

## British Standards

The British Standards Institution (BSI) is the body responsible for determining British Standards for products, materials, systems and services at European and international level.

In the Higher Graphic Communication course it is expected that you will familiarise yourself with the guide **British Standard for Technical Product Specification (TPS), BS 8888**. In the guide a Technical Product Specification is defined as a **working drawing of the proposed design of the whole product**.

Familiarising yourself with BS 8888 will give you the theoretical knowledge needed for the Higher exam and assist in the completion of production drawings for the Thematic Presentation.

The main purpose of the guide is to establish a common standard for communicating product and drawing details between designers and manufacturers, with clear understanding and consistency worldwide.

British Standards are universally understood by everyone involved in producing or using production drawings. Using British Standards has a number of advantages:

- drawings are easier and quicker to draw because products are simplified
- drawings are easier to understand due to their concise nature
- drawings can impart lots of information efficiently.

This section of the book gives a brief overview of the requirements of producing production drawings which conform to BS 8888. There are four main areas to consider:

- setting up production drawings
- projection methods
- making drawings easier to understand
- representing standard components.

This section is intended as reference only. For more detailed information on each of these topics, refer to BS 8888 itself.

## Setting up a production drawing

Ensuring that all production drawings are set out in a consistent way helps reduce errors which might inadvertently be introduced by the use of an unusual or non-standard presentation.

### Title Blocks

Title blocks should be at the bottom of the sheet and extend to the lower right-hand corner of the page. The following information should be contained within:

- name
- date
- projection symbol
- original scale
- title
- drawing number
- dimensional tolerances.

### Drawing Scales

Every technical drawing needs to be drawn in accurate proportion, i.e. to a uniform scale. This scale should be given in the title block as a ratio, e.g. ORIGINAL SCALE 1:2.




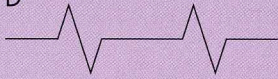


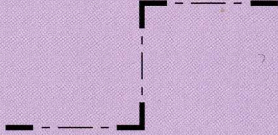

In the Higher course you should be aware of the following recommended scales within BS 8888:

Full size	Reduction scales (drawings less than full size)	Enlargement scales (drawings larger than full size)
1:1	1:2, 1:5, 1:10, 1:20, 1:50, 1:100, 1:200, 1:500, 1:1000	2:1, 5:1, 10:1, 20:1, 50:1

### Lines and line work

On working drawings the line work should be the appropriate type, thickness and density. The type and thickness of a drawn line conveys specific information to the reader. Failure to do this could lead to the intentions of the designer being misunderstood by the user. A selection of lines that may be encountered in the Higher course is shown in the table on the following page.



Line	Description	Application
A 	Continuous thick	Visible outlines and edges
B 	Continuous thin	Dimension, projection and leader lines, hatching, outlines of revolved sections, short centre lines, imaginary intersections
C 	Continuous thin irregular	Limits of partial or interrupted views and sections if the limit is not an axis
D 	Continuous thin with straight zigzags	Limits of partial or interrupted views and sections if the limit is not an axis
E 	Dashed thin	Hidden outlines and edges
F 	Chain thin	Centre lines, lines of symmetry, trajectories, loci, pitch lines and pitch circles
G 	Chain thin thick at ends and changes of direction	Cutting planes
H 	Double dashed chain thin	Outlines and edges of adjacent parts, outlines and edges of alternative and extreme positions of movable parts, initial outlines prior to forming, bend lines on developed blanks or patterns

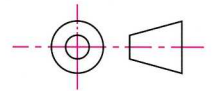
## Projection methods

BS 8888 identifies two main methods of projection, **orthographic** projection and **axonometric** projection, that are relevant to students of Higher Graphic Communication.

### Orthographic projection

Standards for orthographic projection include the two types of orthographic projection in use, **first angle** orthographic projection and **third angle** orthographic projection. These are the most commonly used methods of representing technical objects and are considered to be the accepted technical language. Of the two methods the most widely used is third angle orthographic projection.

The third angle projection symbol indicates the method of projection used on orthographic drawings. This is the method used in this course.



### Axonometric projection

Standards for axonometric projection include the most commonly used methods of pictorial representation: **oblique** projection, **isometric** projection and **planometric** projection. These methods do not usually provide all the information required to define a product, but may be used to provide general information without requiring special skills or knowledge to be able to interpret drawings.

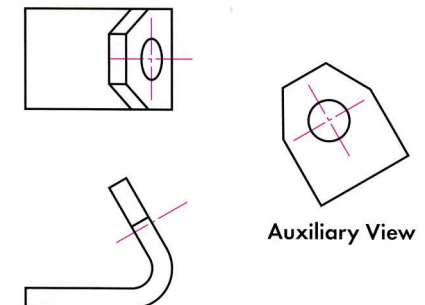
## Making drawings easier to understand

One of the most important features of good drawings is that they should be easy to understand. With complex components, there are occasions when orthographic drawing may have limitations and it is sometimes necessary to provide further information in the form of additional or partial views of the component parts of a product. The main methods to consider are:

- auxiliary views
- sectional views
- partial views
- interrupted views.

### Auxiliary views

An auxiliary view is a view added to the main view to impart more information about the product. These views are completely new elevations of the product used to give true representations of features where this cannot be achieved by orthographic projections (see pages 38–47).

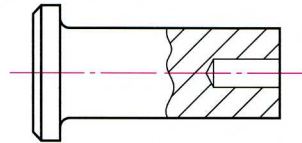




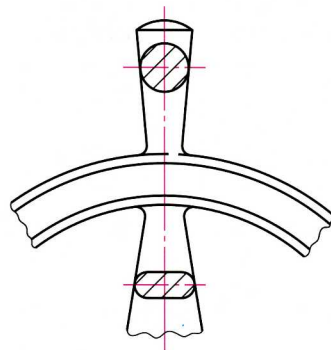
## Sectional views

There are many types of sectional view (other than a section along one plane) that can be employed to aid the clarity and understanding of production drawings. The following types of sectional views are useful for showing detail in more complex engineered objects:

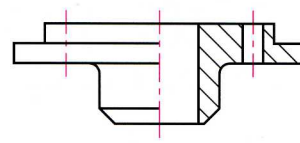
### • local or part sectional view



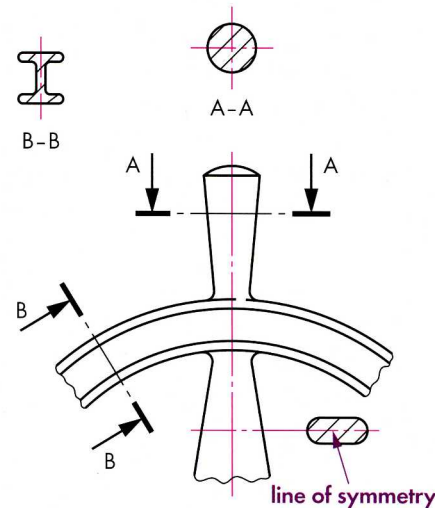
### • revolved sections



### • half sectional view

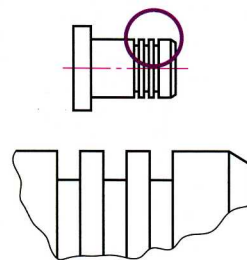


### • removed sections



## Partial views

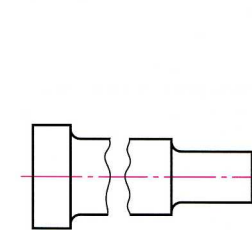
It is not always necessary or desirable to enlarge a full view. There are occasions when a partial view can be used to enlarge a detail and improve clarity.



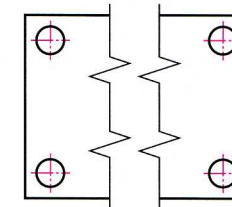
Enlarged Partial View

## Interrupted views

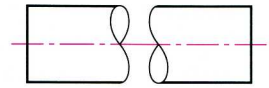
Drawings can be made to fit a sheet or screen more easily using interrupted views. These views only show the portions of a long or large object that are necessary to define it. They are drawn close to each other and break lines are used to define the edges of the section that has been removed.



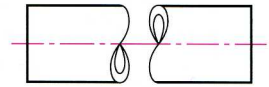
Type C lines used for solid shaft



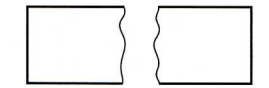
Type D break lines



Conventional break lines for solid shaft



Conventional break lines for hollow shaft



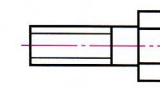
General break lines (type C lines)

## Representing standard components

Modern engineering makes use of an extensive range of standard components. It's important that these standard components are all represented properly to allow products to be assembled correctly.

### Screws and nuts

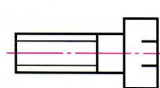
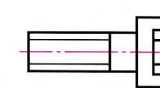
The simplified representations of a range of screws and nuts are shown below. Although you may not need to use many of the representations shown here, learning them builds your theoretical knowledge and enables you to read engineering drawings more accurately. Note that these are not actual representations, but are drawn to conventions. A convention is an agreed method that is accepted as common usage.



Hexagon head screw



Hexagon socket screw



Cylinder screw cross set



Countersunk screw



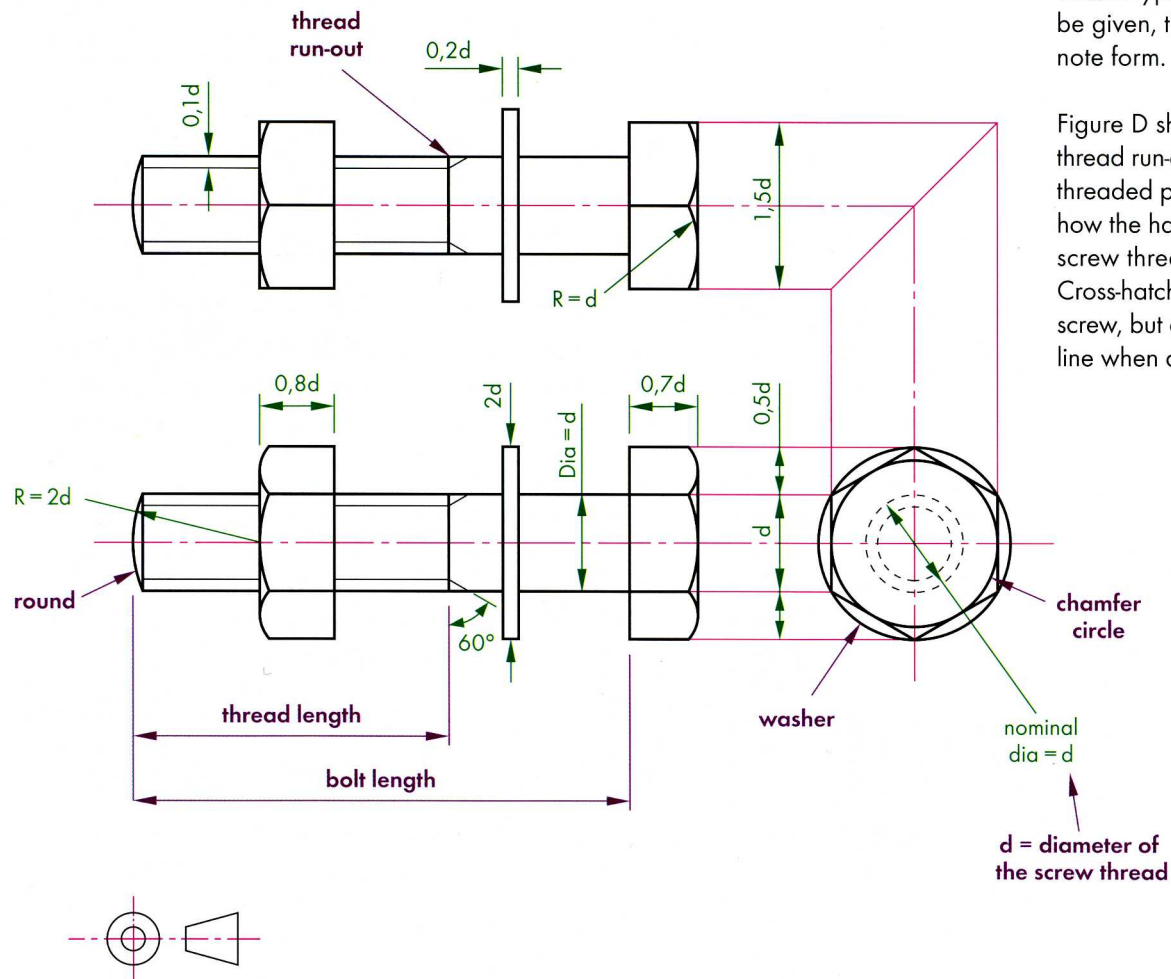
Hexagon nut



Square nut

## Bolt construction

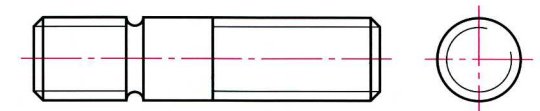
The figure below gives recommended sizes and construction details of an assembled hexagon head bolt, nut and washer. Familiarise yourself with the parts of the bolt that are labelled – you may be asked to draw them.



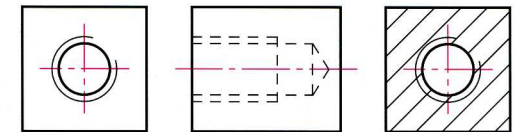
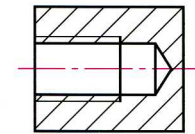
## Screw threads

Figures A, B and C show the main conventions and details of how orthographic and sectional views of threaded parts are drawn. These conventions are used irrespective of thread type. However, if the thread type and size needs to be given, this is usually done in note form.

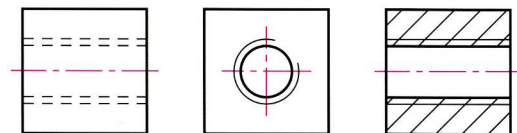
Figure D shows details of the thread run-out and how assembled threaded parts are drawn. Note how the hatching is affected when screw threads are assembled. Cross-hatching lines stop at the screw, but continue to the inside line when a screw is not present.



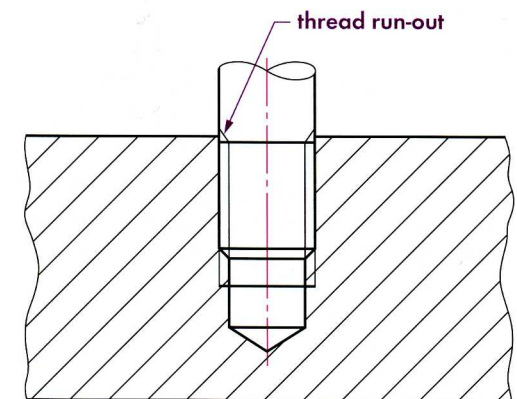
### A External screw threads



### B Internal threads (blind hole)



### C Internal threads (through hole)

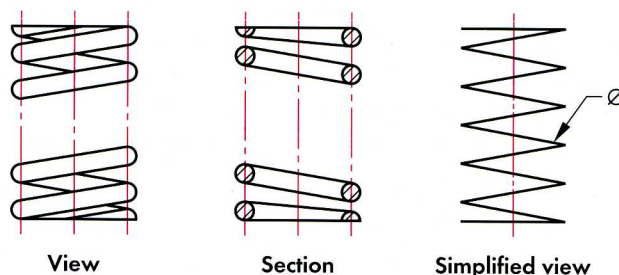


#### D Assembled screw thread

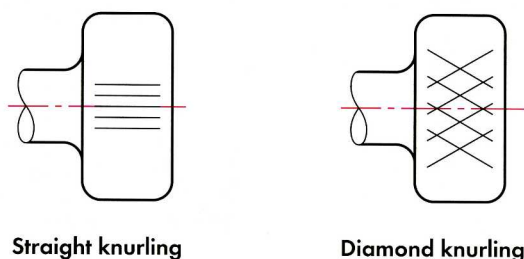


## Helical springs

The figures below give the conventional representations of a cylindrical helical spring made of wire with a circular cross section. If necessary the cross section of the spring material can be indicated in words or by a symbol.



Knurling is represented by showing only part of the surface it is applied to. For diamond knurling the lines should be drawn at 30° to the centre line.



## Symbols and abbreviations

Symbols and abbreviations are used to save time and space on engineering drawings. Consistent use of symbols and abbreviations aids clarity. Use the following list as a reference – you will come across several examples during this course and they may be used in your thematic presentation.

AF	Across flats
ASSY	Assembly
CRS	Centres
CL	Centre line

CHAM	Chamfer
CH HD	Cheese head
CSK	Countersunk
CSK HD	Countersunk head

CBORE	Counter bore
CYL	Cylinder or cylindrical
20°	Degree symbol
DIA	Diameter (in a note)
Ø	Diameter (preceding a dim)
DRG	Drawing
EQUI SP	Equally spaced
EXT	External
FIG.	Figure
HEX	Hexagon
HEX HD	Hexagon head
I/D	Inside diameter
O/D	Outside diameter
INT	Internal
LH	Left hand
LG	Long
✓	Machining symbol
M	Metric screw thread
MATL	Material
MAX	Maximum
MIN	Minimum
mm	Millimetre

NO.	Number
NTS	Not to scale
PCD	Pitch circle diameter
R	Radius (preceding a dim)
RAD	Radius (in a note)
RH	Right hand
RD HD	Round head
SCR	Screw or screwed
SPHERE	Spherical
SØ	Spherical diameter (only preceding a dimension)
SR	Spherical radius (only preceding a dimension)
SFACE	Spotface
SQ	Square (in a note)
□	Square (preceding a dim)
STD	Standard
THD	Thread
THK	Thick
TYP	Typical or typically
UCT	Undercut
VOL	Volume
WT	Weight



## Dimensioning

Dimensioning is the process of stating measurements on technical drawings. Dimensions are a key element of communication between the design engineer and the manufacturer of the product. The system of dimensioning currently used in the UK is set by the British Standards Institution in their document BS 8888.

## General principles

- There should be no more dimensions than are necessary to completely define the object.
- Linear dimensions should be expressed in millimetres (mm). If this is stated in the title block then the unit symbol **mm** should be omitted from the individual dimensions.
- All measurements should be in millimetres unless instructed otherwise. If other units are used the symbols should be shown with their respective values.
- Dimensions should be expressed to the least number of significant figures, e.g. 22 not 22,0.
- Crossing of projection/leader lines should be avoided if possible.
- Dimensions should not, where possible, be crossed by other lines in the drawing.

## Dimensioning standard practice

### Radii

Always show the radius on arcs, curves and rounded corners. The letter symbol **R** is always shown in front of the figure. Radii should be dimensioned by a line that passes through or inline with the centre of the arc. The dimension line should have only one arrowhead, which should touch the arc.

### Diameters

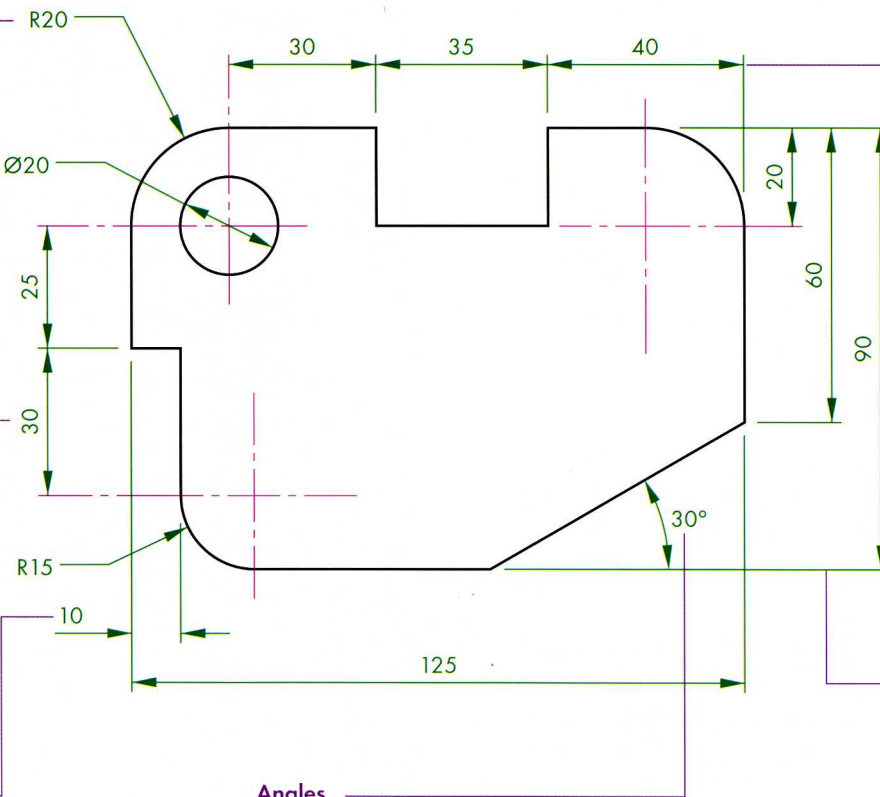
Where a complete circle is shown in a drawing, the diameter is shown by placing the symbol **Ø** in front of the figure. The radius should never be used to dimension a complete circle. When holes or circles are dimensioned, the diameter is shown as well as the location of the centre.

### Figures on linear dimension lines

Figures on dimension lines should be placed so that they can be read from either the bottom or the right-hand side (above and along the line). Figures should not touch outlines, dimension lines or centre lines. Figures that require a decimal marker should use a comma, e.g. 22,1.

### Dimensioning small features

Where space is limited for dimensioning small features, the figure can be placed centrally, above or in line with one of the dimension lines.



### Intermediate dimensions

Intermediate dimensions give sizes for individual parts of the drawing which appear in line with each other. In this example the arrangement of these dimensions shown is known as **chain dimensioning** (one after the other).

### Datum line

Multiple dimensions can be taken from a datum line (as in this example) and set out parallel to each other, using **parallel dimensioning**.

### Overall dimension lines

Overall dimensions give the maximum sizes of objects (total length and total height). They should be placed outside all other dimensions.

### Projection/leader lines

Projection, or leader, lines are used to allow the dimension line to be placed outside the outline of the drawing to aid clarity. A small gap should be left between the outline of the drawing and the projection line. Projection lines should be drawn at right angles to the dimension line and extend past it slightly.

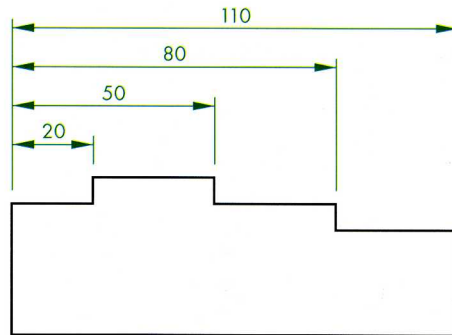
### Angles

Figures on angular dimensions should be oriented so that they can be read from the bottom or the right-hand side of the drawing.

## Examples of dimensioning methods

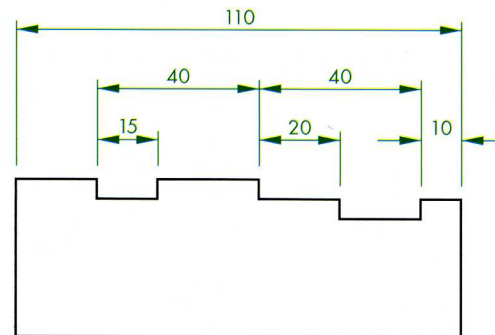
### Parallel dimensioning

Parallel dimensioning consists of a number of dimensions that originate from a common reference feature (a datum edge).



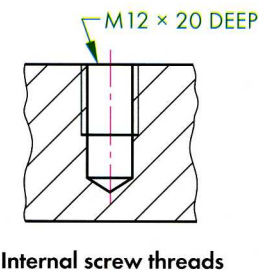
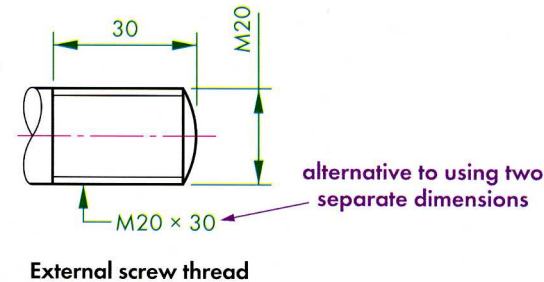
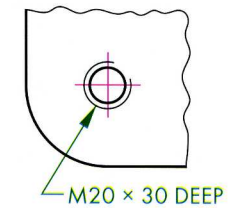
### Combined dimensioning

Combined dimensioning is a combination of parallel dimensioning and chain dimensioning that can be used when space is limited or the drawing is very complex.



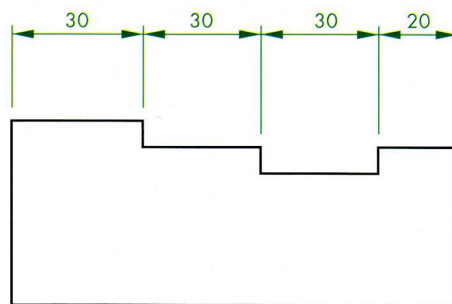
### Dimensioning screw heads

When dimensioning screw threads, the thread system and size should be given. The letter **M** indicates ISO metric threads and is followed by the nominal diameter.



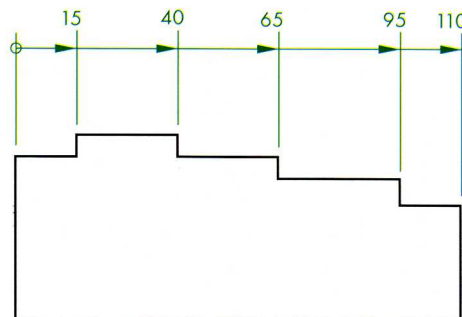
### Chain dimensioning

Chain dimensioning consists of a chain of dimensions. This method can lead to an accumulation of tolerances that will affect the function of the part.



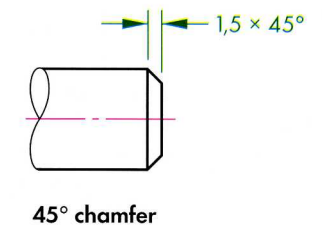
### Running dimensioning

Running dimensioning is a simplified form of parallel dimensioning that can be used when space is limited. It has a common origin as shown below. Dimension values may be either above and clear of the dimension line (as in this example), or along the corresponding projection line.



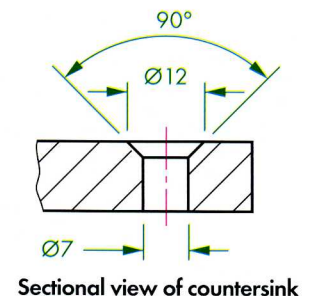
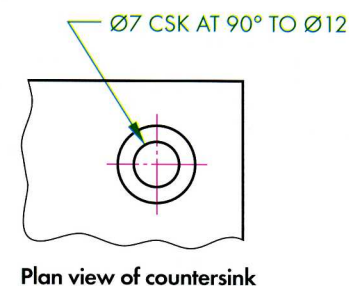
### Chamfers

Chamfers at 45° should be dimensioned as shown. Chamfers at an angle other than 45° should dimension the angle separately.



### Countersinks

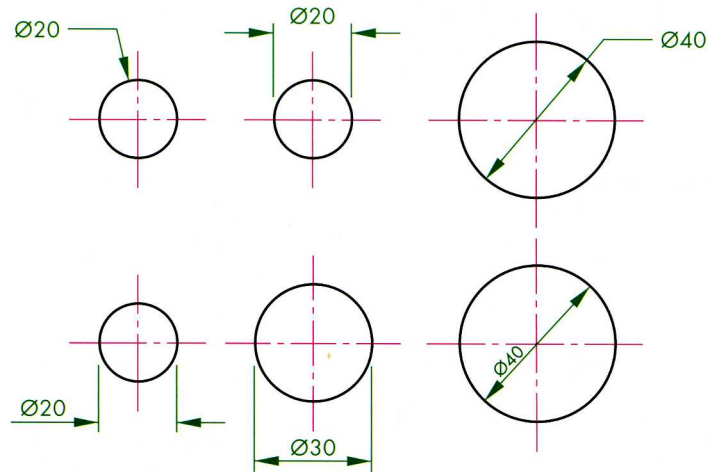
Two examples of dimensioning countersunk holes are shown. The diameters of the countersink and the hole and the angle of the countersink should be given.



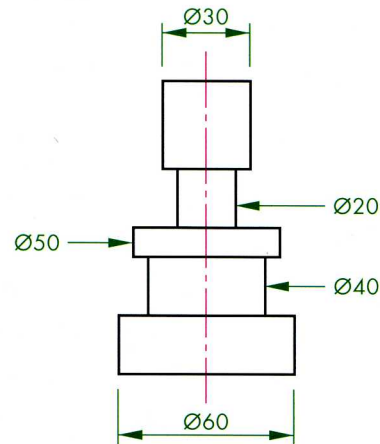
# DIMENSIONING

## Dimensioning diameters

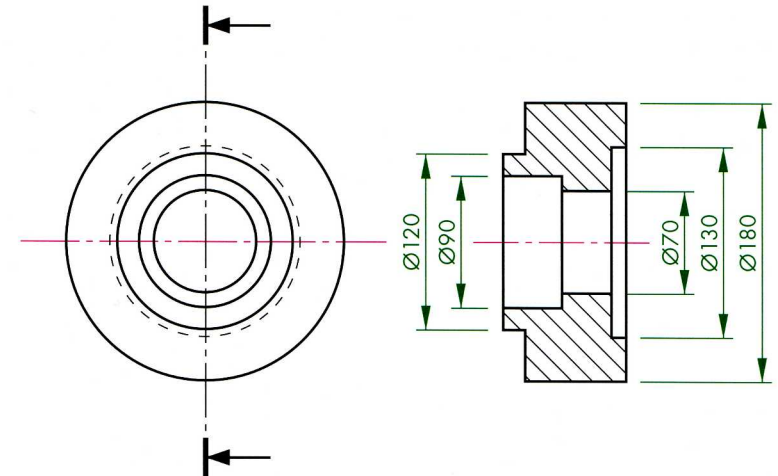
Circles dimensioned in a variety of acceptable methods:



Dimensions of diameters indicated by leader lines:

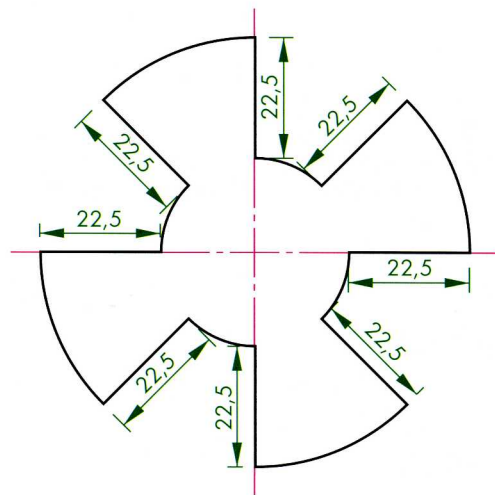


Dimensions of diameters should be placed on the view providing the greatest clarity:

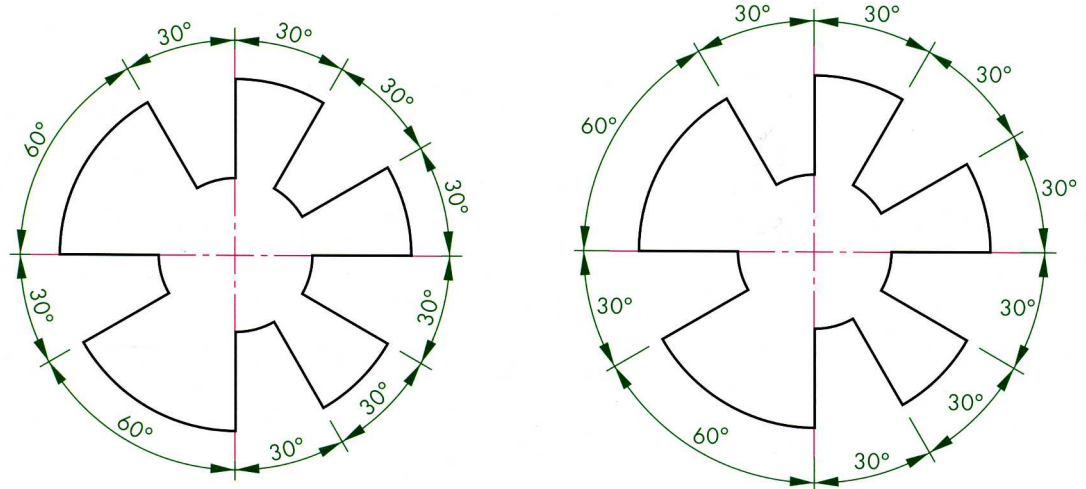


## Orientation of dimensions

This diagram shows where linear dimensions should be placed on sloping edges:



Angular dimensions can be positioned using either of the methods shown below:



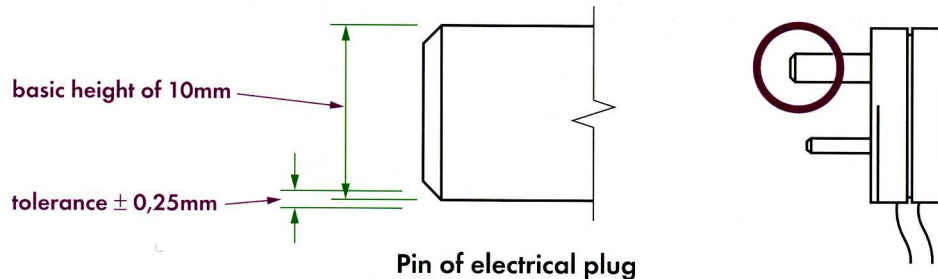


## Tolerances

When products are manufactured in industry, because of inaccuracy in manufacturing processes it is very difficult to achieve absolute accuracy in the size of the finished item. This creates problems when manufactured items have to fit accurately with other parts. When individual component parts are manufactured in batches of thousands or more, it is not economic to accept parts that do not fit and so cannot be assembled. To overcome this problem, items are manufactured with an acceptable margin of dimensional error called the **tolerance**.

Tolerances that affect the size of an item or features contained within an item are known as **dimensional tolerances**. Tolerances can also be applied to the dimensions of location features on the item, e.g. the position of holes and slots to ensure that one part can be assembled with the next part.

For example, the height of a pin of an electrical plug, as shown below, is 10mm. The company has determined that this size could vary between 9,75mm and 10,25mm and still be able to fit in the slot provided for it in the wall socket. In this case a tolerance of 0,5mm could be applied to this dimension without affecting the function of the part. This 0,5mm tolerance band is normally stated as  $\pm 0,25\text{mm}$ .



## Functional and non-functional dimensions

In practice, all dimensions in manufacturing drawings are subject to tolerances. There are however two distinct types to consider: **functional** and **non-functional** dimensions.

**Functional dimensions** are dimensions that directly affect the function and fit of parts. An example is the diameter of a sink plug which must fit into a plug hole in a sink. **Non-functional dimensions** are dimensions that do not directly affect the function or fit of a part, but may allow the product to meet other criteria such as final appearance or strength. An example is the height of a sink plug, which could vary without affecting its function.

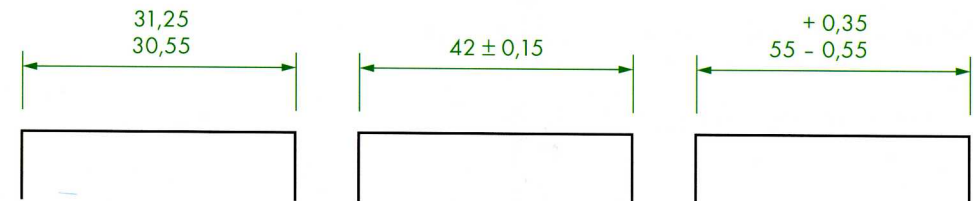
There are two ways to represent tolerances in manufacturing drawings. **Non-functional dimensions** are generally represented in note form in the title block and are often referred to as general tolerances. For example:

TOLERANCES UNLESS OTHERWISE STATED  
 LINEAR  $\pm 0,25$  ANGULAR  $\pm 0^\circ 30'$

Tolerances on **functional dimensions** are represented by attaching information to individual dimensions on the drawing. The methods used to indicate tolerances on individual dimensions are shown below.

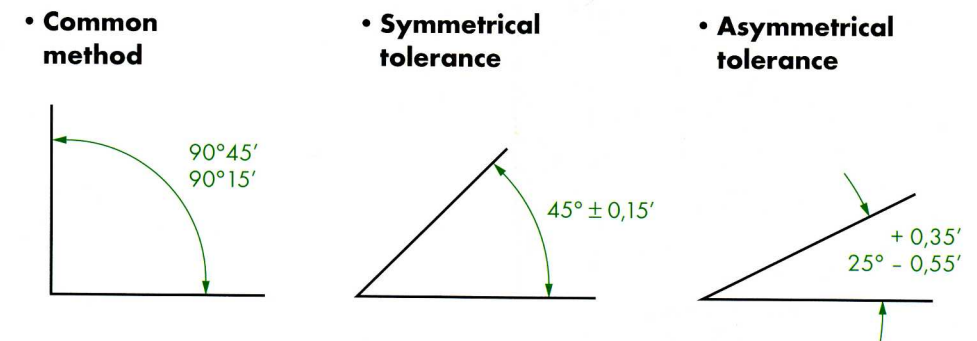
### Linear dimensions

- The **common method** shows the upper limit of size placed above the lower limit.
- **Symmetrical tolerance** shows the nominal size and the symmetrical tolerance band.
- **Asymmetrical tolerance** shows the nominal size plus the upper and lower limits of the tolerance band.



### Angular dimensions

Tolerances of angular functional dimensions are indicated in much the same way as linear dimensions by giving information on individual dimensions, as shown.



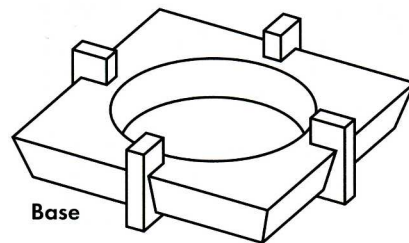
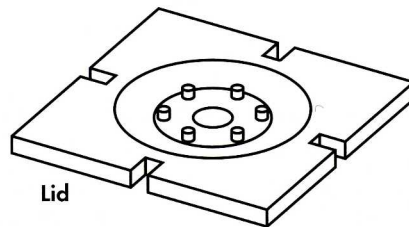
# DIMENSIONING AND TOLERANCING EXAMPLE

## Dimensioning and tolerancing example

Component drawings of a cast aluminium soap dish have been produced by a manufacturing company. To ensure that the lid locates with the legs on the base, slots 1, 2, 3 and 4 must be accurately machined (cut).

The functional dimensions and relevant tolerances are:

Functional dimension	Tolerance
Dimension between slots 2 and 4 (A)	-0,1 -0,2
Dimension between slots 1 and 3 (B)	-0,1 -0,2
Width of each slot (C)	+0,55 +0,35
Slot locations (D)	-0,2 -0,3
Depth of slots 1 and 2 from corner X	+0,15 0
All other (non-functional) dimensions	$\pm 0,25$



Exploded view

### For you to do

- Draw the plan view of the lid to a scale of 1:1.
- Add all the functional dimensions to the drawing and show the tolerances.
- Find the maximum and minimum depths of slots 3 and 4.

The solution is given on page 221.

