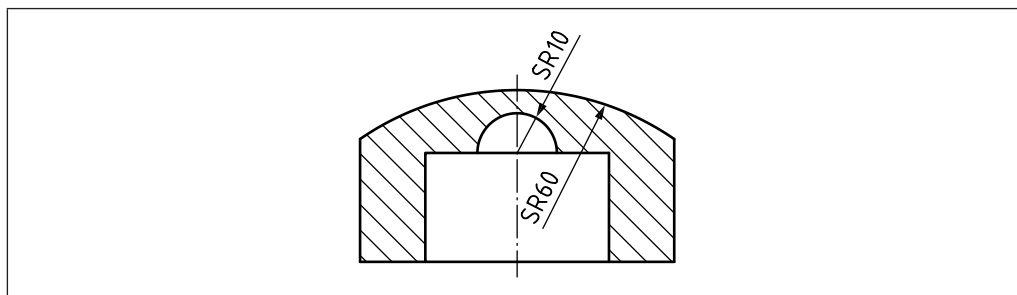
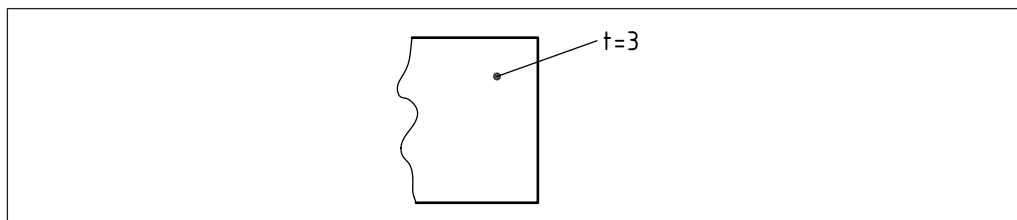


Figure 30 Indications of special dimensions: Thickness



When counterbore is indicated, the diameter, and depth if needed, of the counterbore shall be specified below the dimension value of the hole (see Figure 31). When countersink is indicated, the size and inclusive angle of the countersink shall be specified below the dimensional value of the hole (see Figure 32).

Figure 31 Diameter and depth of counterbore

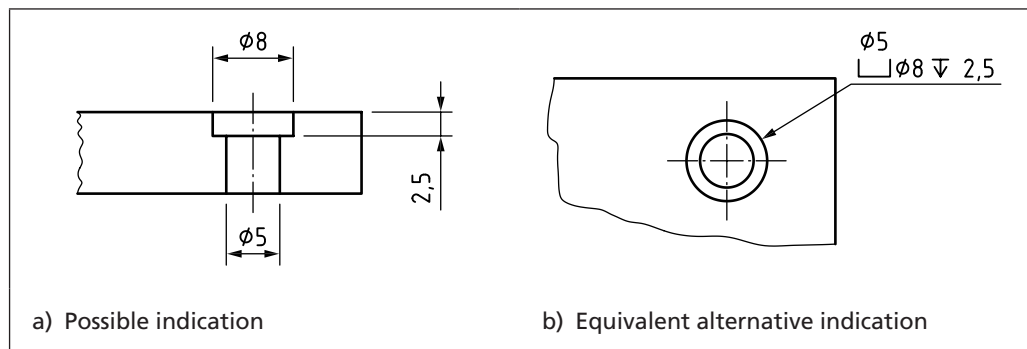
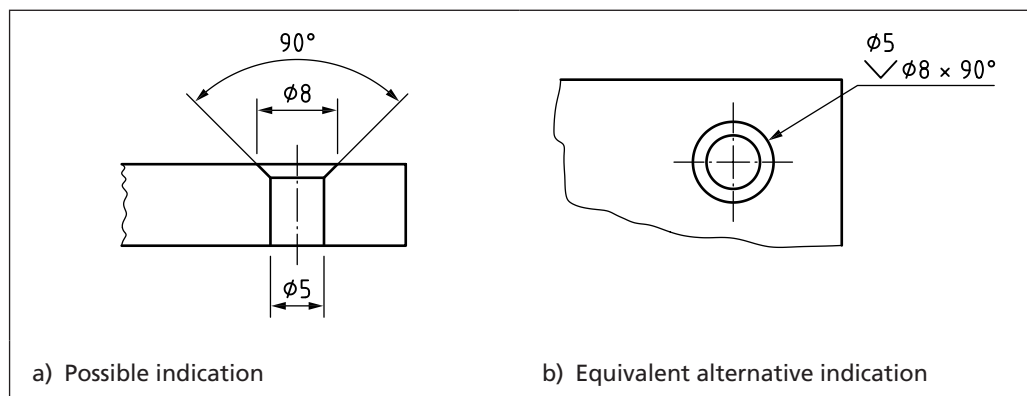


Figure 32 Size and angle of countersink



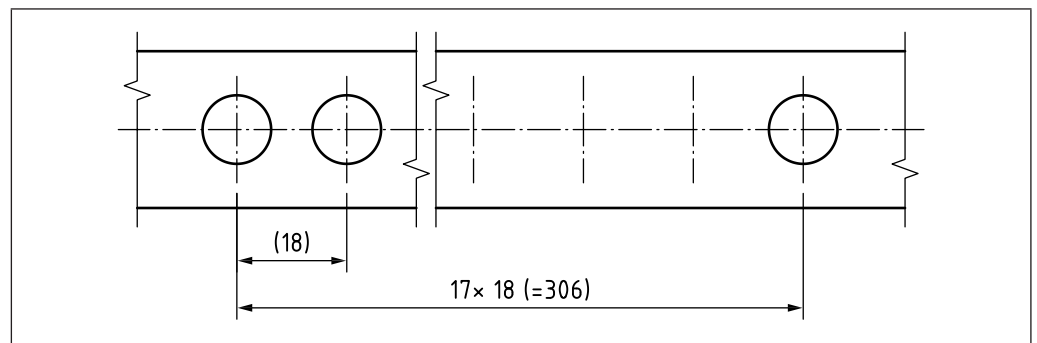
6.1.9 Equally-spaced and repeated features

6.1.9.1 Equally-spaced features

Where features have the same spacing and are uniformly arranged, their dimensioning shall, where appropriate, be simplified as follows.

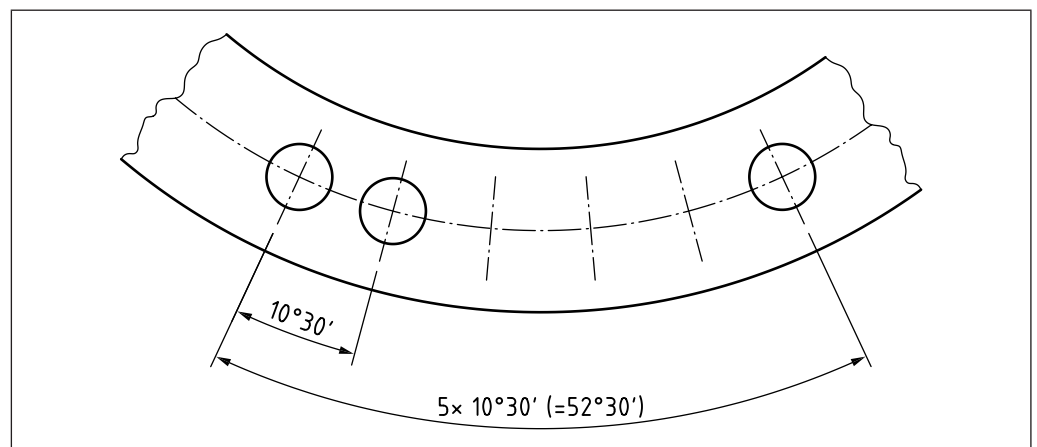
- Repeated linear and angular spacing can be indicated with the number of spacings and their dimensional value separated by the symbol "x". The number of features shall directly precede the symbol "x" without a space and the dimensional value shall be preceded by a space, e.g. 17x 18. If there is any risk of confusion between the length of the space and the number of spacings, one space may additionally be dimensioned (see Figure 33).
- The sum of the linear or angular spacing of the indicated features is an auxiliary dimension (see 6.1.14 and Figure 33 and Figure 34). The total representation shall be indicated as the number of spacings times the dimensional value of the spacings, and the sum given in parenthesis preceded by the equal sign.

Figure 33 Number of equally-spaced features and the dimensional value



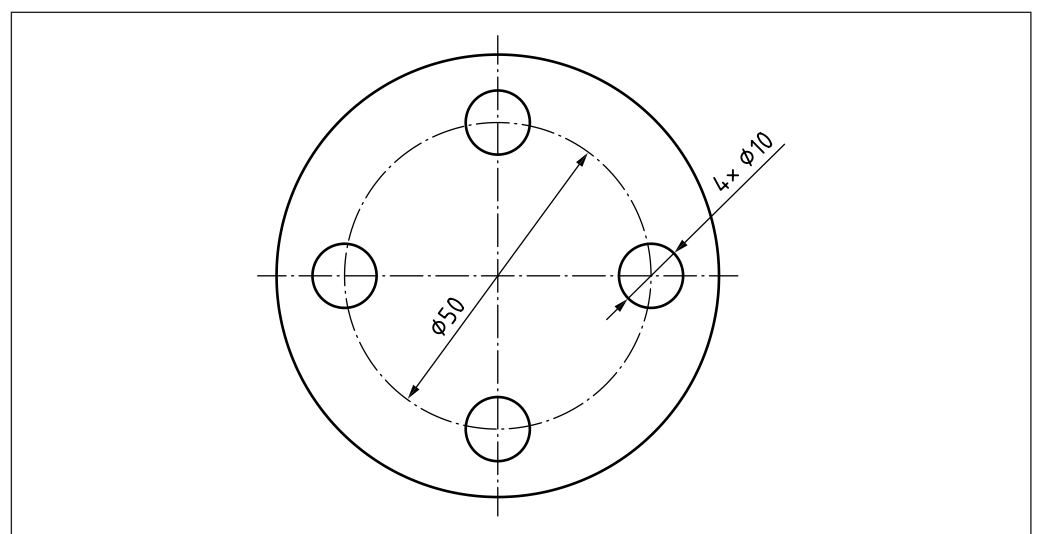
c) Angular spacing can be dimensioned as shown in Figure 34.

Figure 34 Dimensioning of angular spacing



d) The angles of the spacings can be omitted where spacings are self-evident and the indication does not lead to confusion (see Figure 35).

Figure 35 Angles of spacings



6.1.9.2 Repeated features

Where clarity is not impaired, features having the same dimensional value shall be indicated by that value preceded by the number of features and the symbol "x" (see Figure 36 and Figure 37).

Figure 36 Indication of features having the same dimensional value

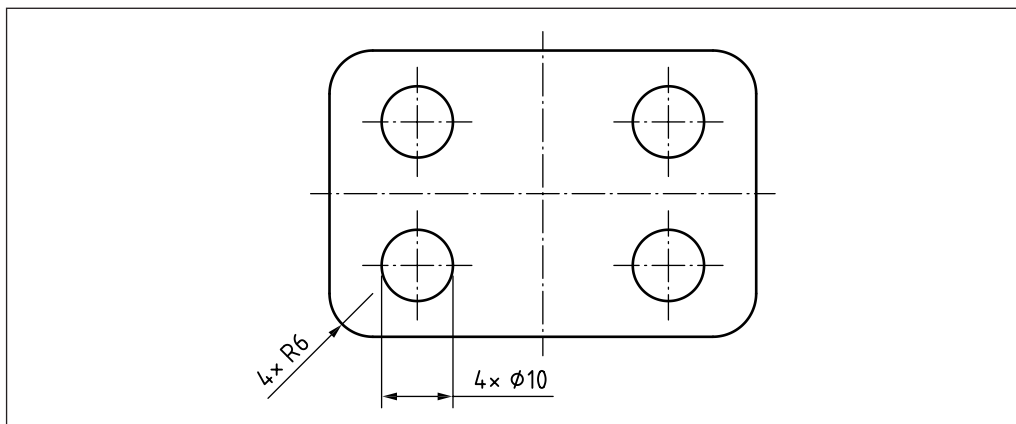
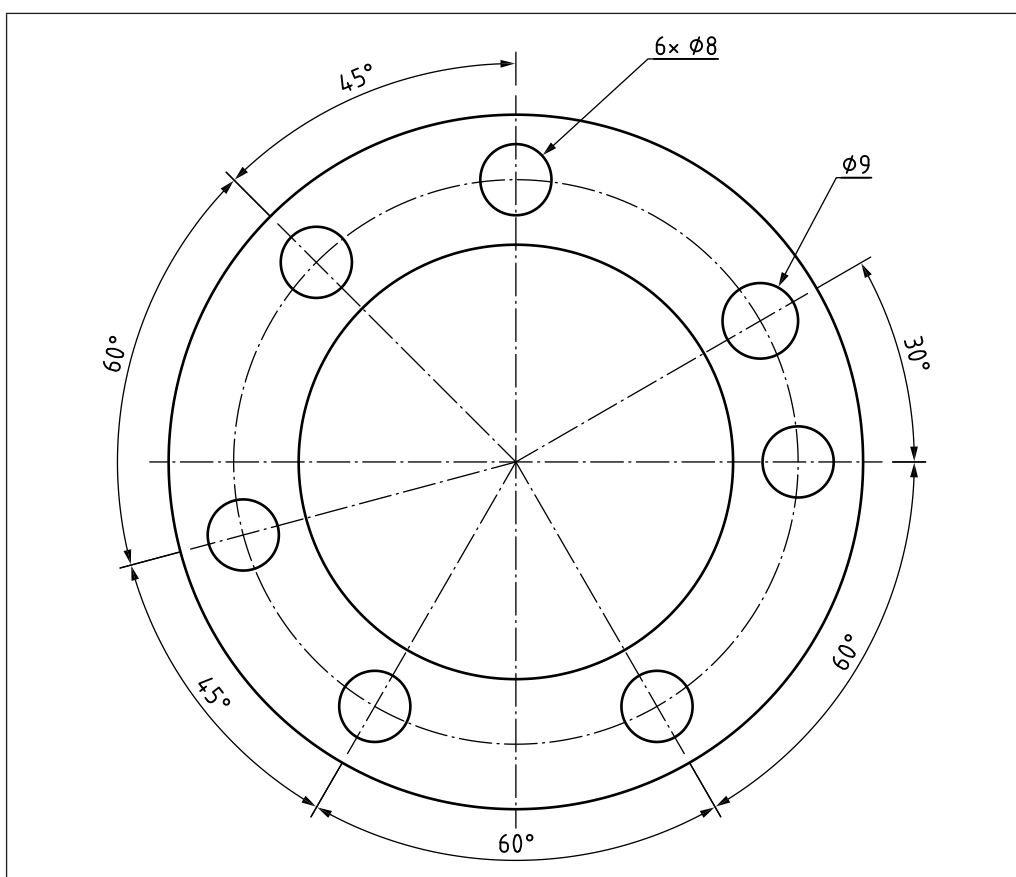


Figure 37 Indication of features having the same dimensional value

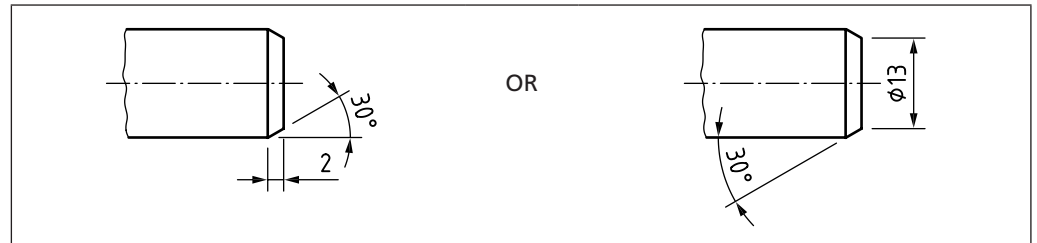


6.1.10 Chamfers

6.1.10.1 External chamfer

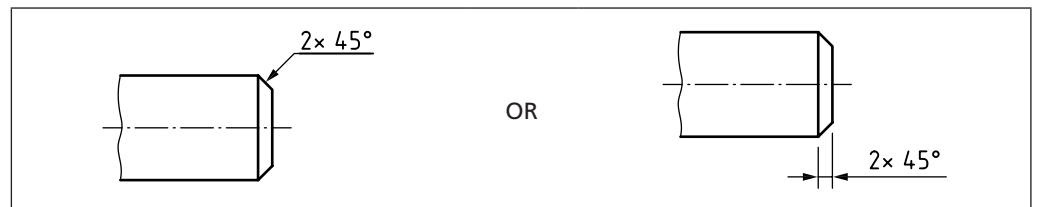
An external chamfer shall be dimensioned conventionally if the angle of the chamfer is not equal to 45° (see Figure 38).

Figure 38 Dimension of external chamfer not equal to 45°



If the chamfer angle is 45° , the indication can be simplified (see Figure 39).

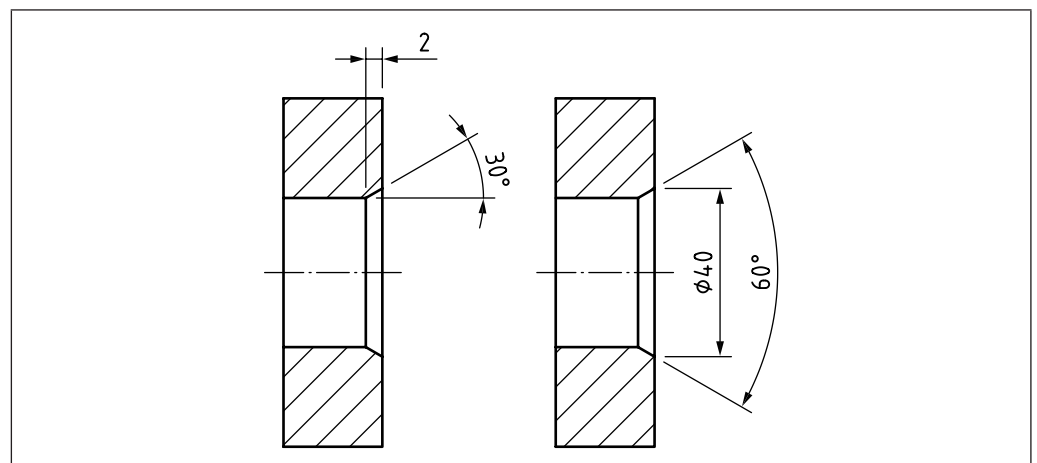
Figure 39 Dimension of external chamfer equal to 45°



6.1.10.2 Internal chamfer

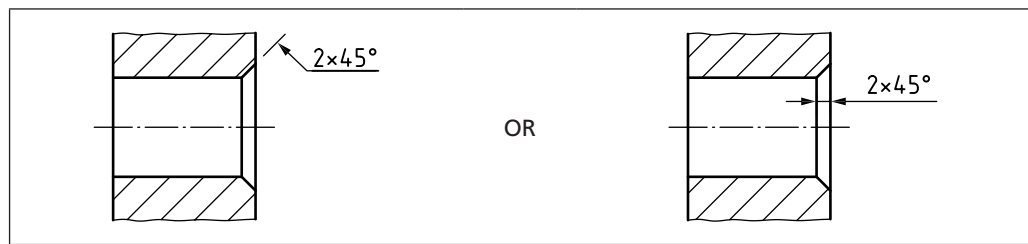
An internal chamfer shall be dimensioned conventionally if the angle of the chamfer is not equal to 45° (see Figure 40).

Figure 40 Dimension of internal chamfer not equal to 45°



If the chamfer angle is 45° the indication can be simplified (see Figure 41).

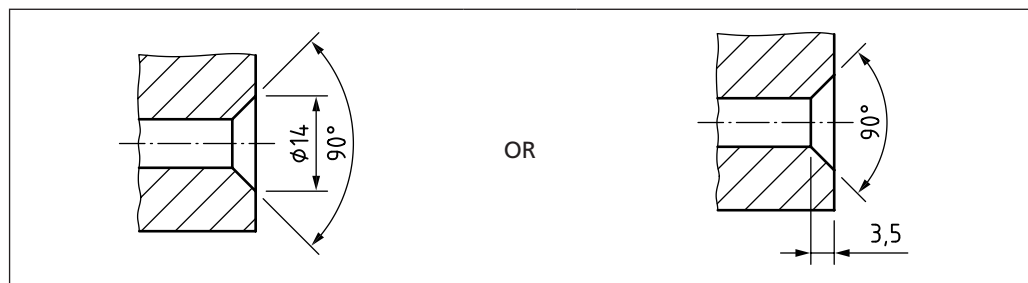
Figure 41 Dimension of internal chamfer equal to 45°



6.1.11 Countersink

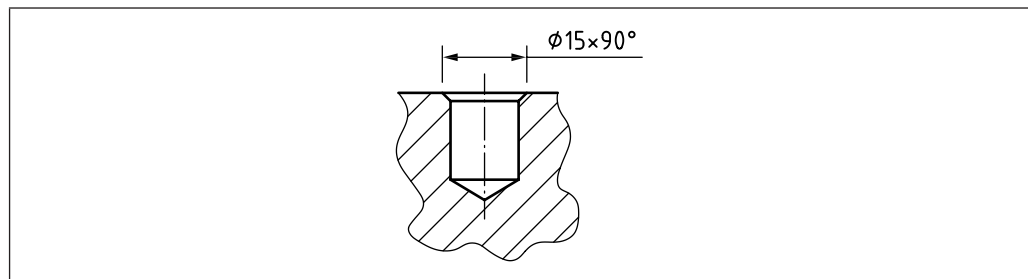
A countersink shall be dimensioned by showing either the required diametrical dimension at the surface and the included angle, or the depth and the included angle (see Figure 42).

Figure 42 Dimension of countersink



If the included angle is 90°, the indication may be simplified in accordance with BS ISO 15786 (see Figure 43).

Figure 43 Dimension of countersink: simplification



6.1.12 Symmetrical parts

The dimensions of symmetrical arranged features shall be indicated once only (see Figure 44 to Figure 46). The dimension shall indicate the total number of features which occur in the part.

Usually, the line of symmetry of features shall not be dimensioned (see Figure 44 to Figure 46).

In the case of half or quarter representations and if also required in the case of full representations, a symmetry symbol (see BS ISO 128-30) shall be indicated at both ends of the line of symmetry (see Figure 44 to Figure 46).

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 Figure 44 to Figure 46).

Figure 44 Symmetrical parts

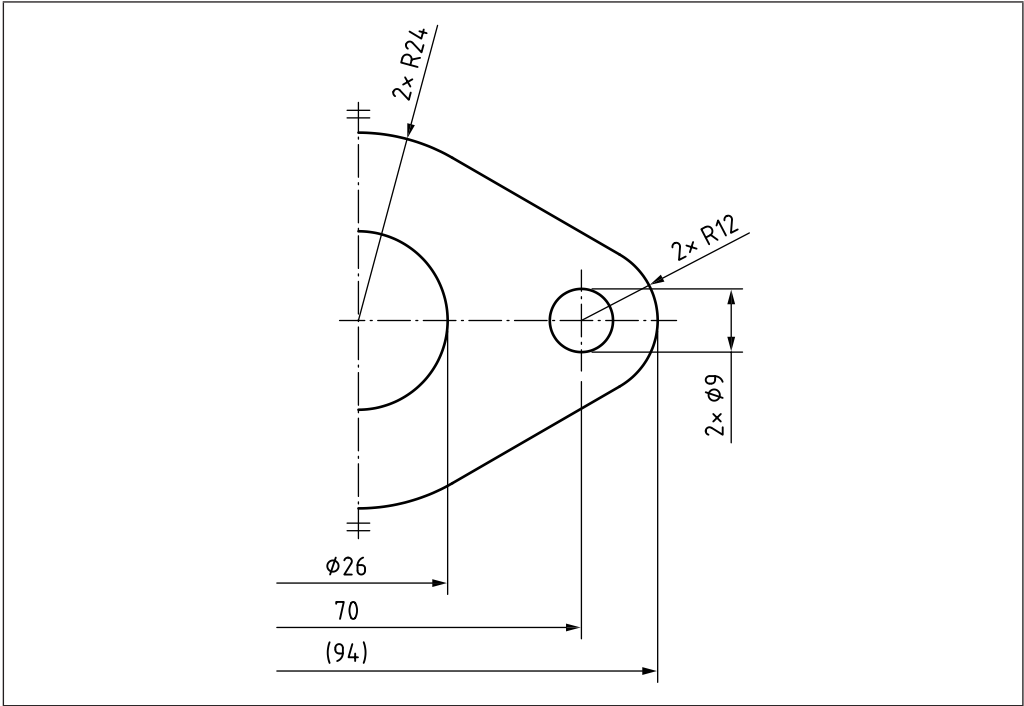


Figure 45 Symmetrical parts

