


UNDERSTANDING OF ENGINEERING DRAWINGS

Engineering Drawings



- Engineering drawings are industrial language.
- Engineering drawings communicate design requirements to machinist, inspector, assembler etc.

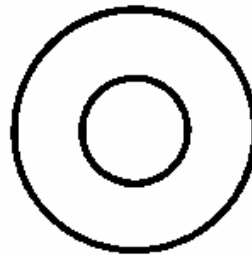
Lines on an Engineering Drawing


Object Line (visible line).  (heavy-solid) Used to show the outer and inner boundaries of surfaces and features in a particular view.

Example: a washer

FIGURE

Washer.

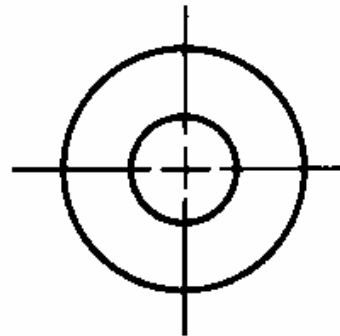


Centerline.  (long and short dashes) Used to show the geometrical center of an object.

Example: a washer

FIGURE

Washer.




Lines on an Engineering Drawing

Hidden Line. — — — — — (short dashes) Used to show surfaces and features that exist, but cannot be seen in that particular view.

Example: a washer

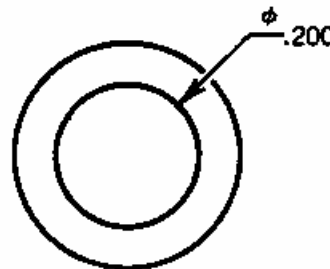
FIGURE
Washer.




Leader Line.  (medium–solid arrow) Used to point (or lead) the reader from a dimension (or note) to the feature or surface where the dimension (or note) applies.

Example: a washer

FIGURE
Washer.



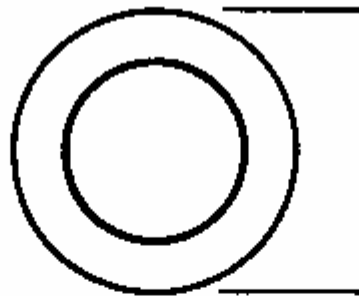
Lines on an Engineering Drawing


Extension Line.  (light-solid) Used to extend a feature (or surface) from the view so that it can be dimensioned.

Example: a washer

FIGURE

Washer.

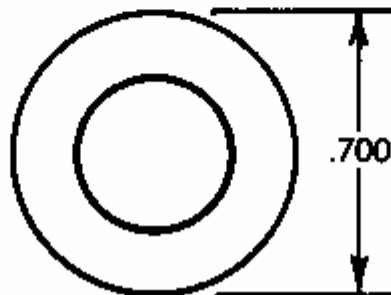


Dimension Line.  (light-solid arrows) Used to dimension the part or to show the distance between the extension lines.


Example: a washer

FIGURE

Washer.



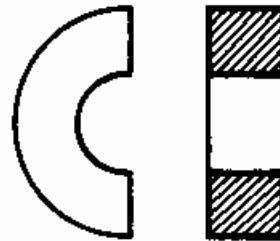
Lines on an Engineering Drawing

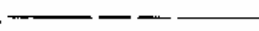
Section Lines.  (light-solid) 45 degrees. Used to show the surfaces of a part that has been sectioned (or cut).

Example: a washer

FIGURE

Washer.



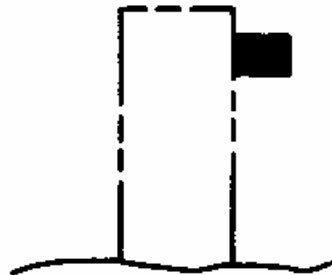
Phantom Lines.  (one long and two short dashes) Used in four main ways:

1. To show an existing structure that needs modification.

Example: A box must be put on an existing pole in the ground. The pole is drawn in phantom lines to show that it is already there

FIGURE

Structure needing modification.



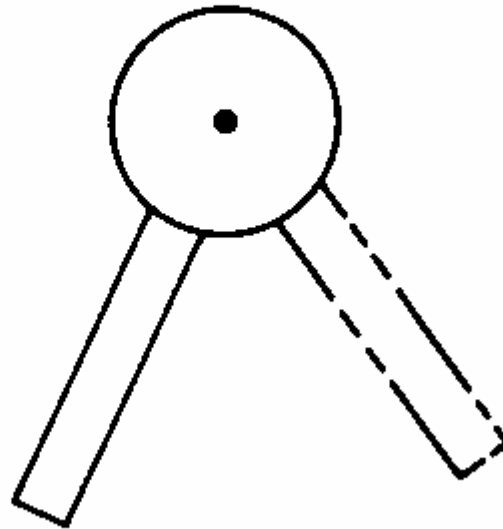
Lines on an Engineering Drawing

2. To show alternate positions of an object.

Example: A lever that moves on an assembly would be drawn solid in one position and drawn in phantom lines to show its other possible positions

FIGURE

Alternate positions of an object.



Lines on an Engineering Drawing

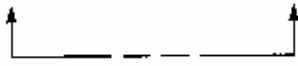
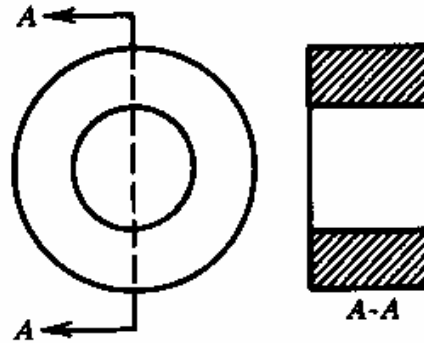
Cutting Plane (or viewing plane lines).  (medium-broken)
Used to show where a part is to be cut, or viewed by the reader.
Example: a washer viewing plane

FIGURE
Washer.




Short Break Line.  (medium-jagged) Used often to break up a particular view and show some of it in section
Example:

FIGURE
Short break line.



Lines on an Engineering Drawing

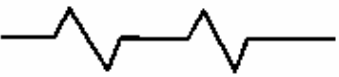
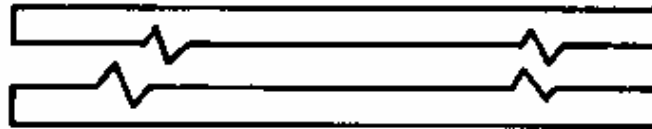
Long Break Line.  (thin) Used to break up a long object along its length
Example:

FIGURE
Long break line.



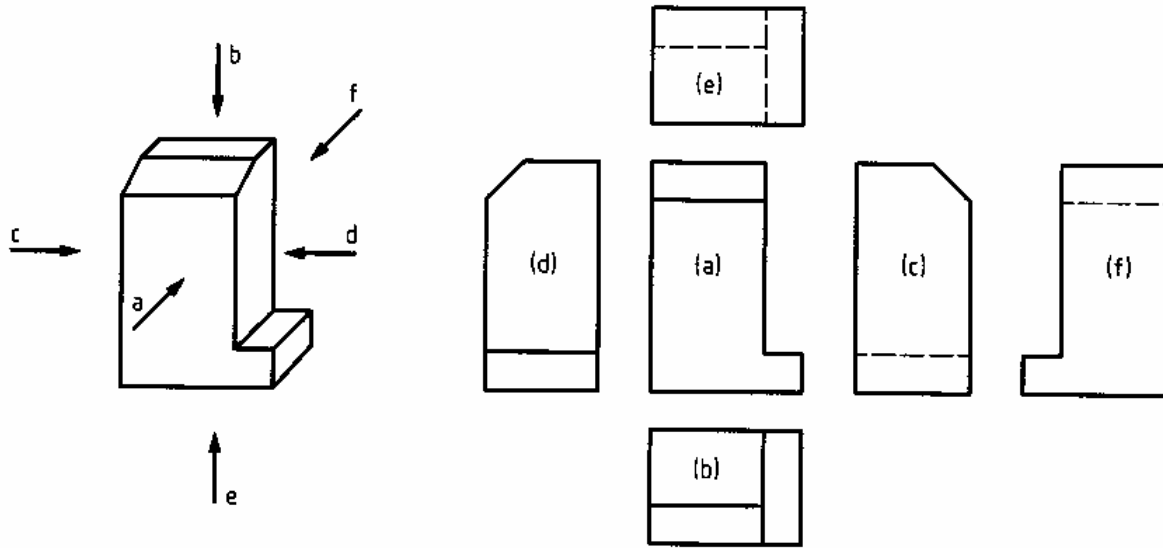
Cylindrical Break Line. Used to show a break in a cylindrical object (such as a drill rod)
Example:

FIGURE
Cylindrical break line.

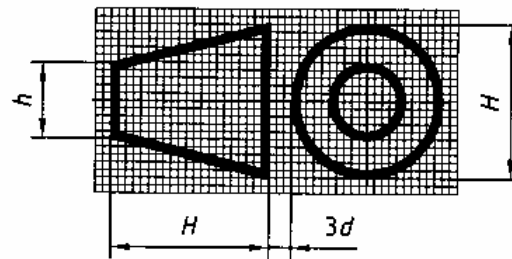


Chain Line.  (heavy and shaped like a centerline)

Orthographic Projection Views

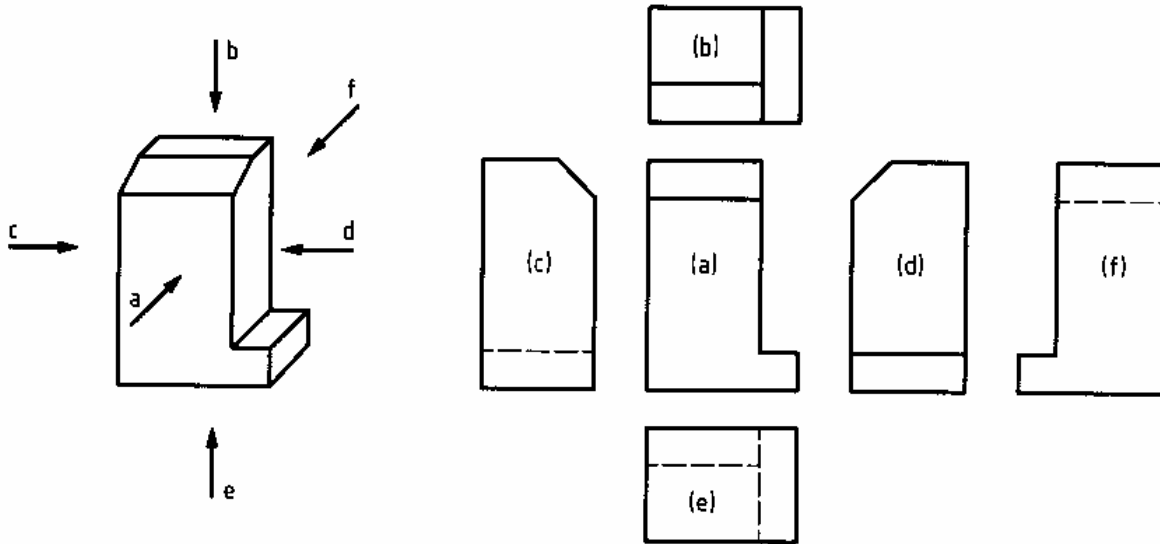


First angle projection method

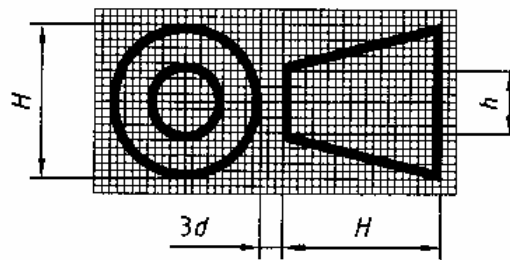


Graphical symbol

Orthographic Projection Views

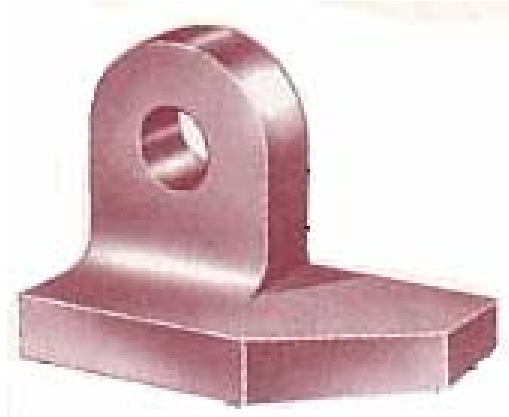
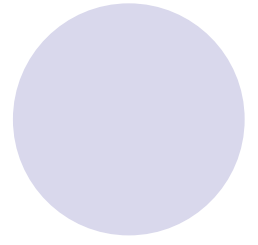
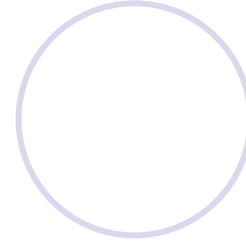
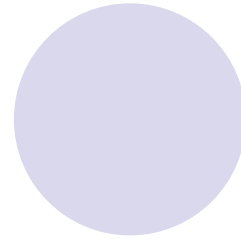
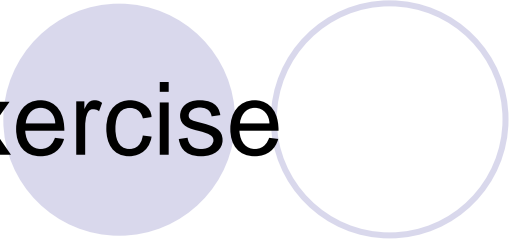


Third angle projection method

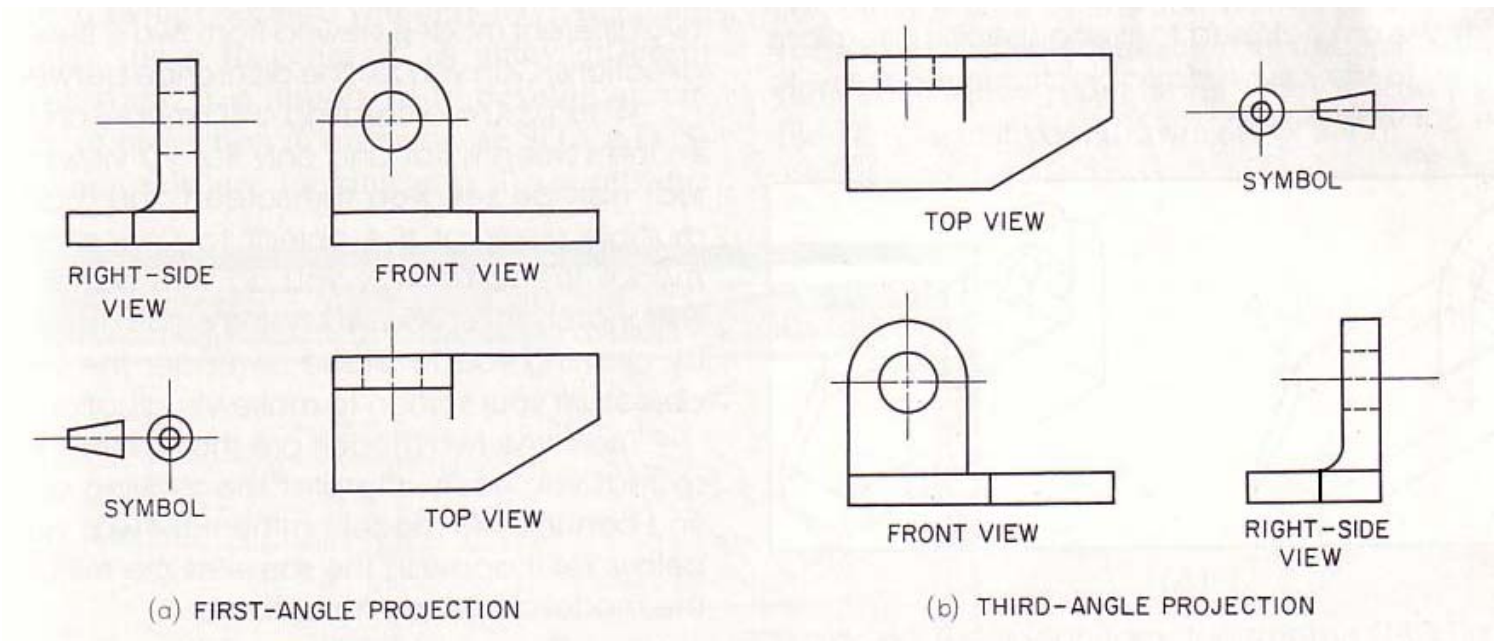


Graphical symbol

Exercise



Exercise



Tolerances

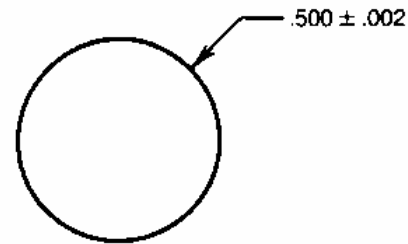
TOLERANCES

There is variation in every process. No two parts can be made exactly alike. Therefore, all dimensions must have a tolerance. *Tolerancing* simply shows how much variation is allowable in a dimension; it is the area between the maximum and minimum limits.

Bilateral Tolerance

Variation is permitted in both directions from a specified dimension

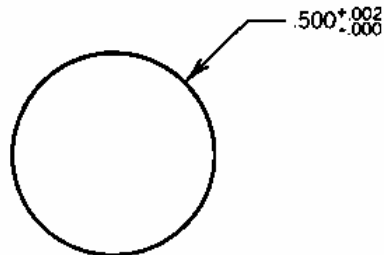
FIGURE
Bilateral tolerance.



Unilateral Tolerance

Variation is permitted in only one direction from a specified dimension

FIGURE
Unilateral tolerance.



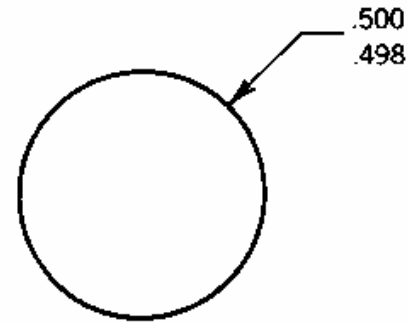
Tolerances

Limit Tolerance

Tolerances show the high and low limits of a dimension

FIGURE

Limit tolerance.

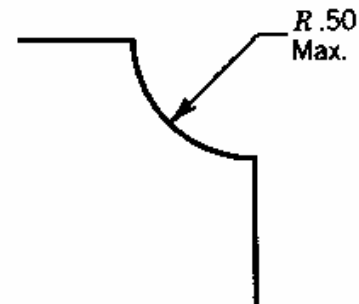


Single Limit Tolerance

A tolerance specifies a maximum or minimum limit only

FIGURE

Example of a single limit tolerance.



Tolerances

Title Block Tolerance

Many dimensions are shown without any tolerance. These are controlled by the title block tolerances at the bottom of the drawing. For example

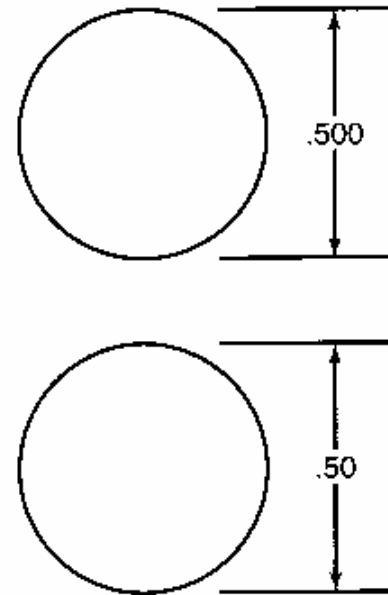
.xxx = $\pm .010$ (a three-place decimal is $\pm .010$)

.xx = $\pm .03$ (a two-place decimal is $\pm .03$)

FIGURE

These dimensions are controlled by title block tolerances.

UNLESS OTHERWISE SPECIFIED
.X = $\pm .03$
.XX = $\pm .01$
.XXX = $\pm .005$
ANGLES = $\pm 1^\circ$



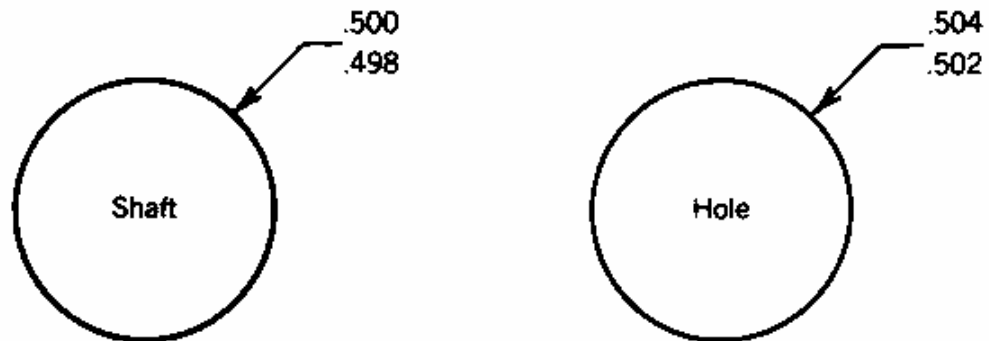
Allowances & Fits

Clearance Fit (Positive Allowance)

This type of allowance permits two mating parts to be assembled easily (with airspace between them after assembly)

FIGURE

Mating parts with clearance fit.



No matter what size the shaft or the hole is, they will easily go together if they are both within their tolerance limits.

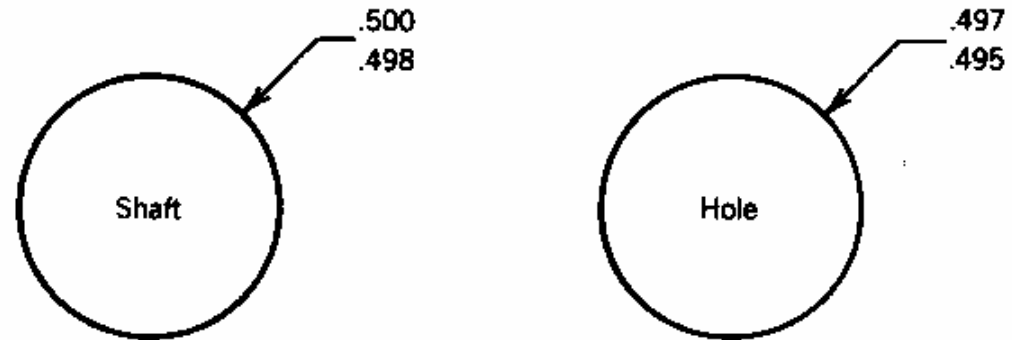
Allowances & Fits

Interference Fit (Negative Allowance)

Two mating parts must be forced together (because the male part is larger than the female part)

FIGURE

Interference fit of two mating parts.



No matter what their sizes (if they are both within their tolerance limits), there will be an interference fit.

Allowances & Fits

Allowance (Positive or Negative)

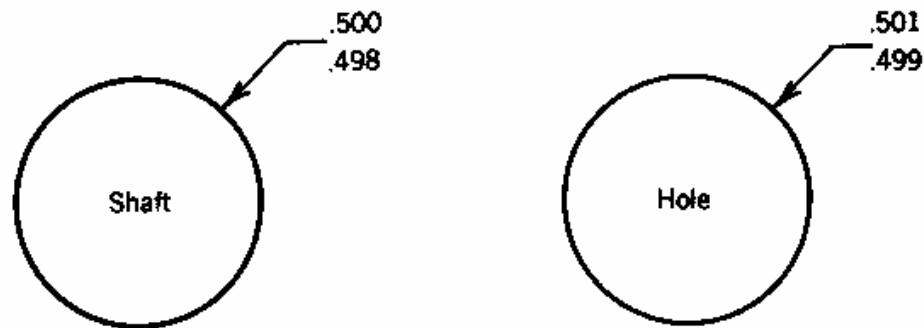
Allowance is defined as the *intended difference* between the virtual sizes of mating parts (whether it is clearance or interference).

Transition Fit

This is a form of allowance that can be clearance or interference, depending solely on the actual sizes of each part

FIGURE

Transition fit of two mating parts.



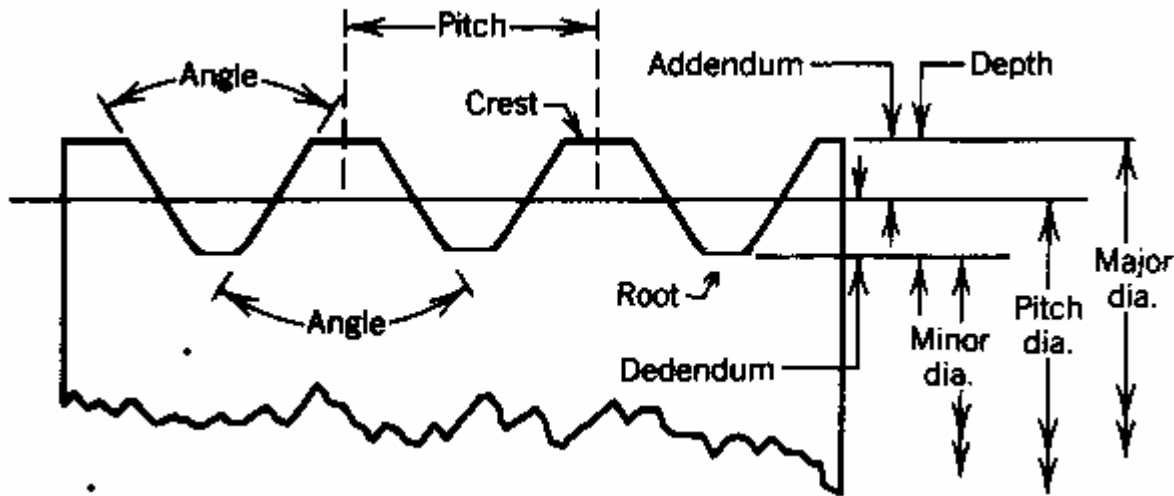
There is interference if the shaft were actually .500 and the hole were actually .499.
There is clearance if the shaft were actually .498 and the hole were actually .500.

Threads

Terminology

Pitch. The distance from a point on one thread to the same point on the next thread.

Crest. The top of the thread.



Threads

Root. The bottom of the thread.

Angle. The included angle between the two flanks of the thread.

Minor Diameter. The distance from root to root.

Major Diameter. The distance from crest to crest.

Depth. The distance from crest to root.

Addendum. The distance from the pitch diameter to the crest on an external thread.

Dedendum. The distance from the pitch diameter to the root on an external thread.

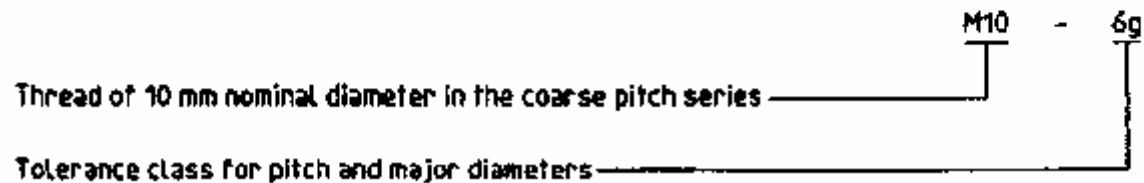
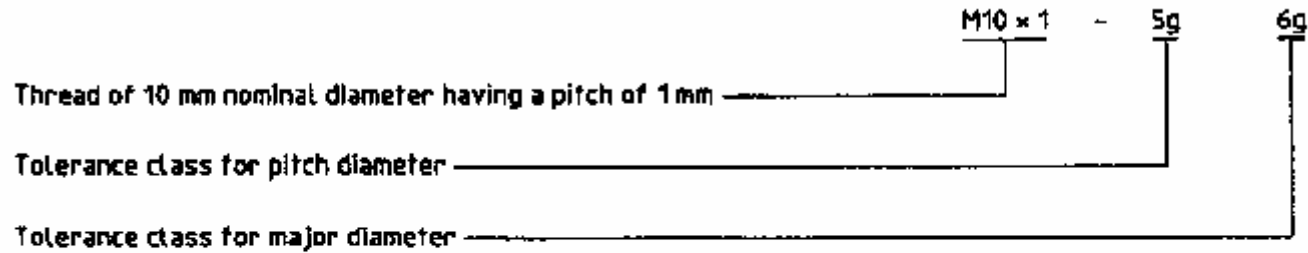
Pitch Diameter. The imaginary cylinder throughout the thread.

Threads

External Thread Designation

M10 X 1 – 5g 6g

External thread

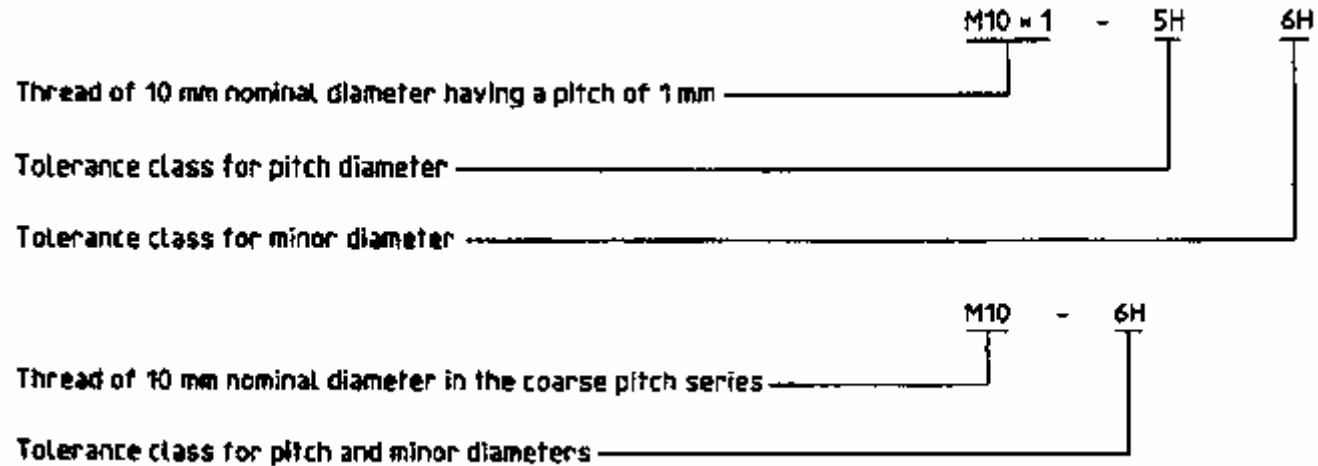


Threads

Internal Thread Designation

M10 X 1 – 5H 6H

Internal thread



Threads

Tolerance Grades

Internal threads

- 5H for threads up to and including M1,4;
- 6H for threads M1,6 and larger.

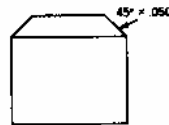
NOTE Except for threads with pitch $P = 0,2$ mm for which the tolerance grade 4 is defined only

External threads

- 6h for threads up to and including M1,4;
- 6g for threads M1,6 and larger.

Chamfers

As Shown on Blueprint



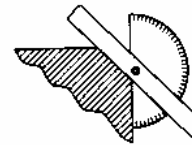
(a)

This Means

The angle should be 45 degrees and the depth should be 0.050 within certain tolerance limits.

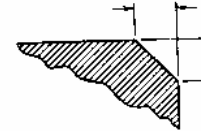
To Measure It

A protractor of some sort.



(b)

45 degrees can be measured in either direction.



(c)

FIGURE

A bidirectional 45° chamfer.

As Shown on Blueprint

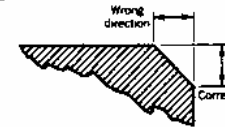


This Means

The angle of cut should be 45 degrees and the depth must be 0.100 within certain tolerances.

To Measure It

The part is still measured with some type of protractor, but now you must measure it in the specified direction. This is true when it is called out as shown, or with any angle other than 45 degrees.



FIGURE

A unidirectional 45° chamfer.

Surface Roughness

Roughness. Closely spaced irregularities on the surface.

Waviness. Widely spaced irregularities on the surface.

- ✓ Surface may be produced by any method.
- ✓ Material removal by machining is required.
- ⊗ Material removal is prohibited.

Ra = Roughness Average

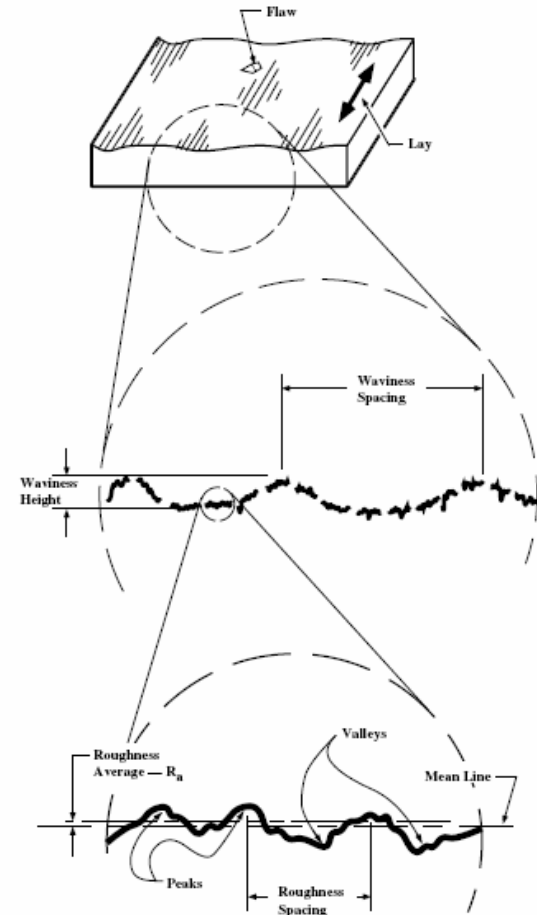
Rz = Max height of profile

Units = μm

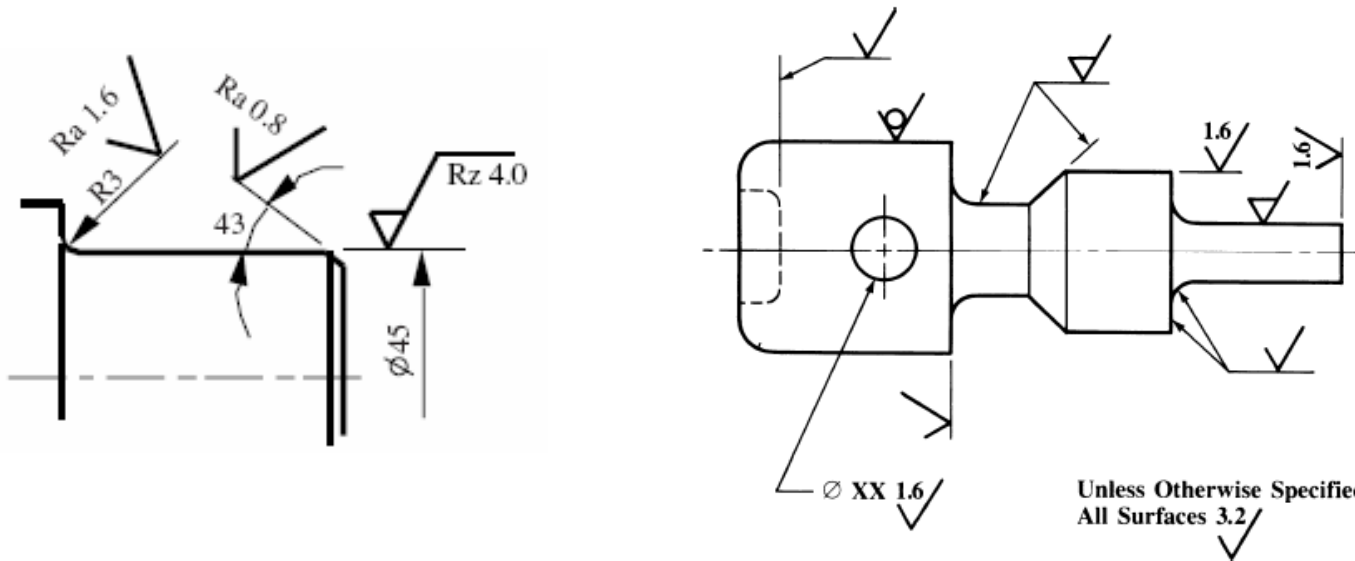
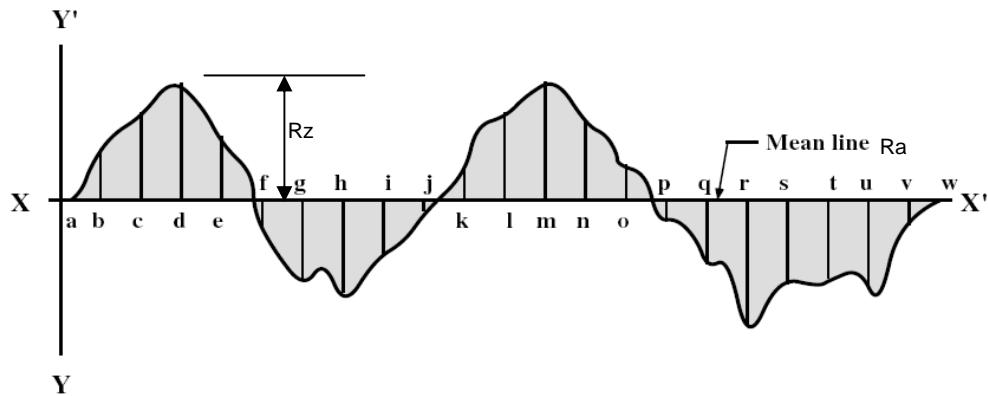
1.6 ✓

1.6
0.8 ✓












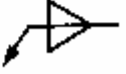

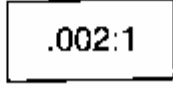
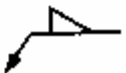
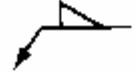
Rz 4.0
⊗



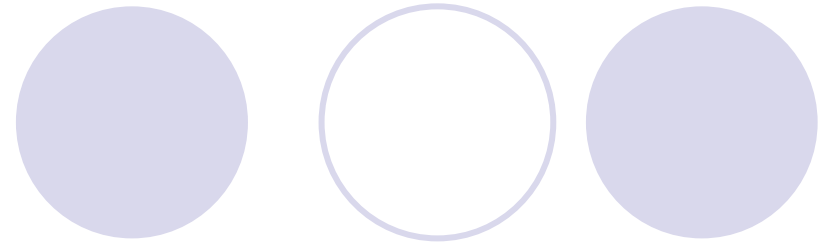
Surface Roughness



Some Symbols

Word	Symbol	Example
Counterbore or spotface		6 X $\varnothing.224 \pm .005$  $\varnothing.375 \pm .010$
Depth		 .250 Min.
Quantity	X	6 X $\varnothing.500 \pm .002$
Countersink		 $\varnothing.320 \pm .010$
Square		5 X 
All around		 
Conical taper		 
Flat taper slope		 $.010 \pm .003:1$

Some Symbols



Radius	R	$R.250 \pm .005$
Controlled radius	CR	$CR.250 \pm .010$
Spherical radius	SR	$SR.500 \pm .005$
Spherical diameter	$S\phi$	$S\phi.500 \pm .005$
Arc length	