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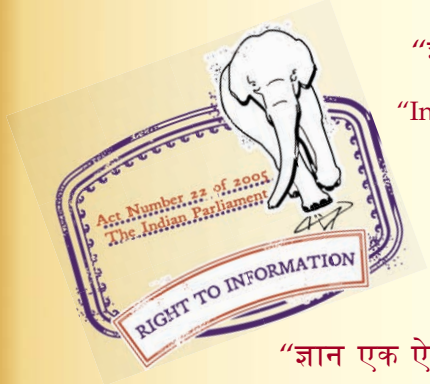
"Step Out From the Old to the New"

IS 8000-1 (1985): Geometrical tolerancing on Technical Drawings, Part 1: Tolerances of form orientation, location and Run-out and appropriate geometrical definitions [PGD 24: Drawings]



"ज्ञान से एक नये भारत का निर्माण"
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"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS : 8000 (Part 1) - 1985
ISO 1101 - 1983

(Reaffirmed 2005)

Indian Standard

GEOMETRICAL TOLERANCING ON TECHNICAL DRAWINGS

PART 1 TOLERANCING OF FORM, ORIENTATION, LOCATION AND RUN-OUT, AND APPROPRIATE GEOMETRICAL DEFINITIONS

(First Revision)

(ISO Title : Technical Drawings—Geometrical Tolerancing—Tolerancing of Form, Orientation, Location and Run-Out—Generalities, Definitions, Symbols, Indications on Drawings)

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UDC 744·43 : 621·753·1

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

Gr 10

April 1987

Technical drawings — Geometrical tolerancing — Toleranced characteristics and symbols — Examples of indication and interpretation

Extract from International Standard ISO 1101

This document forms an extract of ISO 1101, suitable for everyday use.

Form tolerances limit the deviations of an individual feature from its ideal geometrical form.

Orientation, location and run-out tolerances limit the deviations of the mutual orientation and/or location of two or more features. For functional reasons one or more features may be indicated as a datum. If necessary, a geometrical tolerance should be specified to the datum feature in order to ensure that the datum feature is sufficiently exact for its purpose.

The geometrical tolerance applies always to the whole extent of the toleranced feature unless otherwise specified, for example 0,02/50 indicates that a tolerance of 0,02 is permitted for an extent of 50 at any place on the toleranced feature.

When a geometrical tolerance applies to an axis or a median plane, then the arrow of the leader line terminates at the dimension line (figure 4).

When a geometrical tolerance applies to a line or surface itself, then the leader line with its arrow terminating on the contour of the feature has to be clearly separated from the dimension line (figure 5).

The same method of indication is used for the datum triangle.

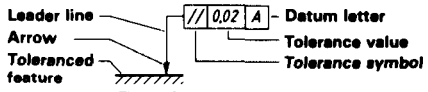


Figure 1

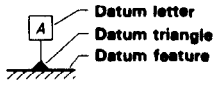


Figure 2

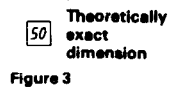


Figure 3


Refers to the axis or the median plane
Figure 4

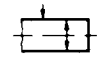
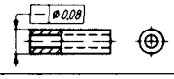
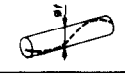
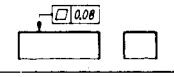
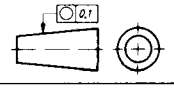
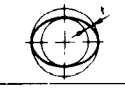
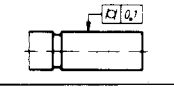
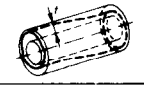
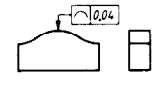
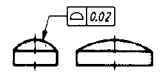
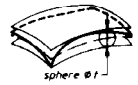
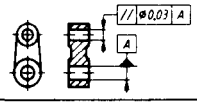
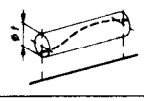
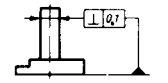
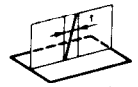
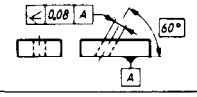
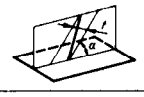
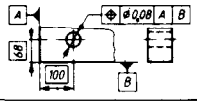
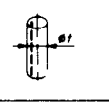
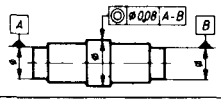
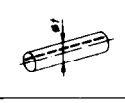
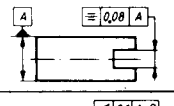
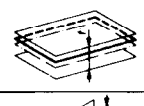
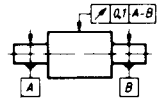
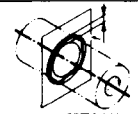
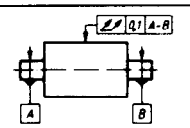
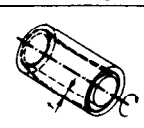

Refers to the generating line or the surface
Figure 5

Figure 6 (M) Maximum material condition (MMC)

Figure 7 (P) Projected tolerance zone

Figure 8 Ø 2 / A1 Datum target (see ISO 5459)

Values in millimetres

Symbols and toleranced characteristics				Examples of indication and interpretation		
				Indication on the drawing	Tolerance zone	Interpretation
Single features	Form tolerances	—	**Straightness**			The axis of the cylinder, to which the tolerance frame is connected, shall be contained in a cylindrical zone of diameter 0.08.
		▱	**Flatness**			The surface shall be contained between two parallel planes 0,08 apart.
		○	**Circularity**			The circumference of each cross-section shall be contained between two co-planar concentric circles 0,1 apart.
		⌭	**Cylindricity**			The considered surface shall be contained between two coaxial cylinders 0.1 apart.
Single or related features		⌒	**Profile of any line**			In each section parallel to the plane of projection, the considered profile shall be contained between two lines enveloping circles of diameter 0.04, the centres of which are situated on a line having the true geometrical profile.
		⌓	**Profile of any surface**			The considered surface shall be contained between two surfaces enveloping spheres of diameter 0,02, the centres of which are situated on a surface having the true geometrical form.
Related features	Orientation tolerances	//	**Parallelism** of a line (axis) with reference to a datum line			The toleranced axis shall be contained in a cylindrical zone of diameter 0,03, parallel to the datum axis **A** (datum line).
		⊥	**Perpendicularity** of a line (axis) with reference to a datum surface			The axis of the cylinder, to which the tolerance frame is connected, shall be contained between two parallel planes 0,1 apart, perpendicular to the datum surface.
		∠	**Angularity** of a line (axis) with reference to a datum surface			The axis of the hole shall be contained between two parallel planes 0,08 apart which are inclined at 60° to the surface **A** (datum surface).
	Location tolerances	⌖	**Position** of a line			The axis of the hole shall be contained within a cylindrical zone of diameter 0,08, the axis of which is in the theoretically exact position of the considered line, with reference to the surfaces **A** and **B** (datum planes).
		◎	**Coaxiality** of an axis			The axis of the cylinder, to which the tolerance frame is connected, shall be contained in a cylindrical zone of diameter 0.08 coaxial with the datum axis **A-B**.
		⌯	**Symmetry** of a median plane			The median plane of the slot shall be contained between two parallel planes, which are 0,08 apart and symmetrically disposed about the median plane with respect to the datum feature **A**.
	Run-out tolerances	↗	**Circular run-out** radial			The radial run-out shall not be greater than 0,1 in any plane of measurement during one revolution about the datum axis **A-B**.
		⌰	**Total run-out** radial			The total radial run-out shall not be greater than 0,1 at any point on the specified surface during several revolutions about the datum axis **A-B**, and with relative axial movement between part and measuring instrument. The movement shall be guided along a line having a theoretically perfect form of the contour and being in correct position to the datum axis.

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Indian Standard

GEOMETRICAL TOLERANCING ON TECHNICAL DRAWINGS

PART 1 TOLERANCING OF FORM, ORIENTATION, LOCATION AND RUN-OUT, AND APPROPRIATE GEOMETRICAL DEFINITIONS

(First Revision)

ISO Title : Technical Drawings — Geometrical Tolerancing — Tolerancing of Form, Orientation, Location and Run-Out — **Generalities, Definitions, Symbols, Indications on Drawings)**

[Ref : Doc : EDC 20 (4628)]
Drawings Sectional Committee, EDC 20; Drawings Subcommittee, EDC 20 : 1

National Foreword

This Indian Standard is identical with ISO 1101-1983 'Technical drawings — Geometrical tolerancing — Tolerancing of form, orientation, location and run-out — Generalities, definitions, symbols, indications on drawings' issued by the International Organization for Standardization (ISO) was adopted by the Indian Standards Institution on the recommendation of the Drawings Sectional Committee and approval by the Mechanical Engineering Division Council.

The original version of this standard, IS : 8000 (Part 1)-1976 'Tolerances of form and of position for engineering drawings: Part 1 Generalities, symbols, indications on drawings' was based on ISO/R 1101-1969 'Tolerances of form and of position: Generalities, symbols, indications on drawings' issued by ISO. Harmonization of the standard with International Standard has been made by the adoption of ISO 1101-1983.

Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.

Cross References

International Standard	*Corresponding Indian Standard*
ISO 128-1982	IS : 10714-1983 General principles of presentation on technical drawings (Identical)
ISO 129-1985	IS : 11669-1986 General principles of dimensioning on technical drawings (Identical)
ISO 1660-1982	IS : 8000 (Part 3)-1985 Geometrical tolerancing on technical drawings: Part 3 Dimensioning and tolerancing of profiles (*first revision*) (Identical)
ISO 2692	IS : 8000 (Part 2)-1976 Geometrical tolerancing on technical drawings: Part 2 Maximum material principles (Technically equivalent)
ISO 5459-1981	IS : 10721-1983 Datum and datum systems for geometrical tolerancing on technical drawings (Identical)
ISO 7083-1983	IS : 11158-1984 Proportions and dimensions of symbols for geometrical tolerancing used in technical drawings (Identical)

There is no Indian Standard corresponding to ISO 8015 to which reference is made in **2**.

Additional Information

This Indian Standard is one of a series of Indian Standards on geometrical tolerancing on technical drawings each identical/technically equivalent with the corresponding ISO Standards indicated within parentheses:

IS : 8000 Part 1 (ISO 1101)	Tolerancing of form, orientation, location and run-out and appropriate geometrical definitions (*first revision*)
IS : 8000 Part 2 (ISO 1101/2)	Maximum material principles
IS : 8000 Part 3 (ISO 1660)	Dimensioning and tolerancing of profiles (*first revision*)
IS : 8000 Part 4 (ISO/R 1661)	Practical examples of indications on drawings

Adopted 1 November 1985 | | Gr 10

BUREAU OF INDIAN STANDARDS
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0 Introduction

For uniformity all figures in this International Standard are in first angle projection.

It should be understood that the third angle projection could equally well have been used without prejudice to the principles established.

For the definitive presentation (proportions and dimensions) of symbols for geometrical tolerancing, see ISO 7083.

1 Scope and field of application

1.1 This International Standard gives the principles of symbolization and indication on technical drawings of tolerances of form, orientation, location and run-out, and establishes the appropriate geometrical definitions. Hence the term "geometrical tolerances" will be used in this document as synonymous with these groups of tolerances.

1.2 Geometrical tolerances shall be specified only where they are essential, that is, in the light of functional requirements, interchangeability and probable manufacturing circumstances.

1.3 Indicating geometrical tolerances does not necessarily imply the use of any particular method of production, measurement or gauging.

2 References

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

ISO 129, *Engineering drawings — Dimensioning — General principles, definitions, methods of execution, and special indications.* [1]

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

ISO 2692, *Technical drawings — Geometrical tolerancing — Maximum material principle.* [2]

ISO 5459, *Technical drawings — Geometrical tolerancing — Datums and datum systems for geometrical tolerances.*

ISO 7083, *Technical drawings — Symbols for geometrical tolerancing — Proportions and dimensions.*

ISO 8015, *Technical drawings — Fundamental tolerancing principle.* [3]

3 General

3.1 A geometrical tolerance applied to a feature defines the tolerance zone within which the feature (surface, axis, or median plane) is to be contained (see 3.7 and 3.8).

3.2 According to the characteristic which is to be toleranced and the manner in which it is dimensioned, the tolerance zone is one of the following :

- the area within a circle;
- the area between two concentric circles;

1) At present at the stage of draft. (Revision of ISO/R 129-1959.)

2) At present at the stage of draft. (Revision of ISO 1101/2-1974.)

3) At present at the stage of draft.

— the area between two equidistant lines or two parallel straight lines;

— the space within a cylinder;

— the space between two coaxial cylinders;

— the space between two equidistant planes or two parallel planes;

— the space within a parallelepiped.

3.3 The toleranced feature may be of any form or orientation within this tolerance zone, unless a more restrictive indication is given, for example by an explanatory note (see figures 8 and 9).

3.4 Unless otherwise specified as in clauses 9 and 11, the tolerance applies to the whole length or surface of the considered feature.

3.5 The datum feature is a real feature of a part, which is used to establish the location of a datum (see ISO 5459).

3.6 Geometrical tolerances which are assigned to features related to a datum do not limit the form deviations of the datum feature itself. The form of a datum feature shall be sufficiently accurate for its purpose and it may therefore be necessary to specify tolerances of form for the datum features.

3.7 The straightness or flatness of a single toleranced feature is deemed to be correct when the distance of its individual points from a superimposed surface of ideal geometrical form is equal to or less than the value of the specified tolerance. The orientation of the ideal line or surface shall be chosen so that the maximum distance between it and the actual surface of the feature concerned is the least possible value.

Example :

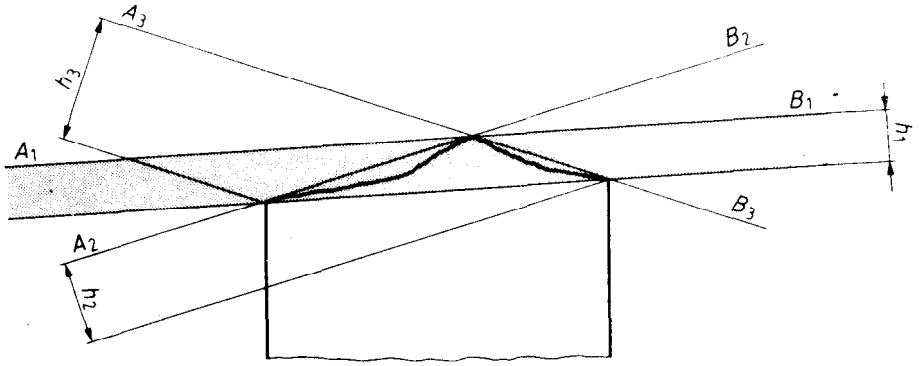


Figure 1

Possible orientations of the line or surface :	$A_1 - B_1$		$A_2 - B_2$		$A_3 - B_3$
Corresponding distances :	h_1		h_2		h_3
In the case of figure 1 :	h_1	<	h_2	<	h_3

Therefore the correct orientation of the ideal line or surface is $A_1 - B_1$. The distance h_1 is to be equal to or less than the specified tolerance.

3.8 For the definition of circularity and cylindricity, the location of the two concentric circles or coaxial cylinders shall be chosen so that the radial distance between them is the minimum.

Example :

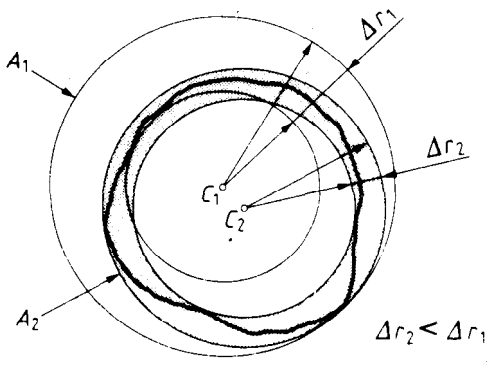


Figure 2

Possible location of the centres of the two concentric circles or the axes of the two coaxial cylinders and their minimal radial distances.

Centre (C_1) of A_1 locates two concentric circles or two coaxial cylinders.

Centre (C_2) of A_2 locates two concentric circles or two coaxial cylinders with minimal radial distance.

Corresponding radial distances : Δr_1 Δr_2

In the case of figure 2 : $\Delta r_2 < \Delta r_1$

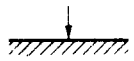
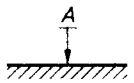
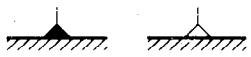
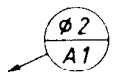
Therefore the correct location of the two concentric circles or the two coaxial cylinders is the one designated A_2. The radial distance Δr_2 should then be equal to or less than the specified tolerance.

4 Symbols

Table 1 — Symbols for toleranced characteristics

Features and tolerances		Toleranced characteristics	Symbols	Subclauses
Single features	Form tolerances	Straightness	—	14.1
		Flatness	▱	14.2
		Circularity	○	14.3
		Cylindricity	⌭	14.4
Single or related features		Profile of any line	⌒	14.5
		Profile of any surface	⌓	14.6
Related features	Orientation tolerances	Parallelism	//	14.7
		Perpendicularity	⊥	14.8
		Angularity	∠	14.9
	Location tolerances	Position	⌖	14.10
		Concentricity and coaxiality	◎	14.11
		Symmetry	⌯	14.12
	Run-out tolerances	Circular run-out	↗	14.13
		Total run-out	⌰	14.14

Table 2 — Additional symbols

Descriptions		Symbols	Clauses
Toleranced feature indications	direct		6
	by letter		7.4
Datum indications	direct		8
	by letter		
Datum target			ISO 5459
Theoretically exact dimension			10
Projected tolerance zone			11
Maximum material condition			12

5 Tolerance frame

5.1 The tolerance requirements are shown in a rectangular frame which is divided into two or more compartments. These compartments contain, from left to right, in the following order (see figures 3, 4 and 5) :

— the symbol for the characteristic to be toleranced;

— the tolerance value in the unit used for linear dimensions. This value is preceded by the sign ø if the tolerance zone is circular or cylindrical;

— if appropriate, the letter or letters identifying the datum feature or features (see figures 4 and 5).

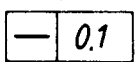


Figure 3

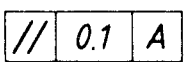


Figure 4

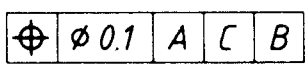


Figure 5

5.2 Remarks related to the tolerance, for example "6 holes", "4 surfaces" or "6x" shall be written above the frame (see figures 6 and 7).

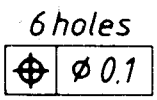


Figure 6

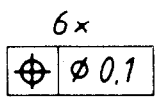


Figure 7

5.3 Indications qualifying the form of the feature within the tolerance zone shall be written near the tolerance frame and may be connected by a leader line (see figures 8 and 9).

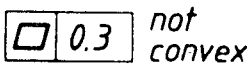


Figure 8

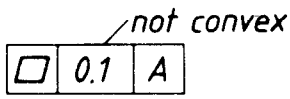


Figure 9

5.4 If it is necessary to specify more than one tolerance characteristic for a feature, the tolerance specifications are given ir tolerance frames one under the other (see figure 10).

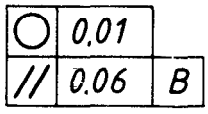


Figure 10

6 Toleranced features

The tolerance frame is connected to the toleranced feature by a leader line terminating with an arrow in the following way :

— on the outline of the feature or an extension of the outline (but clearly separated from the dimension line) when the tolerance refers to the line or surface itself (see figures 11 and 12).

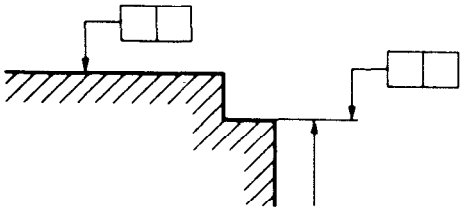


Figure 11

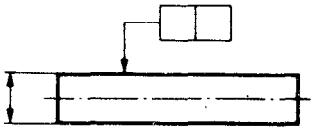


Figure 12

— as an extension of a dimension line when the tolerance refers to the axis or median plane defined by the feature so dimensioned (see figures 13 to 15).

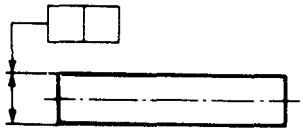


Figure 13

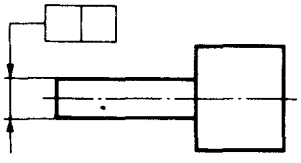


Figure 14

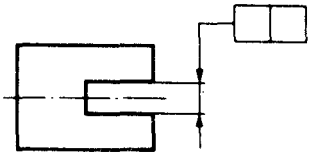


Figure 15

— on the axis when the tolerance refers to the axis or median plane of all features common to that axis or median plane (see figures 16, 17 and 18).

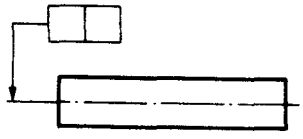


Figure 16

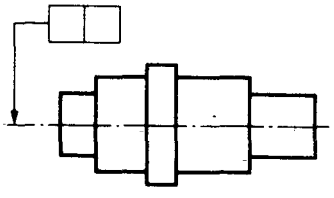


Figure 17

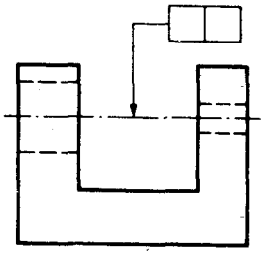


Figure 18

NOTE — Whether a tolerance should be applied to the contour of a cylindrical or symmetrical feature or to its axis or median plane respectively depends on the functional requirements.

7 Tolerance zones

7.1 The width of the tolerance zone is in the direction of the arrow of the leader line joining the tolerance frame to the feature which is toleranced, unless the tolerance value is preceded by the sign ø (see figures 19 and 20).

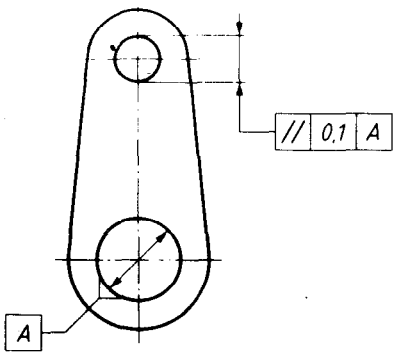


Figure 19

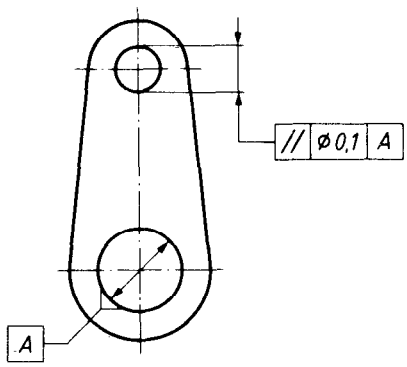


Figure 20

7.2 In general, the direction of the width of the tolerance zone is normal to the specified geometry of the part (see figures 21 and 22).

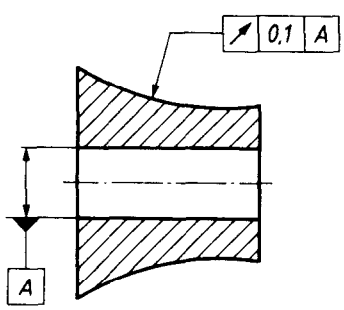


Figure 21

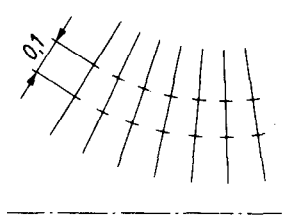


Figure 22

7.3 The direction of the width of the tolerance zone shall be indicated when desired **not** normal to the specified geometry of the part (see figures 23 and 24).

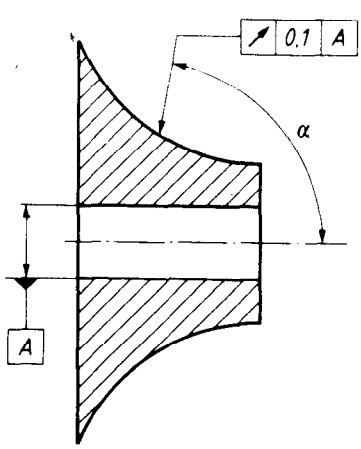


Figure 23

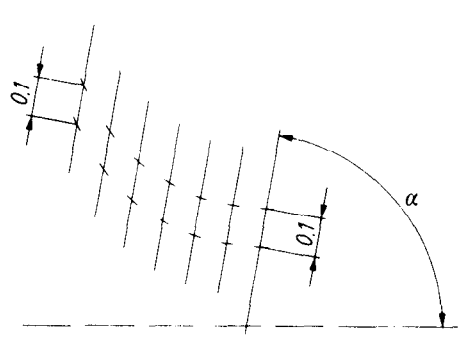


Figure 24

7.4 Individual tolerance zones of the same value applied to several separate features can be specified as shown in figures 25 and 26.

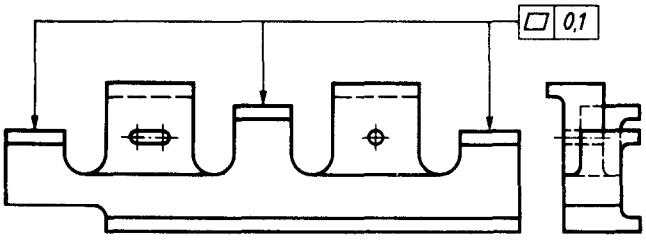


Figure 25

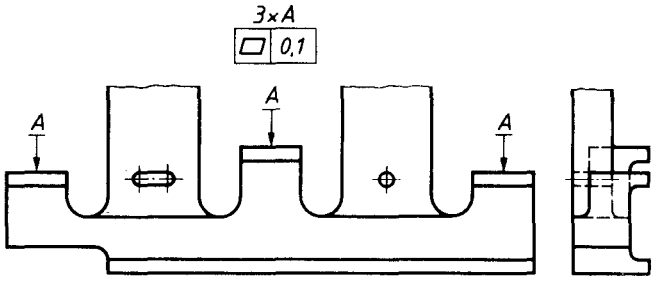


Figure 26

7.5 Where a **common tolerance zone** is applied to several separate features, the requirement is indicated by the words "common zone" above the tolerance frame (see figures 27 and 28).

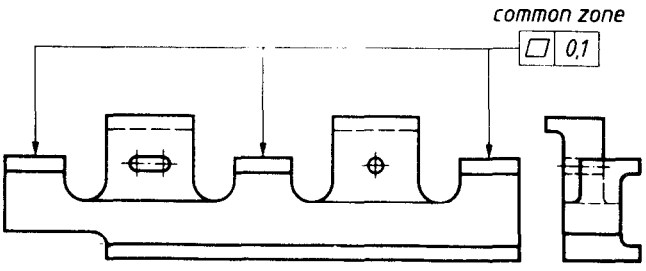


Figure 27

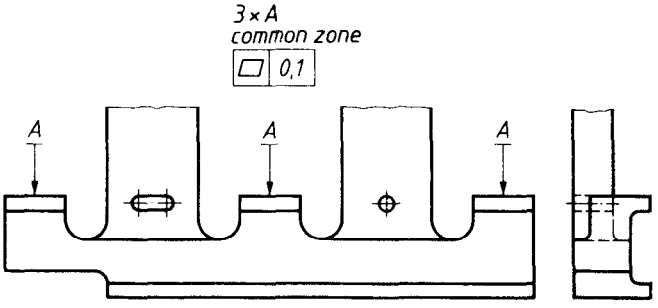


Figure 28

8 Datums

8.1 When a toleranced feature is related to a datum, this is generally shown by datum letters. The same letter which defines the datum is repeated in the tolerance frame.

To identify the datum, a capital letter enclosed in a frame is connected to a solid or blank datum triangle (see figures 29 and 30).

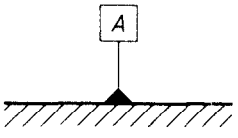


Figure 29

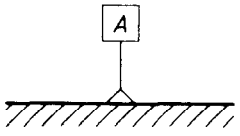


Figure 30

8.2 The datum triangle with the datum letter is placed :

— on the outline of the feature or an extension of the outline (but clearly separated from the dimension line), when the datum feature is the line or surface itself (see figure 31).

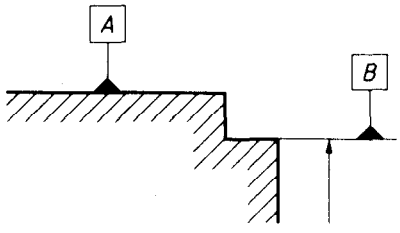


Figure 31

— as an extension of the dimension line when the datum feature is the axis or median plane (see figures 32 to 34).

NOTE — If there is insufficient space for two arrows, one of them may be replaced by the datum triangle (see figures 33 and 34).

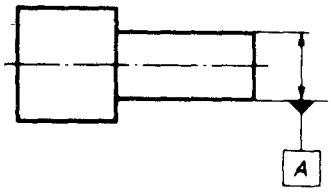


Figure 32

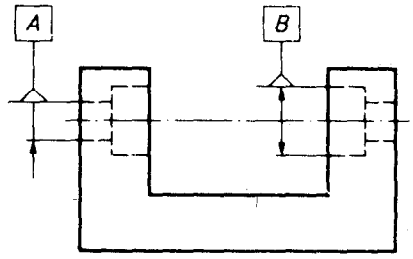


Figure 33

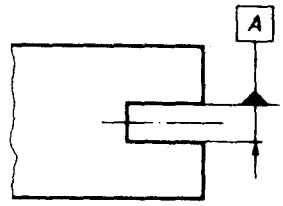


Figure 34

— on the axis or median plane when the datum is :

a) the axis or median plane of a single feature (for example a cylinder);

b) the common axis or plane formed by two features (see figure 35).

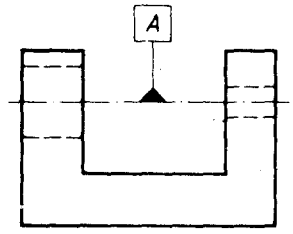


Figure 35

8.3 If the tolerance frame can be directly connected with the datum feature by a leader line, the datum letter may be omitted (see figures 36 and 37).

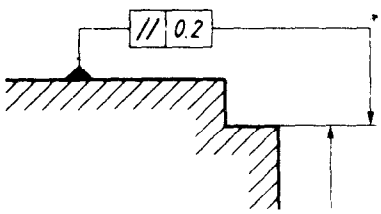


Figure 36

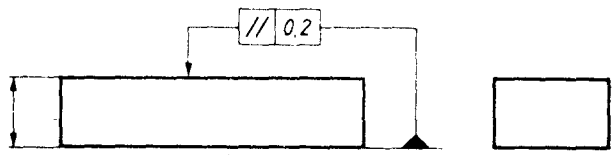


Figure 37

8.4 A single datum is identified by a capital letter (see figure 38).

A common datum formed by two datum features is identified by two datum letters separated by a hyphen (see figure 39).

If the sequence of two or more datum features **is** important the datum letters are placed in different compartments (see figure 40), where the sequence from left to right shows the order of priority.

If the sequence of two or more datum features **is not** important the datum letters are indicated in the same compartment (see figure 41).

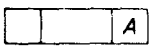


Figure 38

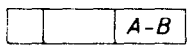


Figure 39

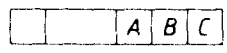


Figure 40

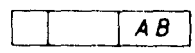


Figure 41

9 Restrictive specifications

9.1 If the tolerance is applied to a restricted length, lying anywhere, the value of this length shall be added after the tolerance value and separated from it by an oblique stroke.

In the case of a surface, the same indication is used. This means that the tolerance applies to all lines of the restricted length in any position and any direction (see figure 42).

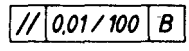


Figure 42

9.2 If a smaller tolerance of the same type is added to the tolerance on the whole feature, but restricted over a limited length, the restrictive tolerance shall be indicated in the lower compartment (see figure 43).

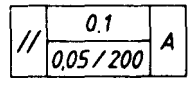


Figure 43

9.3 If the tolerance is applied to a restricted part of the feature only, this shall be dimensioned as shown in figure 44.

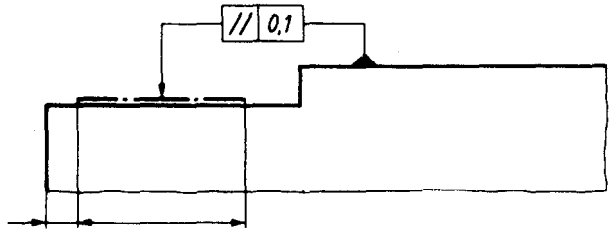


Figure 44

9.4 If the datum is applied to a restricted part of the datum feature only, this shall be dimensioned as shown in figure 45.

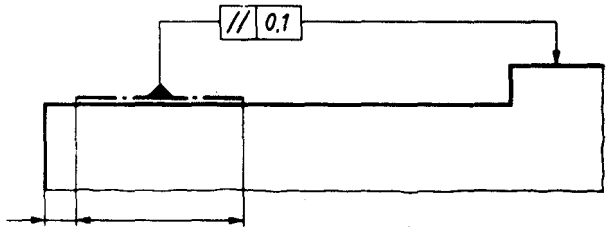


Figure 45

9.5 Restrictions to the form of the feature within the tolerance zone are shown in 5.3.

10 Theoretically exact dimensions

If tolerances of position or of profile or of angularity are prescribed for a feature, the dimensions determining the theoretically exact position, profile or angle respectively, shall not be toleranced.

These dimensions are enclosed, for example [30] . The corresponding actual dimensions of the part are subject only to the position tolerance, profile tolerance or angularity tolerance specified within the tolerance frame (see figures 46 and 47).

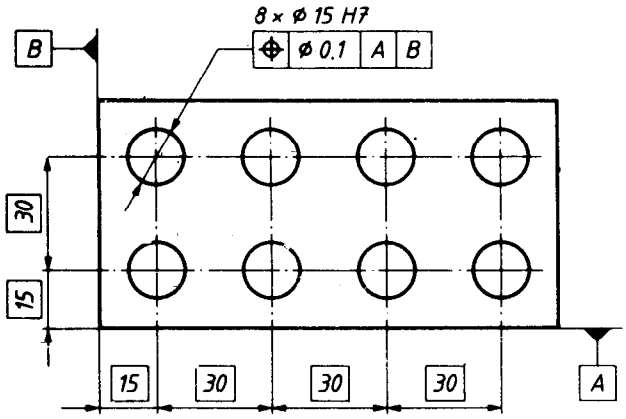


Figure 46

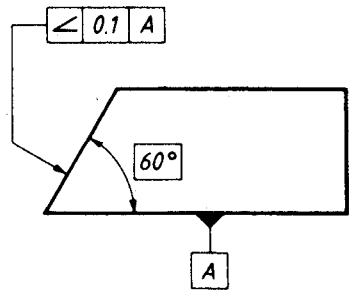


Figure 47

11 Projected tolerance zone

In some cases the tolerances of orientation and location shall apply not to the feature itself but to the external projection of it. Such projected tolerance zones are to be indicated by the symbol Ⓟ (see figure 48).

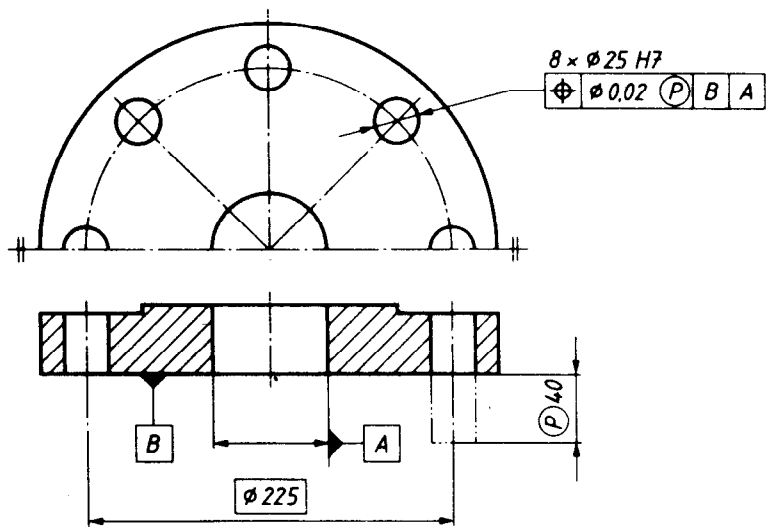


Figure 48

12 Maximum material condition

The indication that the tolerance value applies at the maximum material condition is shown by the symbol Ⓜ placed after :

- the tolerance value (see figure 49);
- the datum letter (see figure 50);
- or both (see figure 51);

according to whether the maximum material principle is to be applied respectively to the toleranced feature, the datum feature or both.

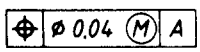


Figure 49

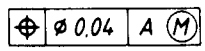


Figure 50

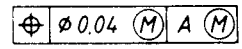


Figure 51

13 Definitions of tolerances

13.1 The various geometrical tolerances are defined with their tolerance zones in the following pages. In all the illustrations of the definitions only those deviations are shown with which the definitions deal.

13.2 Where required for functional reasons, one or more characteristics will be toleranced to define the geometrical accuracy of a feature. When the geometrical accuracy of a feature is defined by a certain type of tolerance, other deviations of this feature in some cases will be controlled by this tolerance (for example, straightness deviation is limited by parallelism tolerance). Thus it would rarely be necessary to symbolize all of these characteristics, since the other deviations are included on the zone of tolerance defined by the symbol specified.

However, certain other types of tolerances do not control other deviations (for example, straightness tolerance does not control deviation of parallelism).

13.3 For some tolerance zones (for example, for straightness of a line or axis in one direction only) there are two possible methods of graphical representation :

- by two parallel planes a distance t apart (see figure 52);
- by two parallel straight lines a distance t apart (see figure 53).

Figure 52 shows a three-dimensional representation, figure 53 its projection in a plane.

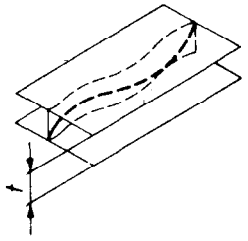


Figure 52

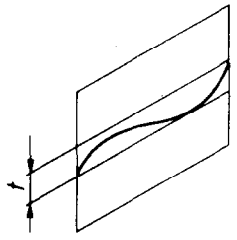
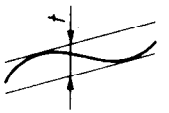
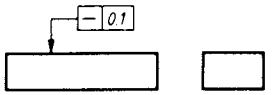
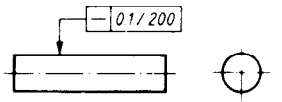
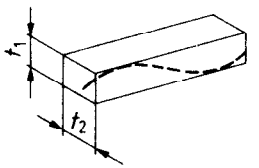
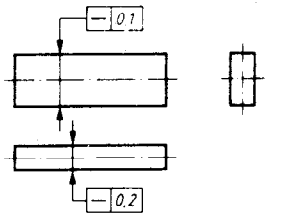
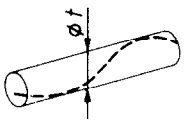
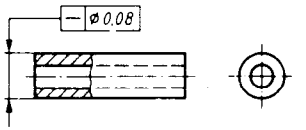
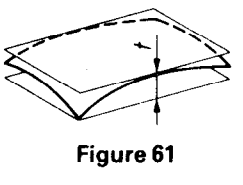
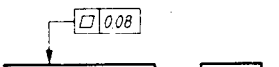


Figure 53

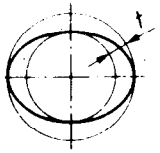
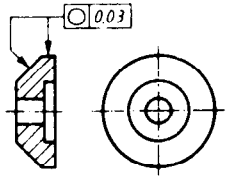
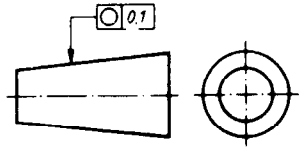
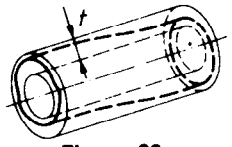
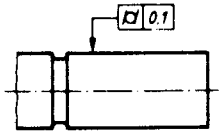
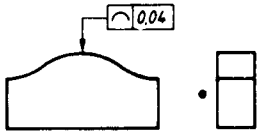
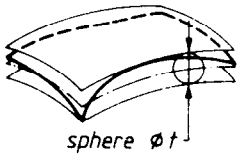
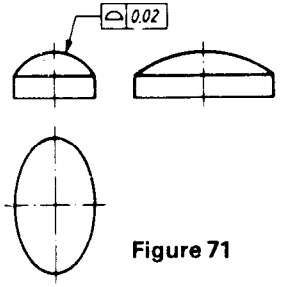
There is no difference in the meaning of the two representations (such a tolerance does not restrict the deviation in any direction perpendicular to the arrow). The simpler method as shown in figure 53 is normally used in this International Standard.

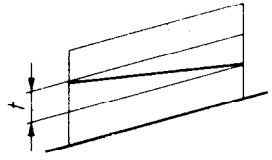
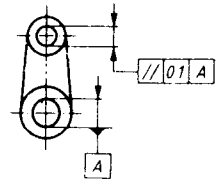
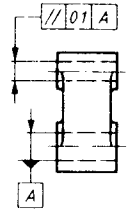
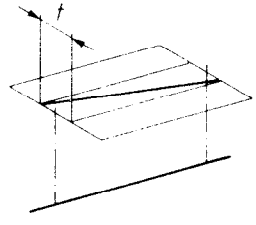
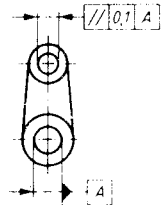
14 Detailed definitions of tolerances

Values in millimetres

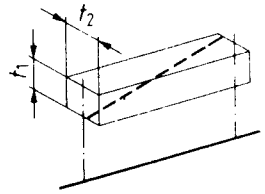
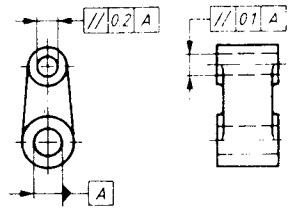
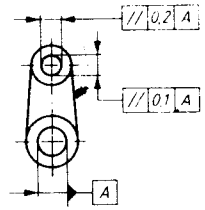
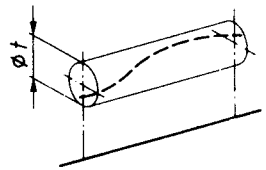
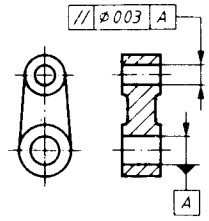
Symbol	Definition of the tolerance zone	Indication and interpretation
	14.1 Straightness tolerance	
—	The tolerance zone when projected in a plane is limited by two parallel straight lines a distance t apart.  **Figure 54**	 **Figure 55** Any line on the upper surface parallel to the plane of projection in which the indication is shown shall be contained between two parallel straight lines 0,1 apart.
		 **Figure 56** Any portion of lengths 200 of any generator of the cylindrical surface indicated by the arrow shall be contained between two parallel straight lines 0,1 apart in a plane containing the axis.
	The tolerance zone is limited by a parallelepiped of section $t_1 \times t_2$ if the tolerance is specified in two directions perpendicular to each other.  **Figure 57**	 **Figure 58** The axis of the bar shall be contained within a parallelepipedic zone of width 0,1 in the vertical and 0,2 in the horizontal direction.
	The tolerance zone is limited by a cylinder of diameter t if the tolerance value is preceded by the sign ø.  **Figure 59**	 **Figure 60** The axis of the cylinder to which the tolerance frame is connected shall be contained in a cylindrical zone of diameter 0,08.
	14.2 Flatness tolerance	
▱	The tolerance zone is limited by two parallel planes a distance t apart.  **Figure 61**	 **Figure 62** The surface shall be contained between two parallel planes 0,08 apart.

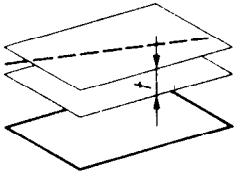
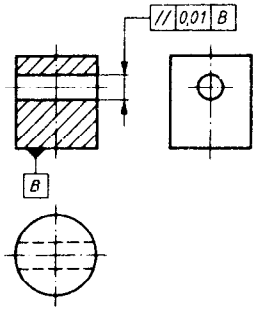
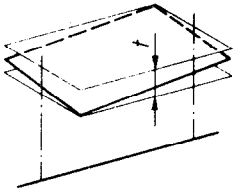
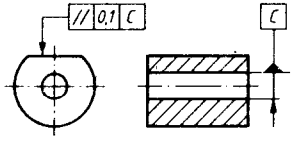
Values in millimetres

Symbol	Definition of the tolerance zone (*continued*)	Indication and interpretation (*continued*)
○	**14.3 Circularity tolerance** The tolerance zone in the considered plane is limited by two concentric circles a distance t apart.  Figure 63	 Figure 64 The circumference of each cross-section of the outer diameter shall be contained between two co-planar concentric circles 0,03 apart.  Figure 65 The circumference of each cross-section shall be contained between two co-planar concentric circles 0,1 apart.
⌭	**14.4 Cylindricity tolerance** The tolerance zone is limited by two coaxial cylinders a distance t apart.  Figure 66	 Figure 67 The considered surface shall be contained between two coaxial cylinders 0,1 apart.
⌒	**14.5 Profile tolerance of any line** The tolerance zone is limited by two lines enveloping circles of diameter t, the centres of which are situated on a line having the true geometrical form.  Figure 68	 Figure 69 In each section parallel to the plane of projection the considered profile shall be contained between two lines enveloping circles of diameter 0,04, the centres of which are situated on a line having the true geometrical profile.
⌓	**14.6 Profile tolerance of any surface** The tolerance zone is limited by two surfaces enveloping spheres of diameter t, the centres of which are situated on a surface having the true geometrical form.  Figure 70	 Figure 71 The considered surface shall be contained between two surfaces enveloping spheres of diameter 0,02, the centres of which are situated on a surface having the true geometrical form.

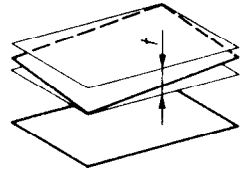
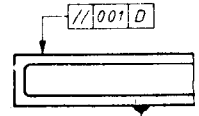
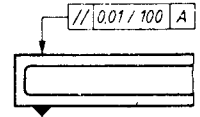
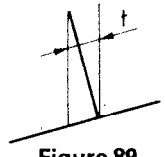
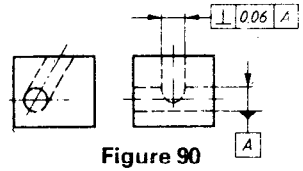
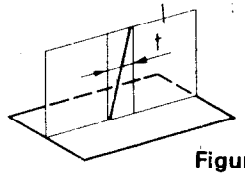
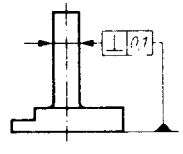
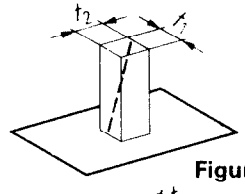
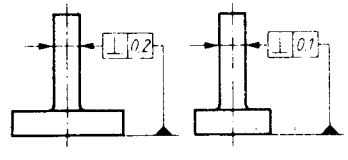
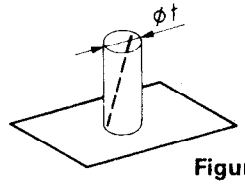
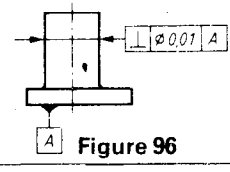
Symbol	Definition of the tolerance zone (*continued*)	Indication and interpretation (*continued*)
	14.7 Parallelism tolerance	
	14.7.1 Parallelism tolerance of a line with reference to a datum line	
//	The tolerance zone when projected in a plane is limited by two parallel straight lines a distance *t* apart and parallel to the datum line, if the tolerance is only specified in one direction.  **Figure 72**	 **Figure 73** The toleranced axis shall be contained between two straight lines 0,1 apart, which are parallel to the datum axis **A** and lie in the vertical direction (see figure 73 or 74).  **Figure 74**
	 **Figure 75**	 **Figure 76** The toleranced axis shall be contained between two straight lines 0,1 apart, which are parallel to the datum axis **A** and lie in the horizontal direction.

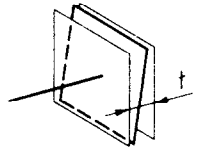
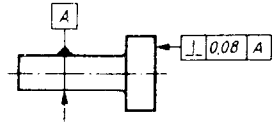
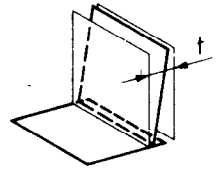
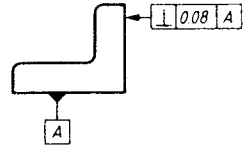
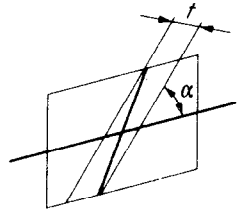
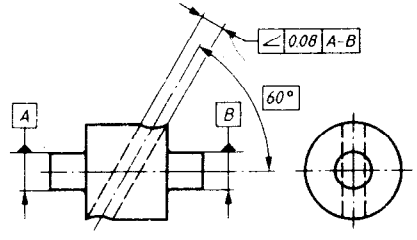
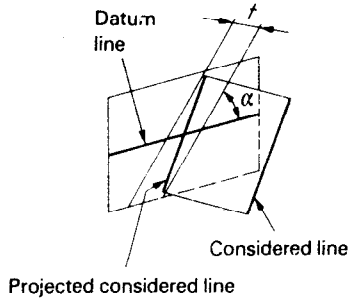
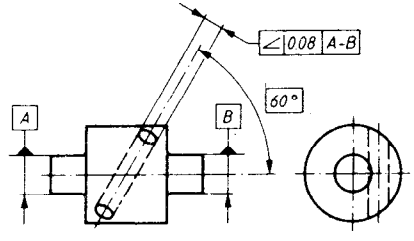
Values in millimetres

Symbol	Definition of the tolerance zone (*continued*)	Indication and interpretation (*continued*)
	14.7.1 Parallelism tolerance of a line with reference to a datum line (*concluded*)	
//	The tolerance zone is limited by a parallelepiped of section $t_1 \times t_2$ and parallel to the datum line if the tolerance is specified in two planes perpendicular to each other.  **Figure 77**	 **Figure 78** The toleranced axis shall be contained in a parallelepipedic tolerance zone having a width of 0,2 in the horizontal and 0,1 in the vertical direction and which is parallel to the datum axis **A** (see figures 78 or 79).  **Figure 79**
	The tolerance zone is limited by a cylinder of diameter t parallel to the datum line if the tolerance value is preceded by the sign ø.  **Figure 80**	 **Figure 81** The toleranced axis shall be contained in a cylindrical zone of diameter 0,03 parallel to the datum axis **A** (datum line).

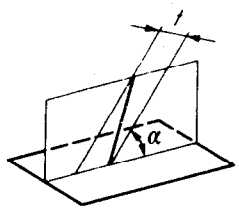
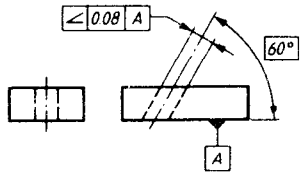
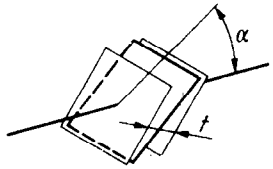
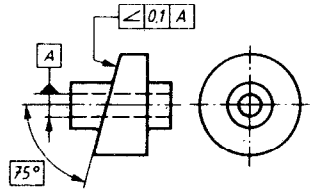
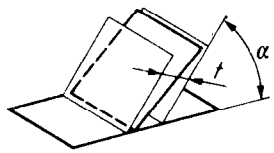
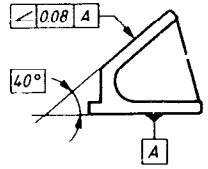
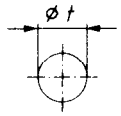
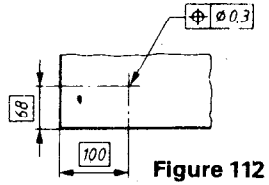
Symbol	Definition of the tolerance zone (*continued*)	Indication and interpretation (*continued*)
//	**14.7.2 Parallelism tolerance of a line with reference to a datum surface**	
	The tolerance zone is limited by two parallel planes a distance t apart and parallel to the datum surface.  **Figure 82**	 **Figure 83** The axis of the hole shall be contained between two planes 0,01 apart and parallel to the datum surface **B**.
	14.7.3 Parallelism tolerance of a surface with reference to a datum line	
	The tolerance zone is limited by two parallel planes a distance t apart and parallel to the datum line.  **Figure 84**	 **Figure 85** The toleranced surface shall be contained between two planes 0,1 apart and parallel to the datum axis **C** of the hole.

Values in millimetres

Symbol	Definition of the tolerance zone (*continued*)	Indication and interpretation (*continued*)
	14.7.4 Parallelism tolerance of a surface with reference to a datum surface	
//	The tolerance zone is limited by two parallel planes a distance t apart and parallel to the datum surface.  **Figure 86**	 **Figure 87** The toleranced surface shall be contained between two parallel planes 0,01 apart and parallel to the datum surface **D**.  **Figure 88** All the points on the toleranced surface in a length of 100, placed anywhere on this surface, shall be contained between two parallel planes 0,01 apart and parallel to the datum surface **A**.
	14.8 Perpendicularity tolerance	
	14.8.1 Perpendicularity tolerance of a line with reference to a datum line	
	The tolerance zone when projected in a plane is limited by two parallel straight lines a distance t apart and perpendicular to the datum line.  **Figure 89**	 **Figure 90** The axis of the inclined hole shall be contained between two parallel planes 0,06 apart and perpendicular to the axis of the horizontal hole **A** (datum line).
	14.8.2 Perpendicularity tolerance of a line with reference to a datum surface	
⊥	The tolerance zone when projected in a plane is limited by two parallel straight lines a distance t apart and perpendicular to the datum plane if the tolerance is specified only in one direction.  **Figure 91**	 **Figure 92** The axis of the cylinder, to which the tolerance frame is connected, shall be contained between two parallel planes 0,1 apart, perpendicular to the datum surface.
	The tolerance zone is limited by a parallelepiped of section $t_1 \times t_2$ and perpendicular to the datum plane if the tolerance is specified in two directions perpendicular to each other.  **Figure 93**	 **Figure 94** The axis of the cylinder shall be contained in a parallelepipedic tolerance zone of 0,1 × 0,2 which is perpendicular to the datum surface.
	The tolerance zone is limited by a cylinder of diameter t perpendicular to the datum plane if the tolerance value is preceded by the sign ø.  **Figure 95**	 **Figure 96** The axis of the cylinder to which the tolerance frame is connected shall be contained in a cylindrical zone of diameter 0,01 perpendicular to the datum surface **A**.

Symbol	Definition of the tolerance zone (*continued*)	Indication and interpretation (*continued*)
⊥	**14.8.3 Perpendicularity tolerance of a surface with reference to a datum line**	
	The tolerance zone is limited by two parallel planes a distance *t* apart and perpendicular to the datum line.  **Figure 97**	 **Figure 98** The toleranced face of the piece shall be contained between two parallel planes 0,08 apart and perpendicular to the axis **A** (datum line).
	14.8.4 Perpendicularity tolerance of a surface with reference to a datum surface	
	The tolerance zone is limited by two parallel planes a distance *t* apart and perpendicular to the datum surface.  **Figure 99**	 **Figure 100** The toleranced surface shall be contained between two parallel planes 0,08 apart and perpendicular to the horizontal datum surface **A**.
∠	**14.9 Angularity tolerance**	
	14.9.1 Angularity tolerance of a line with reference to a datum line	
	a) Line and datum line in the same plane. The tolerance zone when projected in a plane is limited by two parallel straight lines a distance *t* apart and inclined at the specified angle to the datum line.  **Figure 101**	 **Figure 102** The axis of the hole shall be contained between two parallel straight planes 0,08 apart which are inclined at 60° to the horizontal axis **A-B** (datum line).
	b) Line and datum line in different planes. If the considered line and the datum line are not in the same plane, the tolerance zone is applied to the projection of the considered line on the plane containing the datum line and parallel to the considered line.  **Figure 103**	 **Figure 104** The axis of the hole, projected on a plane containing the datum axis, shall be contained between two parallel straight lines 0,08 apart which are inclined at 60° to the horizontal axis **A-B** (datum line).

Values in millimetres

Symbol	Definition of the tolerance zone (*continued*)	Indication and interpretation (*continued*)
	14.9.2 Angularity tolerance of a line with reference to a datum surface	
	The tolerance zone when projected in a plane is limited by two parallel straight lines a distance t apart and inclined at the specified angle to the datum surface.  **Figure 105**	 **Figure 106** The axis of the hole shall be contained between two parallel planes 0,08 apart which are inclined at 60° to the surface **A** (datum surface).
	14.9.3 Angularity tolerance of a surface with reference to a datum line	
∠	The tolerance zone is limited by two parallel planes a distance t apart and inclined at the specified angle to the datum line.  **Figure 107**	 **Figure 108** The inclined surface shall be contained between two parallel planes 0,1 apart which are inclined at 75° to the axis **A** (datum line).
	14.9.4 Angularity tolerance of a surface with reference to a datum surface	
	The tolerance zone is limited by two parallel planes a distance t apart and inclined at the specified angle to the datum surface.  **Figure 109**	 **Figure 110** The inclined surface shall be contained between two parallel planes 0,08 apart which are inclined at 40° to the surface **A** (datum surface).
	14.10 Positional tolerance	
	14.10.1 Positional tolerance of a point	
⌖	The tolerance zone is limited by a circle of diameter t, the centre of which is in the theoretically exact position of the considered point.  **Figure 111**	 **Figure 112** The actual point of intersection shall lie inside a circle of 0,3 diameter, the centre of which coincides with the theoretically exact position of the considered point of intersection.

Symbol	Definition of the tolerance zone (*continued*)	Indication and interpretation (*continued*)
	14.10.2 Positional tolerance of a line	
	The tolerance zone is limited by two parallel straight lines a distance t apart and disposed symmetrically with respect to the theoretically exact position of the considered line if the tolerance is specified only in one direction.	Each of the lines shall be contained between two parallel straight lines 0,05 apart which are symmetrically disposed about the theoretically exact position of the considered line, with reference to the surface **A** (datum plane).
	The tolerance zone is limited by a parallelepiped of section $t_1 \times t_2$ the axis of which is in the theoretically exact position of the considered line if the tolerance is specified in two directions perpendicular to each other.	Each of the axes of the eight holes shall be contained within a parallelepipedic zone of width 0,05 in the horizontal and 0,2 in the vertical direction and the axis of which is in the theoretically exact position of the considered hole.
⌖	The tolerance zone is limited by a cylinder of diameter t the axis of which is in the theoretically exact position of the considered line if the tolerance value is preceded by the sign ø.	The axis of the hole shall be contained within a cylindrical zone of diameter 0,08 the axis of which is in the theoretically exact position of the considered line, with reference to the surfaces **A** and **B** (datum planes).
	14.10.3 Positional tolerance of a flat surface or a median plane	
	The tolerance zone is limited by two parallel planes a distance t apart and disposed symmetrically with respect to the theoretically exact position of the considered surface.	The inclined surface shall be contained between two parallel planes which are 0,05 apart and which are symmetrically disposed with respect to the theoretically exact position of the considered surface with reference to the surface **A** (datum plane) and the axis of the datum cylinder **B** (datum line).

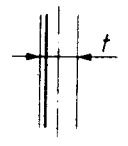


Figure 113

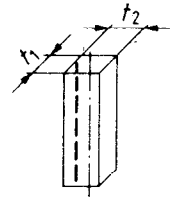


Figure 115

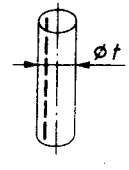


Figure 117

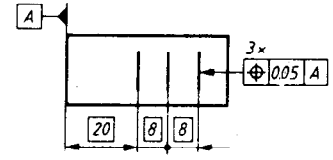


Figure 114

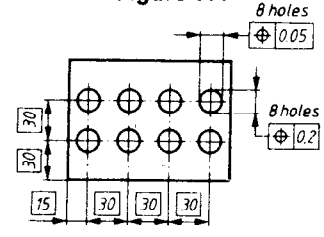


Figure 116

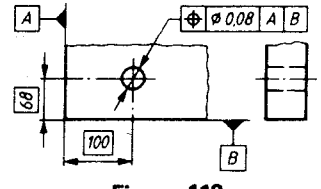


Figure 118

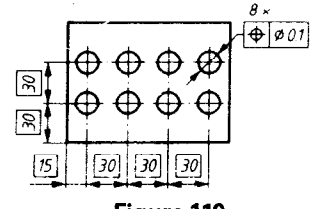


Figure 119

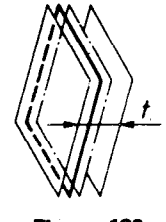


Figure 120

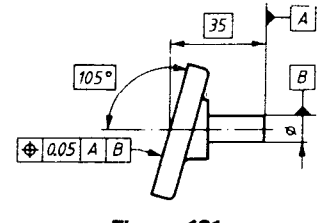
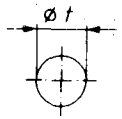
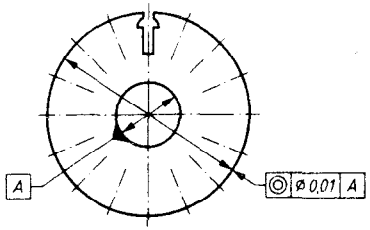
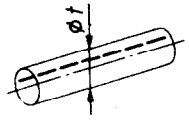
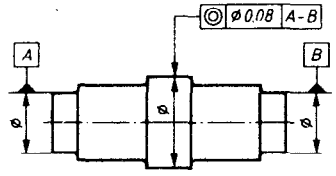
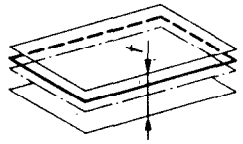
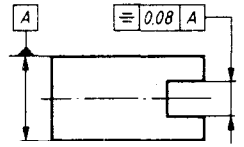
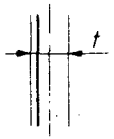
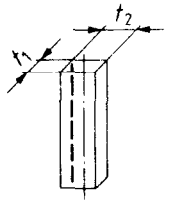
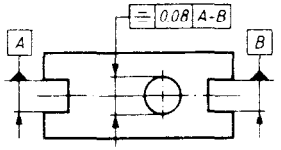
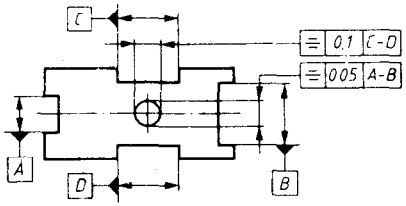
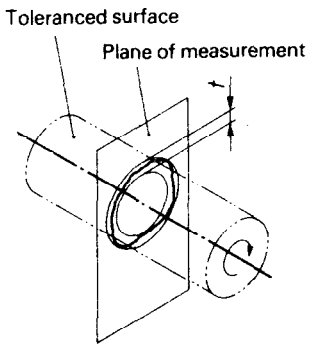
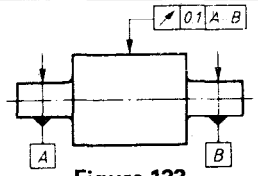
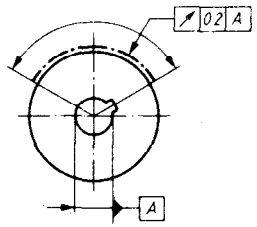
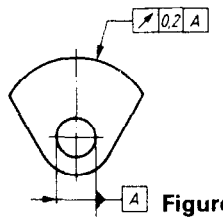
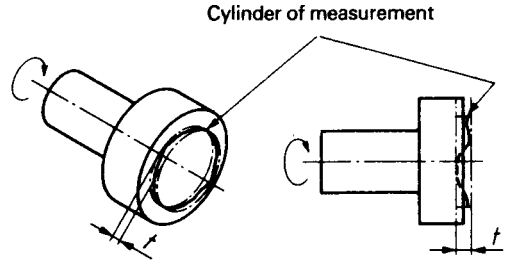
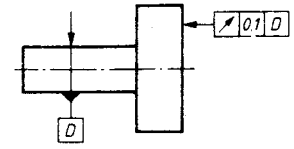
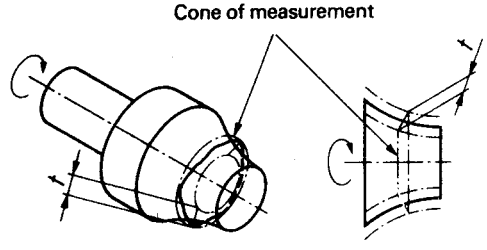
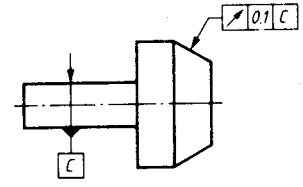
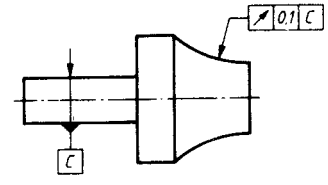
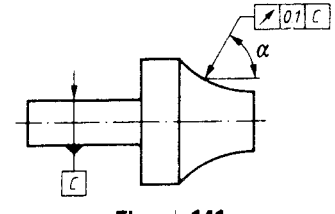
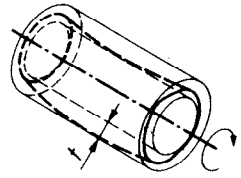
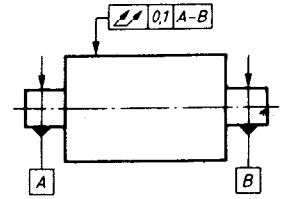
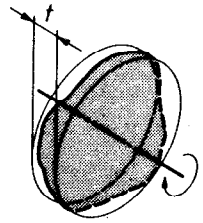
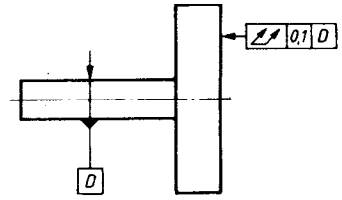


Figure 121

Symbol	Definition of the tolerance zone (*continued*)	Indication and interpretation (*continued*)
	14.11 *Concentricity and coaxiality tolerance*	
	14.11.1 Concentricity tolerance of a point	
◎	The tolerance zone is limited by a circle of diameter *t* the centre of which coincides with the datum point.  **Figure 122**	 **Figure 123** *The centre of the circle, to which the tolerance frame is connected, shall be contained in a circle of diameter 0,01 concentric with the centre of the datum circle* **A**.
	14.11.2 Coaxiality tolerance of an axis	
	The tolerance zone is limited by a cylinder of diameter *t*, the axis of which coincides with the datum axis if the tolerance value is preceded by the sign ø.  **Figure 124**	 **Figure 125** The axis of the cylinder, to which the tolerance frame is connected, shall be contained in a cylindrical zone of diameter 0,08 coaxial with the datum axis **A-B**.
	14.12 Symmetry tolerance	
⌯	**14.12.1 *Symmetry tolerance of a median plane***	
	The tolerance zone is limited by two parallel planes *a distance t apart and disposed symmetrically to the median plane with respect to the datum axis or datum plane.*  **Figure 126**	 **Figure 127** The median plane of the slot shall be contained between two parallel planes, which are 0,08 apart and symmetrically disposed about the median plane with respect to the datum feature **A**.

Symbol	Definition of the tolerance zone (*continued*)	Indication and interpretation (*continued*)
	14.12.2 Symmetry tolerance of a line or an axis	
⌯	The tolerance zone when projected in a plane is limited by two parallel straight lines a distance t apart and disposed symmetrically with respect to the datum axis (or datum plane) if the tolerance is specified only in one direction.  **Figure 128** The tolerance zone is limited by a parallelepiped of section $t_1 \times t_2$, the axis of which coincides with the datum axis if the tolerance is specified in two directions perpendicular to each other.  **Figure 130**	 **Figure 129** The axis of the hole shall be contained between two parallel planes which are 0,08 apart and symmetrically disposed with respect to the actual common median plane of the datum slots **A** and **B**.  **Figure 131** The axis of the hole shall be contained in a parallelepipedic zone of width 0,1 in the horizontal and 0,05 in the vertical direction and the axis of which coincides with the datum axis formed by the intersection of the common median planes **A-B** and **C-D**.
	14.13 Circular run-out tolerance	
↗	**14.13.1 Circular run-out tolerance — radial**	
	The tolerance zone is limited within any plane of measurement perpendicular to the axis by two concentric circles a distance t apart, the centre of which coincides with the datum axis.  **Figure 132** Run-out normally applies to complete revolutions about the axis but could be limited to apply to a part of a revolution.	 **Figure 133** The radial run-out shall not be greater than 0,1 in any plane of measurement during one revolution about the datum axis **A-B**.  **Figure 134** The radial run-out shall not be greater than 0,2 in any plane of measurement when measuring the toleranced part of a revolution about the centre line of hole **A** (datum axis).  **Figure 135**

Symbol	Definition of the tolerance zone (*continued*)	Indication and interpretation (*continued*)
	14.13.2 Circular run-out tolerance — axial	
	The tolerance zone is limited at any radial position by two circles a distance *t* apart lying in a cylinder of measurement, the axis of which coincides with the datum axis.  **Figure 136**	 **Figure 137** The axial run-out shall not be greater than 0,1 at any position of measurement during one revolution about the datum axis **D**.
	14.13.3 Circular run-out tolerance in any direction	
↗	The tolerance zone is limited within any cone of measurement, the axis of which coincides with the datum axis by two circles a distance *t* apart. Unless otherwise specified the measuring direction is normal to the surface.  **Figure 138**	 **Figure 139** The run-out in the direction indicated by the arrow shall not be greater than 0,1 in any cone of measurement during one revolution about the datum axis **C**.  **Figure 140** The run-out in the direction perpendicular to the tangent of a curved surface shall not be greater than 0,1 in any cone of measurement during one revolution about the datum axis **C**.
	14.13.4 Circular run-out tolerance in a specified direction	
	The tolerance zone is limited within any cone of measurement of the specified angle, the axis of which coincides with the datum axis by two circles a distance *t* apart.	 **Figure 141** The run-out in the specified direction shall not be greater than 0,1 in any cone of measurement during one revolution about the datum axis **C**.

Symbol	Definition of the tolerance zone (*concluded*)	Indication and interpretation (*concluded*)
	14.14 Total run-out tolerance	
	14.14.1 Total radial run-out tolerance	
	The tolerance zone is limited by two coaxial cylinders a distance *t* apart, the axes of which coincide with the datum axis.  **Figure 142**	 **Figure 143** The total radial run-out shall not be greater than 0,1 at any point on the specified surface during several revolutions about the datum axis **A-B**, and with relative axial movement between part and measuring instrument. With relative movement the measuring instrument or the workpiece shall be guided along a line having the theoretically perfect form of the contour and being in correct position to the datum axis.
	14.14.2 Total axial run-out tolerance	
	The tolerance zone is limited by two parallel planes a distance *t* apart and perpendicular to the datum axis.  **Figure 144**	 **Figure 145** The total axial run-out shall not be greater than 0,1 at any point on the specified surface during several revolutions about the datum axis **D** and with relative radial movement between the measuring instrument and the part. With relative movement the measuring instrument or the workpiece shall be guided along a line having the theoretically perfect form of the contour and being in correct position to the datum axis.

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