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Mechanical standardization of semiconductor devices —

Part 1: General rules for the preparation of outline drawings of discrete devices

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British Standards

National foreword

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Mechanical standardization of semiconductor devices –

Part 1: General rules for the preparation of outline drawings of discrete devices

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IEC 60191-1:2007(E)

CONTENTS

MECHANICAL STANDARDIZATION OF SEMICONDUCTOR DEVICES –

Part 1: General rules for the preparation of outline drawings of discrete devices

1 Scope and object

This part of IEC 60191 gives guidelines on the preparation of outline drawings of discrete devices.

NOTE For preparation of outline drawings of surface mounted discrete devices, IEC 60191-6 should be referred to as well.

The primary object of these drawings is to indicate the space which should be allowed for devices in an equipment, together with other dimensional characteristics required to ensure mechanical interchangeability.

It should be noted that complete interchangeability involves other considerations such as the electrical and thermal characteristics of the semiconductor devices concerned.

The international standardization represented by these drawings therefore encourages the manufacturers of devices to comply with the tolerances shown on the drawings in order to extend their range of customers internationally. It also gives equipment designers an assurance of mechanical interchangeability between the devices obtained from suppliers in different countries, provided they allow the space in their equipment that is indicated by the drawings and take note of the more precise information on bases, studs, etc.

NOTE Additional details on the standardization philosophy used in this standard are given in Annex B.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60191-2:1966, *Mechanical standardization of semiconductor devices – Part 2: Dimensions* (including all supplements and amendments)

IEC 60191-4, *Mechanical standardization of semiconductor devices – Part 4: Coding system and classification into forms of package outlines for semiconductor device packages*

ISO 370, *Toleranced dimensions – Conversion from inches to millimetres and vice versa (withdrawn 2000-05)*

3 Terms and definitions

For the purposes of this document, the following definitions apply.

3.1
device outline drawing
drawing which includes all dimensional characteristics required for the mechanical interchangeability of the complete device. It includes the case or body, all terminals and the locating tab if present

3.2
terminal
that part of the semiconductor device primarily used in making an electrical, mechanical or thermal connection. Examples of terminals are flexible leads, rigid leads, pins, studs, etc.

3.3
case outline drawing
drawing which includes all dimensional characteristics required for the mechanical interchangeability of the case or body. It does not include the dimensions of the terminals or the locating tab if present, but their positions are shown by dotted lines

3.4
base drawing
drawing which includes all dimensional characteristics required for the mechanical interchangeability of the terminals and mechanical index

NOTE 1 Examples of these characteristics are: lead length, lead diameters with controlled zones, lead spacing, pitch circle diameter, thickness, width and length of a tab, etc

NOTE 2 The diameter or major axis of the case outline should not be given on the base drawing.

NOTE 3 Many semiconductor devices have identical cases, but differ in the number or the length of terminals. It is also possible to have the same type of base associated with cases which are not identical.

Consequently, there are advantages in having:

a) a single drawing including only the dimensional characteristics of the case outline and separate drawings for the various bases which can be associated with this case outline,

or

b) a single drawing including only the dimensional characteristics of the base and separate drawings for the various case outlines which can be associated with this base.

3.5
mechanical index
locating feature, or that portion of the device specifically designed to provide orientation.

NOTE Examples of a mechanical index are: key, keyway, locating tab, etc.

3.6
visual index
any single terminal (or omission of) readily distinguished by the eye from others or any distinctive boss, stippled pattern or colour mark adjacent to a terminal

3.7
datum
a theoretically exact geometric reference (such as axes, planes, straight lines etc.) to which toleranced features are related. Datums may be based on one or more datum features of a part

[ISO 5459:1981, definition 3.1]

3.8
seating plane or seating base
reference plane from which, in general, outline and base dimensions are given

3.9
seated height or mounted height
distance from the seating plane to the top of any exposed tip or rigid terminal present, otherwise to the top of the outline. Flexible terminals should not be included as part of the seated height, but the mounted height should include a minimum allowance necessary for an axially mounted flexible lead to be bent at right angles

3.10
controlled cylindrical zone
zone which defines a portion of the body of minimum length over which the diameter is controlled to closer tolerances than is allowed over the full length of the body

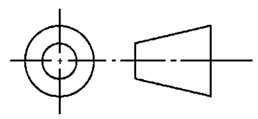
4 General rules for all drawings

NOTE General rules for the preparation of outline drawings of surface mounted semiconductor device packages are given in IEC 60191-6.

4.1 Drawing layout

General rules for the drawing layout are as follows.

a) A drawing should show all dimensions required to ensure mechanical interchangeability.
b) The drawing using third angle projection, should include:
   – a suitable side-view;
   – suitable end-views, where appropriate;
   – such additional views and details as are required to show any special configuration or features.
c) The following information should be put in the cartouche, at the bottom of the page:
   – the projection method where there is more than one view, indicated as follows:



   – date of publication of the drawing;
   – IEC code number;
   – country of origin and code of that country indicated by sign Δ;

   NOTE This is no longer in practice.

   – other interested countries and codes of those countries.
d) When a drawing is re-issued because of modifications, the changes made should be indicated by arrows in the margin. The date of publication of the revised issue and of the superseded issue should be stated.
e) While drawings need not to be drawn to scale, they should be roughly in proportion and, where necessary for clarity, enlarged detail drawing(s) should be used.

4.2 Dimensions and tolerances

Application of dimensions and tolerances are as follows.

a) Dimensions of bases, outlines, etc. quoted shall apply to the finished product. They should, therefore, not quote manufacturing tolerances, but give customers acceptance limits.

b) The following types of dimension may be used on the drawings as appropriate:

   i) Toleranced dimensions
   A toleranced dimension can be expressed:

   – preferably by both minimum and maximum limits
     (example: L_{min} = 5,77 mm, L_{max} = 5,82 mm); or

   – by a nominal value and maximum and minimum limits. Such a nominal value need not necessarily be the average of two limits
     (example: $L = 6\,^{+0,4}_{-0,2}$ mm).

   ii) Untoleranced dimensions

   – Untoleranced limiting dimensions
     i.e.: minimum only or maximum only
     (example: L_{max} = 5,85 mm) .

   – Untoleranced nominal dimensions
     These dimensions may be used:

     – either for general information as an actual nominal figure;

     – or to specify true geometrical position (by means of linear or angular dimensions). Such dimensions shall be indicated by an asterisk (*) after the numerical value, the asterisk in this sense meaning "true geometrical position"
       (example: L_{nom} = 5,85 mm).

c) Single minimum, single maximum or single nominal (where not given for general information) dimensions should be stated in decimals to such a number of places as is considered adequate to express the degree of accuracy appropriate for that dimension; e.g. if measurement to the nearest 0,001 mm is considered appropriate, the dimension should be expressed to the third decimal place (for example 0,500 mm), but if the measurement to the nearest 0,01 mm is sufficient, the dimension should be expressed to the second decimal place (for example 0,50 mm) and so on. Similar consideration should be given to the number of decimal places necessary when an original dimension is expressed in millimetres.

d) Limiting values or nominal value and limits of a toleranced dimension should be stated with the same number of decimal places (e.g. 0,016 mm min. – 0,017 mm nom. – 0,019 mm max.).

e) The use of fractional mm dimensions is permitted to describe nominal hexagon sizes.

f) Numerical dimensions should not be shown directly on the figure(s). They should be shown in tabular form under the figure(s) and correspond to the reference letter symbols on the figure(s). The letter symbols on the figure(s) should be upright. Upper case letters should be used for device outline and case outline dimensions and lower case letters for base dimensions. If confusion could arise, upper case letters should preferably be used throughout.

g) In the case of a diameter, the symbol “Ø” should appear in front of the reference letter concerned both on the figure(s) and in the table. In cases where the cross-section is uncontrolled (not necessarily round), the “Ø” symbol should not be used.

h) The table shall give dimensions in millimetres. The basic dimensions and system (millimetres or inches) will be indicated immediately above the table.

   NOTE Outline drawings published in IEC 60191-2 before this document came into effect may give dimensions in inches.

i) The dimensions and limits which should normally be given and their corresponding reference letter symbols are contained in Annex A. Some examples of drawings prepared in accordance with these rules are given in Annex E.

   Where a particular reference letter is to be used for more than one dimension on the same drawing, use should be made of a suffix to identify the dimensions.

Annex A cannot be expected to include all dimensions likely to be necessary for mechanical standardization, more particularly in the future. A distinction has been made between primary and secondary reference letter symbols, primary reference letter symbols being those which are used most frequently, secondary reference letter symbols being those which are used less frequently and which can, if necessary, be associated with dimensions other than those given in the table.

j) Where it is self-evident that several angles are equal, it is not necessary to show more than one angle on the figure(s).

k) Notes will be numbered and placed under the table of dimensions, which will have a “notes”' column on the right-hand side. The note reference will be placed opposite the dimension to which the note refers in the table or, when this dimension does not appear in the table, on the figure(s). The numerical sequence of the notes should follow the alphabetical sequence of the dimensional reference letters to which the notes refer. Notes referring to the figure(s) should follow notes referring to dimensions given in the table.

4.3 Methods for locating the datum

These methods are listed below in order of preference. When more than one of these methods is possible for a given device, the method appearing earliest in the list should be used. When none of the following methods is possible, the method best suited to the device should be used.

The datum is

a) the radial line through the centre of the mechanical or visual index;

b) the radial line midway between the two terminals which obviously comprise a gap in an otherwise equally spaced circular terminal array;

c) the radial line 180° from the locating radius of the most isolated terminal;

d) the radial line 180° from the mid-point of, in order of preference:

   – the two most widely spaced terminals;

   – the two most closely spaced terminals;

e) the radial line through the centre of the index terminal. In order of preference, the index terminal is defined as that having:

   – the smallest cross-sectional area at the point of emergence from the case;

   – the greatest axial length, when one terminal is noticeably longer than the others;

   – the smallest axial length, when one terminal is noticeably shorter than the others.

4.4 Numbering of terminals

4.4.1 General

Where possible, device terminals should be identified by numbers according to the system outlined in 4.4.2 to 4.4.7. In all instances terminals are considered as being viewed from their free ends.

4.4.2 Single-ended devices with terminals in a linear array

4.4.2.1 Symmetrical linear array

The terminal nearest the reference mark should be numbered as No.1, the other terminals should be numbered progressively from terminal No.1.

4.4.2.2 Asymmetrical linear array

The terminals should be numbered progressively from the end having the most terminals.

4.4.3 Single-ended devices with terminals in a circular array

- The terminal, the centre of which is past the datum, should be numbered as No.1, the other terminals should be numbered progressively and in a clockwise sequence from No.1.
- Where a terminal is situated in the centre of the base, this should be known as the centre terminal and shall not be given a number.
- Where omission of one terminal in an otherwise equally spaced array identifies the datum, the position of the omitted terminal should not be numbered; but, in a fixed modular circular array, any location of omitted terminal which does not define a datum should be numbered.

4.4.4 Double-ended devices

Terminals on both end views should be numbered without duplication of numbers.

4.4.5 Devices with terminals disposed in a square or rectangular periphery

Visual identification of the top of the device should be provided. The means of identification of terminal position number one should also be provided. These identifications may be combined.

The terminal positions should be numbered progressively in an anti-clockwise direction around the periphery of the device as viewed from the top. The number one terminal position shall be the first position anti-clockwise from the means of identification.

Each terminal shall be identified by the number of its position. Terminals may not necessarily be present in all the numbered positions but those present shall have the number of the position.

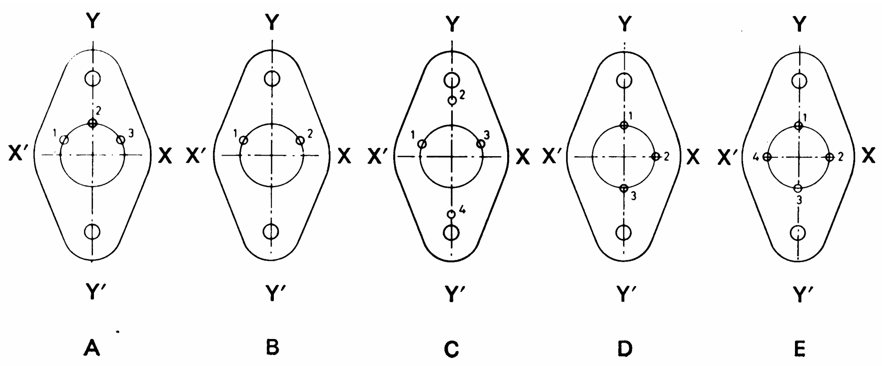
4.4.6 Particular case of lozenge – shaped bases

Given two orthogonal axes, X'X and Y'Y, the device is oriented so that:

a) the greatest diagonal of the base coincides with the Y'Y axis, whereas the smallest diagonal coincides with the X'X axis;
b) the greatest number of terminals is in the upper half (Figure1A, 1B, 1C) or in the right-hand half (Figure 1D).

The numeration is clockwise, starting from the quadrant in the upper left-hand side.

If the terminals are disposed in a cross on the axis (Figure 1E), it is necessary to mark on the body with a visual index the terminal which shall be considered as the first in the clockwise numeration.



IEC 575/07

4.4.7 Other devices

For devices having terminals, mounting studs or holes, in more than one plane, the following rules should apply.

The numbering should start at the end:

– opposite to the end containing a threaded stud or hole;
– opposite to the end with the smallest number of terminals;
– opposite to the end identified by a hand, dot or other applied visual identification;
– opposite to the end with the larger ferrule, flange, insert, etc.

5 Additional rules

5.1 Rules for device and case outline drawings

Rules for device and case outline drawings are as follows.

a) The device outline drawings which appear in chapter I of IEC 60191-2 should include all dimensional characteristics required for interchangeability in accordance with general rules.
b) Where the requirements for mechanical interchangeability will permit, the minimum and maximum dimensions should be chosen so that the creation of unnecessary drawings of variants is avoided.
c) The case outline drawings which appear in Chapter III of IEC 60191-2 should include all dimensional characteristics required for interchangeability in accordance with general rules, omitting the terminal dimensioning which will be given on the associated base drawings appearing in Chapter II of IEC 60191-2.

On the case outline drawings, the terminals should be shown only by dotted lines.

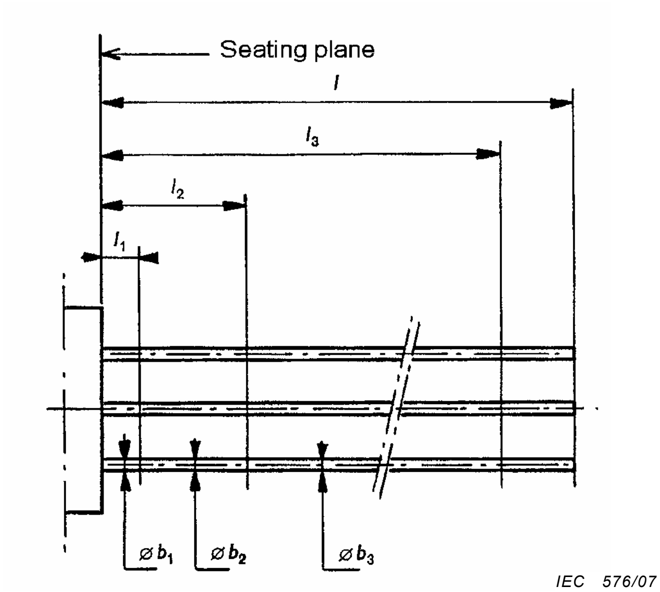
5.2 Rules to specify the dimensions and positions of terminals

5.2.1 General rules

General rules for specifying the dimensions and positions of terminals are as follows.

a) The terminals should be numbered in accordance with 4.4.
b) The following system should be used to locate the terminals on the bases.

   The true geometrical position of the terminals (or of the holes in gauges) is defined by angular spacing on a pitch circle (polar co-ordinates) or by rectangular co-ordinates in relation to certain fixed references. Such dimensions are not toleranced.
c) The positional tolerance is indicated by stating that the cross-section of each terminal at its point of origin or at a specified distance from the seating plane lies in a circle (of stated diameter) centred at the true geometrical point defining the terminal axis.
d) The following system should be used either in total or in part to indicate the dimensions of the terminals.



Ø b_1 applies over the length l_1
Ø b_2 applies over the length $l_2 – l_1$
Ø b_3 applies over the length $l_3 – l_2$ or where appropriate $l – l_2$

Figure 2 – System to indicate the dimensions of the terminals

e) The base drawings which appear in Chapter II of IEC 60191-2 should include the dimensional characteristics required for interchangeability of the base and in certain instances for compatibility between the base and a socket.

5.2.2 Rules to specify the dimensions and the positions of the terminals on a base drawing

See Annex C.

5.3 Rules for gauge drawings

Where possible, the same reference letter symbols should be used as on the associated case outline or base drawing.

6 Inter-conversion of inch and millimetre dimensions and rules for rounding off

Conversion of toleranced dimensions from inches into millimetres or vice-versa should be made according to ISO 370.

Tables I and II of ISO 370 may be extended as necessary.

Warning *When converting inch dimensions to millimetre dimensions and vice-versa, attention is drawn to the fact that the first column of Tables I and II are headed "equal to at least".*

ISO 370 has been withdrawn in May 2000. The rules which were applied before the year 2000 are given now in the informative Annex F at the end of this document.

7 Rules for coding

The classification of forms of package outline for semiconductor devices is specified in IEC 60191-4.

NOTE Drawings in IEC 60191-2, published before IEC 60191-4 came into effect, are classified according to the coding system in the informative Annex G.

Annex A
(informative)

Reference letter symbols

NOTE These symbols were used in the past. Nowadays use of dimensions A, D and E is preferred.

Where appropriate to the particular drawing being prepared, the dimensions listed in the following table should be given with the associated reference letter symbols.

Table A.1 – Dimensions of reference letter symbols

Reference letter symbol	Description of the dimension	Type of limits			Notes
A	Length from seating plane to top of case.	min.	-	max.	P
a	Pitch circle diameter of terminals.	-	nom.[a]	-	P
B, b	Diameter of a terminal, or of the larger terminal if the cross-section is circular. If the cross-section is not circular, width or major axis of the cross-section of a terminal.	min.	-	max.	1, 2, 3, P
B_1, b_1	Other diameter of terminal as shown in the diagram in Subclause 5.2.1, d)	-	-	max.	P
B_2, b_2	Other diameter of terminal as shown in the diagram in Subclause 5.2.1, d)	min.	-	max.	P
B_3, b_3	Other diameter of terminal as shown in the diagram in Subclause 5.2.1, d)	min.	-	max.	P
C, c	Diameter of smaller terminal, if the cross-section is circular. If the cross-section is not circular, thickness or minor axis of the cross-section of a terminal.	min.	-	max.	1, 2, 3, 4, S
D	Diameter or major axis of case.	min.	-	max.	1, P
D_1	Smallest diameter of case.	min.	-	max.	1, P
D_2, D_3, etc.	Other diameters of case.	min.	-	max.	1, P
d	Distance from an axial reference line to a terminal centre.	-	nom. [a]	-	S
E	Minor axis of case.	min.	-	max.	1, S
E	Or across flats dimension of a hexagon.	min.	nom.	max.	1, 2, S
e	Distance between two terminal centres (distance between the centres of the nearest terminal when there are more than two terminals).	-	nom. [a]	-	S
e	Or clearance between two terminals.	min.	-	-	S
e_1, e_2, etc.	Other distances between terminal centres.	-	nom. [a]	-	S
e_1, e_2, etc.	Or clearances between terminals.	min.	-	-	S
F	Thickness or length of flange zone of the case including any fillet if present.	min.	-	max.	2, S
G	Overall length excluding terminals and slugs.	min.	-	max.	1, S
G_1	Overall length excluding terminals but including slugs.	-	-	max.	S
H	Overall length including terminals.	min.	-	-	S
h	Height of a mechanical index.	-	-	max.	S

Table A.1 *(continued)*

Reference letter symbol	Description of the dimension	Type of limits			Notes
J	Seated height or mounted height.	-	-	max.	P
j	Width or diameter of a mechanical index.	min.	-	max.	S
K	Length of top zone of the case.	-	-	max.	S
k	Length of a mechanical index.	min.	-	max.	S
L, l	Length of a terminal.	min.	-	max.	2,5, 6, P
L_1, l_1	Other length of terminal as shown in the diagram in Subclause 5.2.1, d)	-	-	max.	5, P
L_2, l_2	Other length of terminal as shown in the diagram in Subclause 5.2.1, d)	min.	-	-	5, P
L_3, l_3	Other length of the terminal as shown in the diagram in Subclause 5.2.1, d)	min.	-	max.	2, 5, P
M, m	Diameter or width of a terminal stud or slug.	min.	-	max.	1, P
N, n	Overall length of a stud threaded entirely or partially or not at all.	min.	-	max.	P
N_1, n_1	Distance to end of full thread (unthreaded portion) of a stud.	min.	-	max.	1, P
O	Distance between seated plane and centre of hole in the lug of a terminal.	min	-	max.	2, S
P	Length of controlled zone of the case.	min.	-	-	S
p	Diameter of a mounting hole.	min.	-	max.	S
Q	Other dimensions				S
q	Distance between the centres of two mounting holes.	min.	-	max.	S
R, r	Curve radii	min.	-	max.	1, 2, P
R_1, r_2	Curve radii of the ends of the base seat	-	-	max.	P
S	Distance from a reference line to the centre line of a terminal	min.	-	max.	1, S
s	Distance from the reference line through the centres of two terminals to the centre of the mounting hole which is the farthest from this reference line.	-	nom. [a]	-	S
T, t	Diameter of the hole (or smallest dimension of a non-circular hole) in a terminal lug or slug .	min.	-	max.	2, P
V, v	Depth of a tapped hole.	min.	-	max.	S
W, w	Diameter of the threaded portion of a stud with full thread form, or diameter of a tapped hole	Thread reference			7, P
(x – x) (y – y)	Section reference, continuous				P
x – y	Section reference, not continuous				P
Z, z	Other dimensions				S
α	Small angle	-	nom.	-	P
β, γ	Larger angles	-	nom.	-	P

Table A.1 *(continued)*

P primary reference letter symbol	(see Subclause 4.2, i)
S secondary reference letter symbol	(see Subclause 4.2, i)

NOTE 1 Minimum dimension may be omitted where appropriate.

NOTE 2 Maximum dimension may be omitted where appropriate.

NOTE 3 To distinguish in the same drawing between major or minor axes of cross-section of different terminals having different dimensions, the signs (‘) prime, (“) second, etc. may be used with reference letters B, b and C, c.

NOTE 4 Reference letter symbols C_1, c_1; C_2, c_2; C_3, c_3 may also be used in the same manner as reference letter symbols B or b.

NOTE 5 Measured from the seating plane.

NOTE 6 For terminals of different overall lengths, the letter symbols L_Z, l_Z, L_Y, l_Y, L_X, l_X, L_W, l_W, etc. may be used.

NOTE 7 Metric and/or inch thread reference. See ISO 261and ISO 263.

[a] True geometrical position.

Annex B
(normative)

Standardization philosophy

B.1 General considerations

An attempt has been made here to standardize the dimensions and tolerances in the IEC drawings to conform as closely as possible with those of the country of origin.

The IEC drawings are based on proposals from National Committees and it was assumed that the country of origin has given full consideration to the principles of good engineering practice and mechanical interchangeability when preparing its national proposals.

Any alterations subsequently introduced and receiving the general agreement of IEC still have to conform to the principles of mechanical interchangeability and good engineering practice.

It is permissible, of course, for any country when preparing its national standards, to introduce other dimensions or additional details if it is felt these are needed.

If an equipment designer allows for the dimensions and tolerances indicated by the IEC drawing, he will be able to take advantage of the availability of supplies from more than one country.

Where an equipment designer is unable to do this, for instance because of stringent space considerations, it follows that he may be limiting his possible suppliers.

When a device is likely to be used in an equipment where there are stringent packing density requirements (generally the case for low-power devices), the space required for the body of such a device is closely defined.

For a high-power device (where generally the heat sink to which it is attached is larger than the device), packing density is not the chief factor when considering mechanical standardization.

Parts used for fixing the devices, such as bases, studs, etc. are closely defined.

The attempt has therefore been made to standardize those dimensions considered to be important for mechanical interchangeability in all its aspects and to dimension these closely, leaving the device manufacturer as much freedom as possible for other dimensions.

Separate case outline and base drawings have been produced in certain instances because different bases may be associated with the same case outline or different case outlines may be associated with the same base.

Some outline drawings show a controlled cylindrical zone. This zone refers to a mechanical contact surface which may be used for mechanical mounting.

Some drawings show type variants. These embrace devices which have basically the same shape and size, but differ in one or more respects which may affect interchangeability in certain applications. The forms of variations distinguished are as follows.

– The first arises directly from the differing standards of countries using the inch and metric systems. For example, studs with a 1/2 in thread and a 12 mm thread may not be regarded as fully interchangeable, but they will be employed in accordance with national practice on devices which are otherwise the same. These variants are shown on the same drawings as Type 1 and Type 2.

– The second form of variation is a difference in one dimension. Examples are the body diameter of double-ended devices, lengths of terminals and stud lengths. These variants are shown as Type A, Type B, etc.
– In certain drawings, combinations of the foregoing are shown. For example, a stud using a 1/2 in thread with different lengths would be shown as Type 1A, Type 1B, and the 12 mm versions would be shown as Type 2A, Type 2B.

B.2 Space cylinder concept

Most of drawings considered give an outline of space cylinder except where dimensions are required to be more closely defined. For low-power devices, the space cylinder accommodates the body.

For high-power devices, because of the different interchangeability requirements, the space cylinder has been extended to include parts other than the body. This is known as the space cylinder concept and it has been thought desirable to include in this annex full details of the considerations applying this concept to high-power devices.

B.3 High-power devices

B.3.1 The bases

For stud-ended devices, the stud shall be closely defined in terms of diameter, pitch and length.

For flat base devices, the dimensions for fixing shall be precisely stated.

B.3.2 The body

The diameter of the space cylinder depends on the construction: for stud-ended types it would be the "across flats" dimension of the hexagon. The length of the space cylinder depends on the type of termination provided, and examples are considered in B.3.3.

Dimensions for both the across flats and across corners dimensions of the hexagon are to be given: the across flats dimension is useful in choosing a suitable spanner for mounting, the across corners dimension is necessary for interchangeability when the device is screwed into a heat sink.

The height of the hexagon flange is not so important in the space cylinder concept and in general only a minimum will be given for this dimension, which permits the hexagonal prism to extend the full height of the body of the device. There is no need to specify the minimum height of the flats at the corners of the hexagon when the manufacturer states the limits of torque which may be applied.

B.3.3 The terminations

B.3.3.1 Rigid lug devices

Since most devices of this type are stud-ended, the final orientation of the lug(s) is not determined and the space cylinder includes the lug(s). No part of the lug(s) may be outside this space cylinder.

Figure B.1 illustrates this presentation.

B.3.3.2 Flexible terminal devices

The user of a high-power flexible terminal device needs to know:

– the distance from the seating plane to the hole in the termination (when the flexible terminal is very flexible and can easily be bent, only a minimum dimension of this distance is sufficient to ensure interchangeability; if it is not, the difference between the maximum and the minimum shall be compatible with good engineering practice);
– the seated height of the device when the terminal is bent at right angles (the user can then calculate how far the terminal at the end of the flexible terminal will extend laterally from the axis of the device.)

Devices of this type use a space cylinder of diameter equal to the across flats dimension of the hexagon (or as appropriate for flat base devices) and of length equal to a dimension which includes an allowance for the axially mounted terminals to be bent at right angles.

Figure B.2 illustrates this presentation.

B.3.3.3 Post-ended devices

It will be apparent from consideration of B.3.1 and B.3.2 above that the space cylinder will be of length equal to the mounted height and of diameter appropriate to the design, e.g. "across flats" for stud-ended rectifiers.

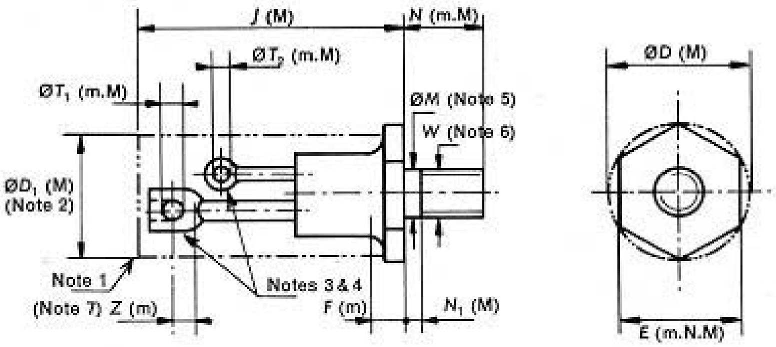


FIGURE 1

(m) = minimum (M) = Maximum (N) = Nominal

1) Ce dispositif à l'exception du contour hexagonal et de l'embout est compris à l'intérieur du cylindre de diamètre D_1 et de longueur J.

2) Le diamètre D_1 ne doit pas être supérieur à la dimension sur plats effective de l'hexagone.

3) La forme et l'orientation des cosses des sorties ne sont pas imposées.

4) La sortie terminée par la grosse cosse est numérotée 1, celle terminée par la petite cosse est numérotée 2.

5) Le diamètre M s'applique à la zone N_1. Sa valeur maximale ne doit pas être supérieure au diamètre extérieur du filetage.

6) Numéro de référence du filetage en inches et/ou dans le système métrique.

7) Longueur minimale du plat.

(m) = minimum (M) = Maximum (N) = Nominal

1) This device with the exception of the hexagon and stud lies within the cylinder of diameter D_1 and length J.

2) Diameter D_1 must not be greater than the actual across flats dimension of the hexagon.

3) Contour and orientation of terminal lugs are undefined.

4) The large terminal lug is No. 1, the small terminal lug is No. 2.

5) Diameter M refers to zone N_1. The maximum value should not exceed the outside diameter of the thread.

6) Inch and/or metric thread reference.

7) Minimum flat.

IEC 577/07

Figure B.1 – Example of rigid lug device

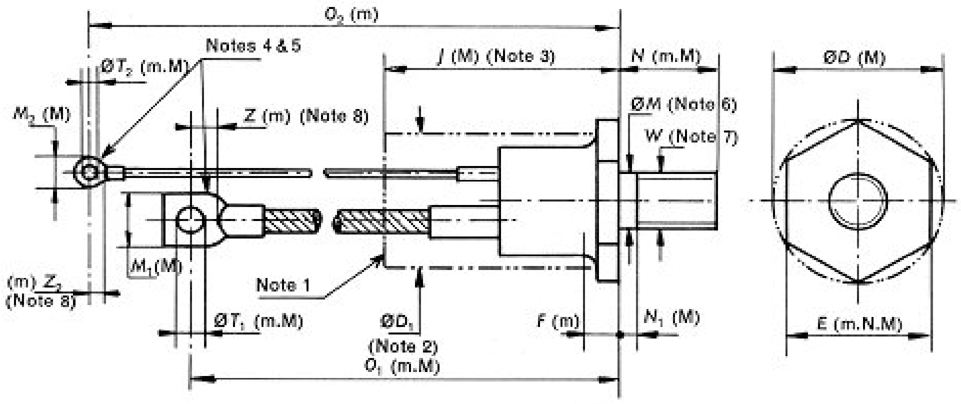


FIGURE 2

(m) = minimum (M) = Maximum (N) = Nominal

1) Le dispositif à l'exception du contour hexagonal de l'embout et des sorties flexibles est compris dans le cylindre de diamètre D_1 et de longueur J.

2) Le diamètre D_1 ne doit pas être supérieur à la dimension sur plats de l'hexagone.

3) La dimension J permet aux sorties flexibles d'être courbées à angle droit.

4) La forme et l'orientation des cosses des sorties ne sont pas imposées.

5) La sortie terminée par la grosse cosse est numérotée 1, celle terminée par la petite cosse est numérotée 2.

6) Le diamètre M s'applique à la zone N_1. Sa valeur maximale ne doit pas être supérieure au diamètre extérieur du filetage.

7) Numéro de référence du filetage en inches et/ou dans le système métrique.

8) Longueur minimale du plat.

(m) = minimum (M) = Maximum (N) = Nominal

1) The device with the exception of the hexagon stud and flexible leads lies within the cylinder of diameter D_1 and length J.

2) Diameter D_1 must not be greater than the actual across flats dimension of the hexagon.

3) Dimension J includes an allowance for the flexible leads to be bent at right angles.

4) Contour and orientation of terminal lugs are undefined.

5) The large terminal lug is No. 1, the small terminal lug is No. 2.

6) Diameter M refers to zone N_1. The maximum value should not exceed the outside diameter of the thread.

7) Metric and/or inch thread reference.

8) Minimum flat.

IEC 578/07

Figure B.2 – Example of flexible terminal device

Annex C
(informative)

Rules to specify the dimensions and positions of terminals on a base drawing

C.1 Example of dimensioning for a circular base outline with no tab and having four terminals located symmetrically on a pitch circle

(See Figure C.1.)

C.1.1 Interpretation of the principle of dimensioning

The base shown in Figure C.1 results from the superposition of two geometrical elements:

– a circular disk having a diameter Ø *D*;
– a set of four terminals positioned on a circle having a diameter Ø *a*.

a) *Disk*

This is a simple contour which is fully defined geometrically by assigning min. and max. limits to diameter Ø *D*.

b) *Set of four terminals*

This set has two sources of dispersion:

– the error in terminal diameter;
– the error in terminal position.

It is therefore necessary to determine:

– a tolerance on diameter Ø *b* (i.e. Ø *b* min. and Ø *b* max.);
– a position tolerance Ø *t* max. (See Figure C.2).

The tolerance Ø *t* max. is determined in the worst case conditions, i.e. when Ø *b* = Ø *b* max.

These two tolerances having been established, they will now be tied to each other by the maximum material condition (MMC).

When the manufacturing process tends to lower one of the tolerances with respect to maximum limits given on the drawing, the MMC allows the other tolerance to increase accordingly. In other words, if the terminal is not made to Ø *b* max., the tolerance Ø *t* can be increased by Ø *b* max. – Ø *b*, where Ø *b* is the actual diameter of the terminal, because the terminal will still lie within the envelope of limiting positions.

As a border-line case, if the terminal is made to Ø *b* min., the tolerance Ø *t* can be increased by Ø *b* max. – Ø *b* min.

Similarly, if the terminal positioning accuracy achieved during manufacture is better than that allowed on the drawing, the limit Ø *b* max. can be increased up to Ø *b* max. + (Ø *t* max. – Ø *t*), where Ø *t* is the actual deviation from the true geometrical position.

As a border-line case, for a perfect centring (Ø *t* = 0), Ø *b* max. can be increased up to Ø *b* max. + Ø *t* max.

c) *Superposition of disk and set of terminals*

Such a superposition cannot be as perfect as that shown in Figure C.1. A possible solution consists of assuming that it is highly improbable that the disk is made to Ø *D* max. The drawing will show that the position tolerance (Ø *t*) equals zero only when the disk diameter equals Ø *D* max., MMC, thus binding together the two sources of dispersion (diameter and position).

In fact, the permissible deviation on the position is equal to Ø *D* max. – Ø *D*, where Ø *D* is the actual diameter of the disk.

If the disk diameter was made to Ø *D* min., this deviation would be maximum and equal to Ø *D* max. – Ø *D* min.

C.1.2 Checking

It follows from the above interpretation that two types of checks are required:

– on dimensions;

– on positions.

Checking the positions shall be made with an overall GO-gauge, i.e. a GO-gauge in which several geometrical elements are taken into account.

Checking the dimensions (of each geometrical element separately) shall be performed with NO GO-gauges for limit min.; limit max., which necessitates a GO-gauge, will not be directly checked.

In effect, due to MMC which binds together position tolerance and dimension toleranced, this limit may be exceeded. The position gauge shall ensure that this excess is still within functionally permissible values.

Therefore, the following gauges are required:

a) Dimension gauges

   – a smooth sleeve ground to Ø *b* min.,

   – a smooth sleeve ground to Ø *D* max.

b) Position gauge

   This gauge, which should be able to check the relative terminal positions, shall consist of four holes in which the terminals will penetrate, even if their diameters are Ø *b* max. and their positions are simultaneously shifted by the maximum permissible amount (i.e. Ø *t* max./2 around their true geometrical positions). The diameter of the holes shall be then equal to Ø *b* max. + Ø *t* max.

In addition, the set of holes shall be centred in a ring which will fit the disk even if it is made to Ø *D* max. (See Figures C.3 and C.3a.)

The machining accuracy of the gauge will depend on

– tolerance on dimension Ø *D* for the ring;

– tolerance on dimension Ø *b* for the holes;

– tolerance Ø *t* max. for diameter *a.*

As a first approximation and for the simplest contour, a ratio of 1/10 between the gauge tolerance and the piece tolerance is acceptable. For more elaborated contours and especially if wear-out limits are to be taken into account, it is recommended to refer to the ISO system on the definition of gauge tolerances.

C.2 Example of dimensioning for a circular base outline with a tab and having four terminals located symmetrically on a pitch circle

(See Figure C.4.)

C.2.1 Interpretation of the principle of dimensioning

The base shown in Figure C.4 results from the superposition of three geometrical elements:

- a circular disk having a diameter Ø *D*;
- a set of four terminals positioned on a circle having a diameter Ø *a;*
- a tab.

The position can then be fixed by using dimensions from the geometry of each of the above elements separately considered, and defining the conditions of their superposition.

The proposed solution for the dimensioning is as follows.

When confronted with a case partially considered in the example of Clause C.1, in addition to the dimensions quoted in Clause C.1, add the dimensions of the tab and its position relative to the other elements.

From a strict dimensional point of view, the width *j* (min. and max.) will be given. The length *k*, or rather the protrusion out of the disk, is more difficult to define because the junction between tab and disk is not a point easily located, which can be difficult to check. As it is not a dimension of prime importance, with tight tolerance, it seems preferable to retain the dimension *Q* (min. and max.) which is easier to measure.

As regards the tab position, this should be functionally defined relative to the terminals, i.e. by the angle *α* as an absolute dimension, the spread around the true geometrical position being limited either by a tolerance of angularity (∠) or by a tolerance of symmetry (≡), with, as a reference, the corresponding axis of symmetry (vertical on Figure C.4) of the pitch circle.

However, this method of dimensioning involves:

- a position gauge for the terminals and the disk as that described in subclause C.1.2, b);
- a position gauge to check the tab position relative to the terminals.

The obtaining of a functionally valid dimensioning system resulting in a single gauge is desirable.

For this reason, a solution is recommended which consists of fixing the tolerance of position of the terminals and the tolerance of position of the tab with respect to the same reference datum, i.e. the diameter Ø *D* of the disk.

See the dimensioning system shown in Figure C.4.

C.2.2 Checking

See also subclause C.1.2

C.2.2.1 Dimension checking

To check limits: Ø *b* min.
Ø *D* min.
j min.
Q min. and Q max.

C.2.2.2 Position checking

Checking the position shall be done with a gauge as shown in Figures C.5 and C.5a. The use of a gauge is convenient, but not compulsory. Any other system of measurement may be used.

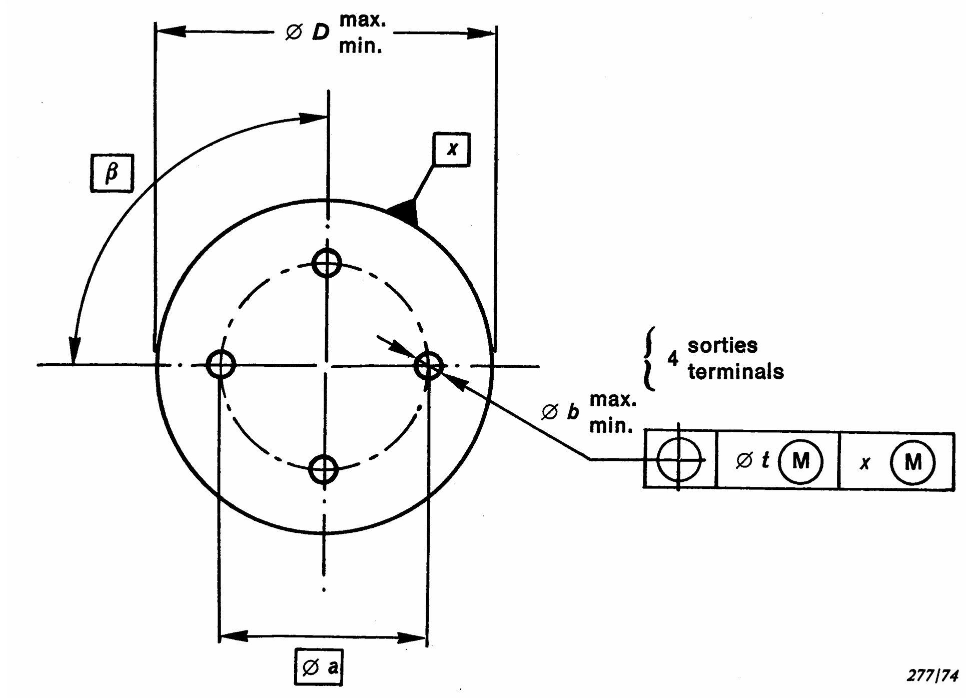


Figure C.1 – Circular base outline with no tab

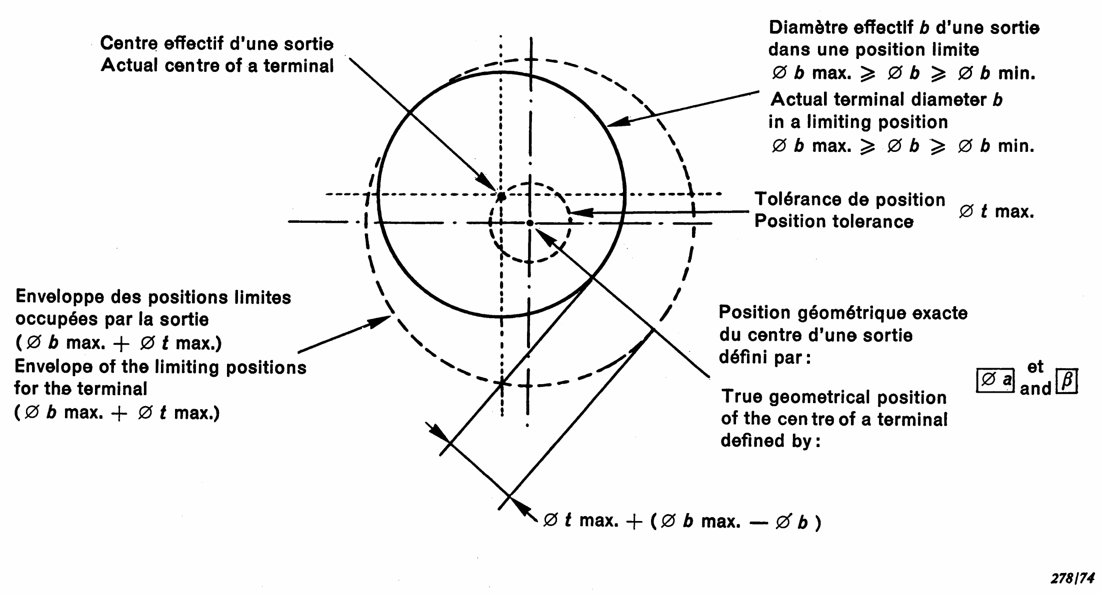


Figure C.2 – Tolerances of terminals

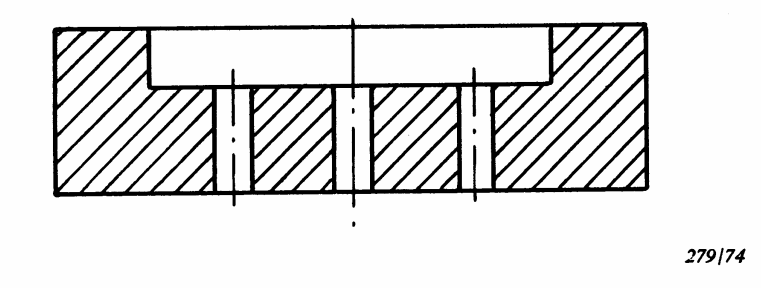


Figure C.3a – Sectional drawing

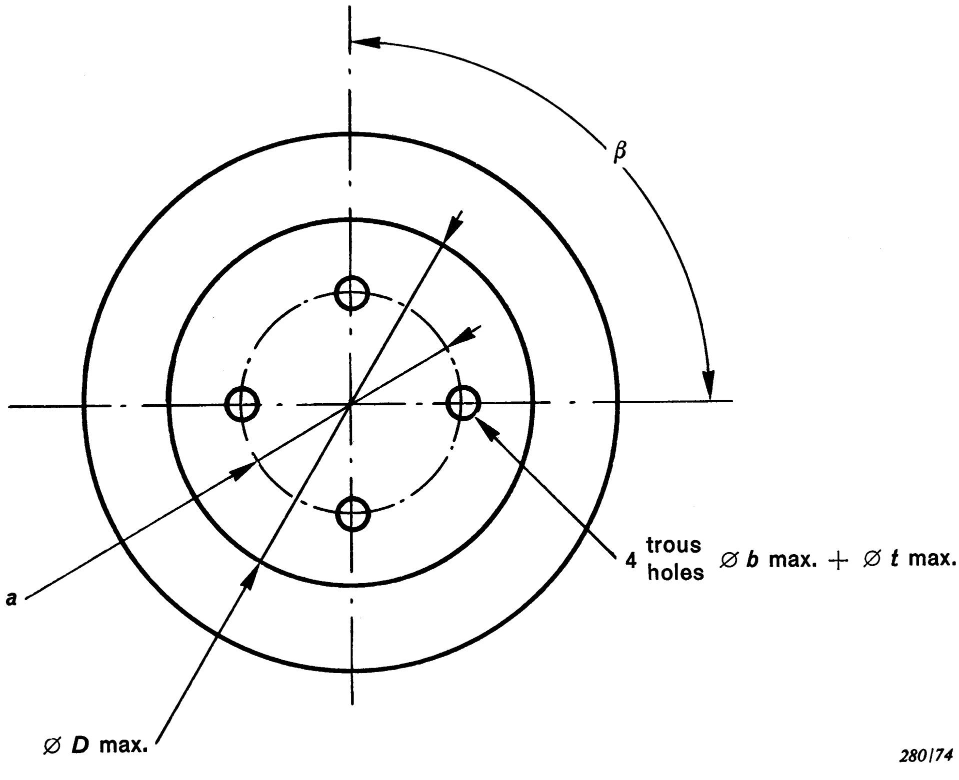


Figure C.3b – Top view

Figure C.3 – Gauge for a circular base outline with no tab

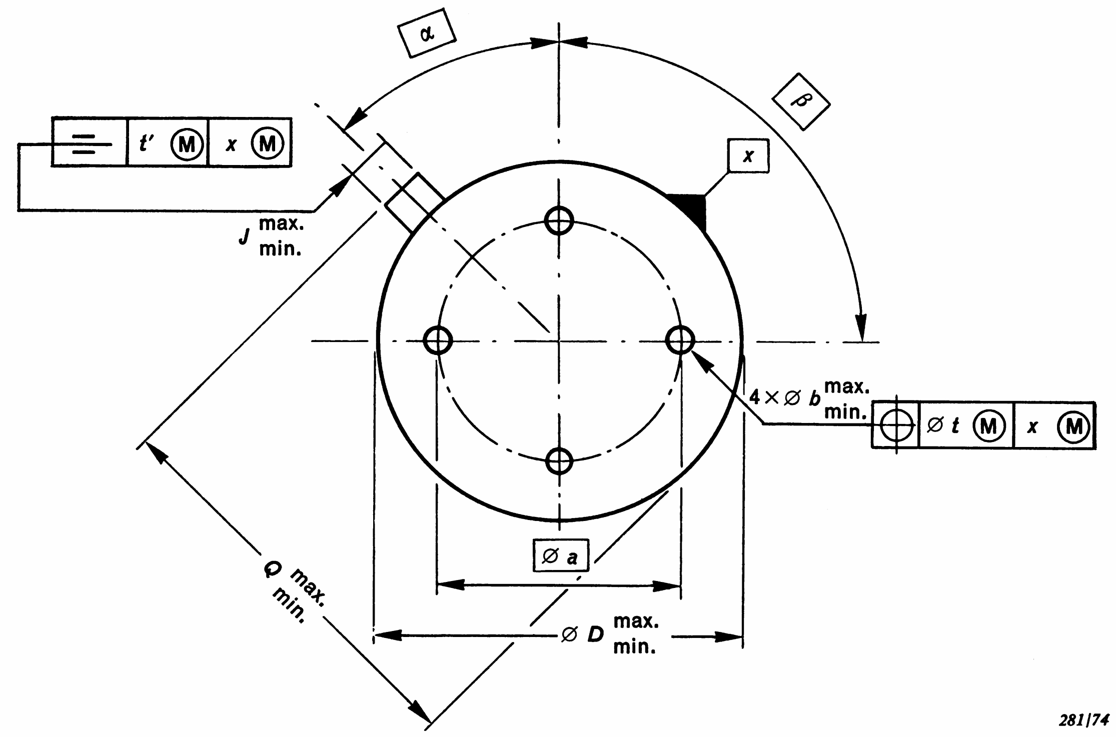


Figure C.4 – Circular base outline with tab

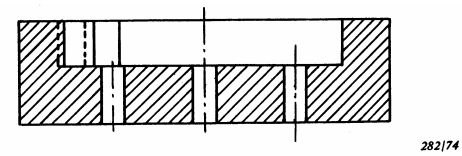


Figure C.5a – Sectional drawing

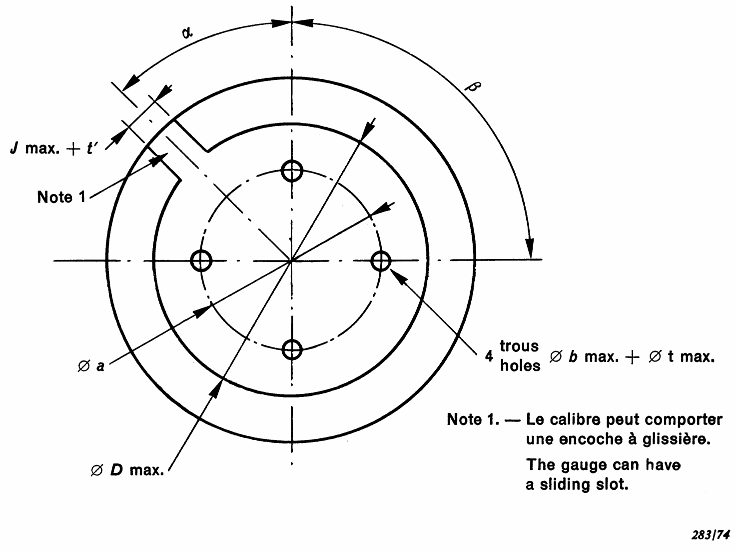


Figure C.5b – Top view

Figure C.5 – Gauge for a circular base outline with tab

Annex D
(normative)

General philosophy of flat base devices

The rules to be applied for flat base devices are as follows.

a) The space cylinder concept shall be applied.

b) The device and its clamping arrangement, whether detachable or integral with the device, shall be shown on a single drawing.

c) The maximum plan view dimension(s) of the clamp, clamp zone, or fastening arrangement shall be shown to give the user the necessary information on the space required for design of the heat sink.

   NOTE When the plan view of the clamp is essentially circular, the single dimension ∅D (the over-all diameter) is sufficient. When orientation of the clamp will allow closer positioning of the devices on the heat sink, at least two dimensions will be necessary, e.g. length and breadth, in case of a rectangular clamp.

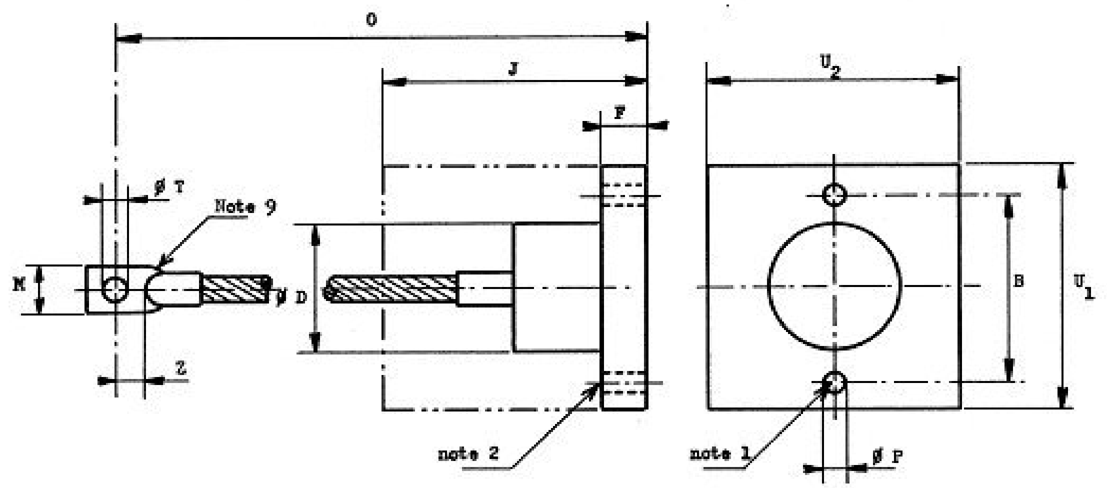
d) The flat surface around the fixing holes shall be dimensioned to indicate the unobstructed space available for fixing purposes. This may be done by stating the maximum body diameter of the device, or by dimensions centred on the fixing holes.

e) The true position and positional tolerance of the fixing holes shall be given. The diameter of the fixing holes shall be stated in terms of maximum acceptable screw size.

f) The maximum height of the clamping arrangements above the seating plane shall also be given to determine the length of the fixing hardware (e.g. screws).

g) All other dimensions shall be given in accordance with IEC 60191-2

Figure D.1 illustrates the application of these rules to flat base rectifier outline.



Les dimensions en inches sont déduites des dimensions d'origine en millimètres

The inch dimensions are derived from the original millimetre dimensions

ref.	millimètres			inches			notes
	min.	nom.	max.	min.	nom.	max.	
B	–	48,50(*)	–	–	1.9094(*)	–	
ø D	–	–	43,8	–	–	1.724	
F	–	–	17,8	–	–	0.700	2
J	–	–	85	–	–	3.34	3, 6
M	–	–	23,5	–	–	0.925	
O	180	–	220	7.1	–	8.6	
ø P	–		–	–		–	4
ø T	–		–	–		–	5
U_1	–	–	65,5	–	–	2.578	6
U_2	–	–	50,5	–	–	1.988	6
Z	11	–	–	0.44	–	–	7

1 – Les trous de fixation ont une tolérance de position d'un diamètre de 0,40 mm (0.0157").

2 – Dimension au point de fixation.

3 – La dimension J est la hauteur à partir du siège avec la sortie pliée à angle droit.

4 – Trou de passage pour un boulon de diamètre maximal M8.

5 – Trou de passage pour un boulon de diamètre maximal M10.

6 – Le dispositif et le rebord de fixation, à l'exception de la sortie flexible est contenu dans la zone U_1 x U_2 de longueur J.

7 – Longueur minimale du plat.

8 – Le système de fixation est contenu à l'intérieur du rectangle U_1 x U_2. Il peut être détachable.

9 – La forme et l'orientation de la cosse de la sortie ne sont pas imposées.

(*) Signifie position géométrique exacte

1 – The fixing holes have positional tolerance of 0,40 mm (0.0157") diameter.

2 – Dimension at fixing point.

3 – Dimension J is the seated height with the terminal bent at right angles.

4 – Clearance holes for fixing screw of maximum diameter M8.

5 – Clearance hole for screw of maximum diameter M10.

6 – The device and mounting flange with the exception of the flexible terminal are contained within the zone U_1 x U_2 and length J.

7 – Minimum flat.

8 – The mounting flange lies within the rectangle U_1 x U_2. It may be detachable.

9 – The contour and orientation of the terminal slug or lug are undefined.

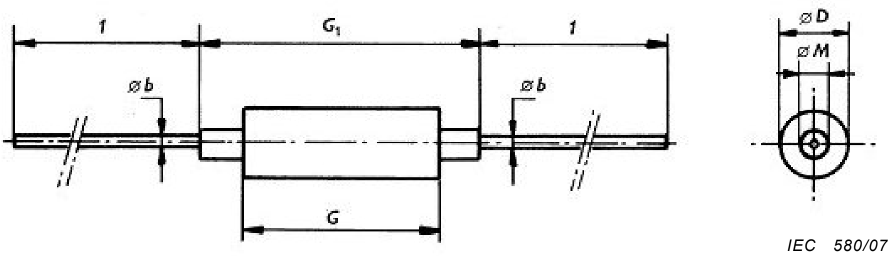
(*) Means true geometrical position

IEC 579/07

Figure D.1 – Example of flat base outline

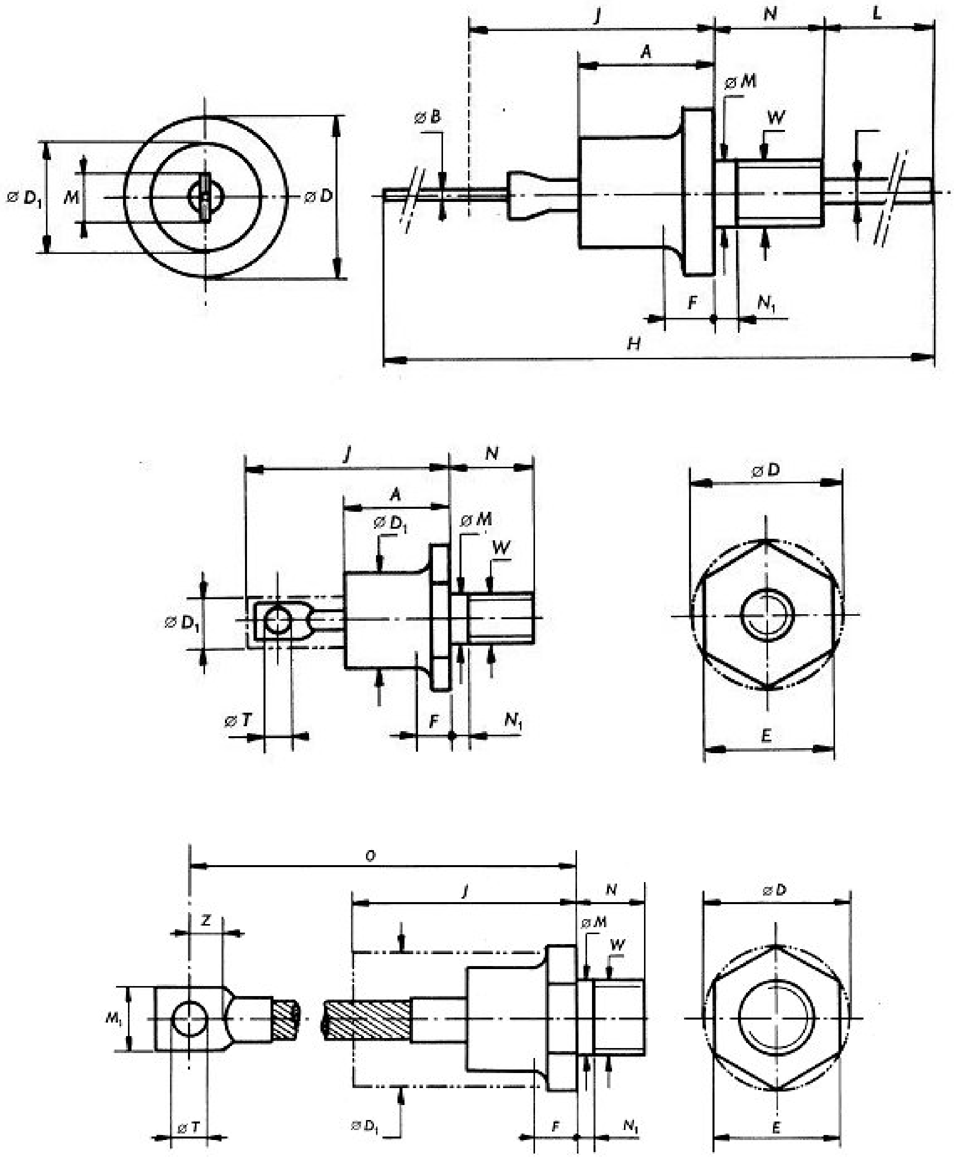
Annex E
(informative)

Examples of semiconductor device drawing



IEC 580/07

Figure E.1 – Long form package



IEC 581/07

Figure E.2 – 3 types of post/stud mount packages

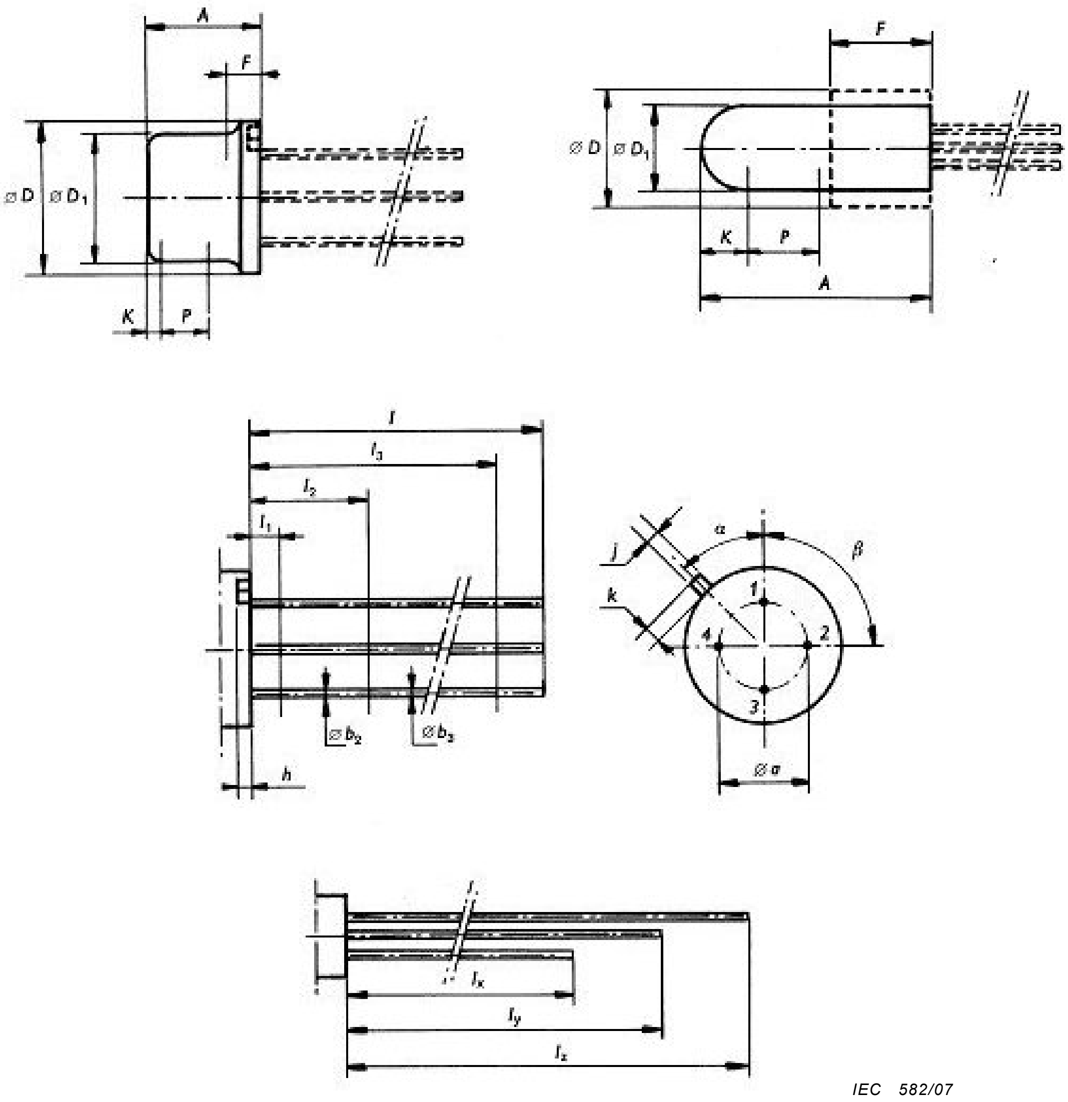


Figure E.3 – 2 types of cylindric packages

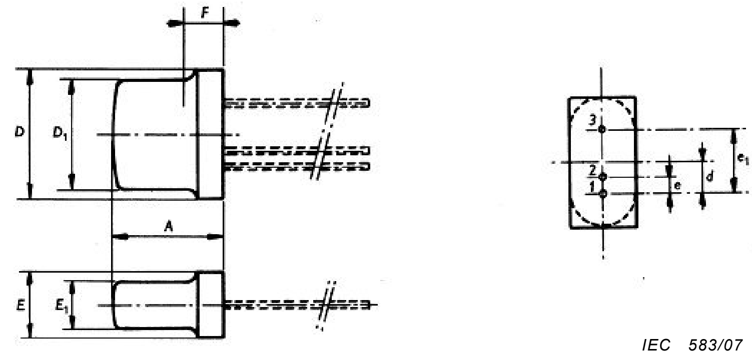


Figure E.4 – Oval package, terminals in line

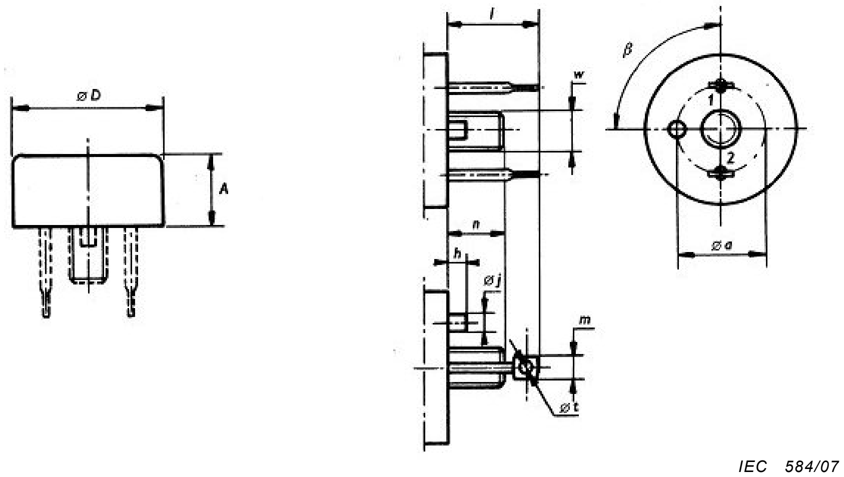


Figure E.5 – Cylindric package with different terminations

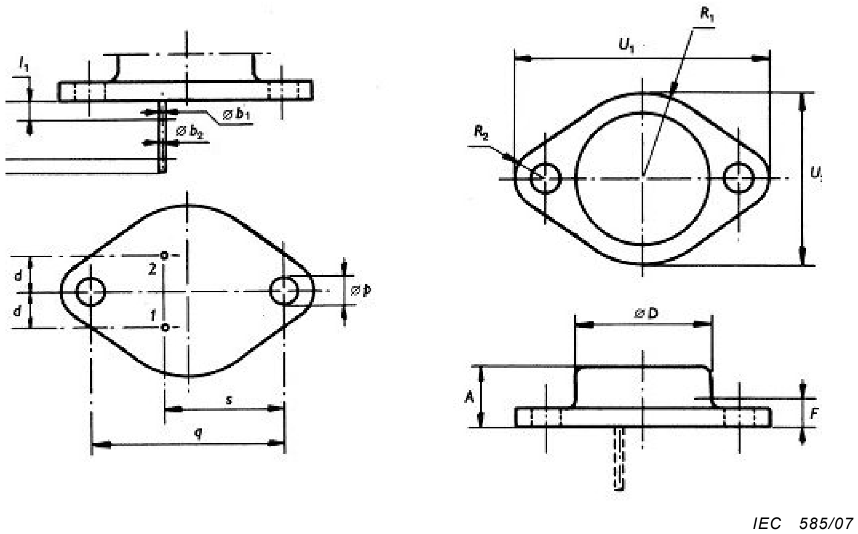


Figure E.6 – Flange mount package

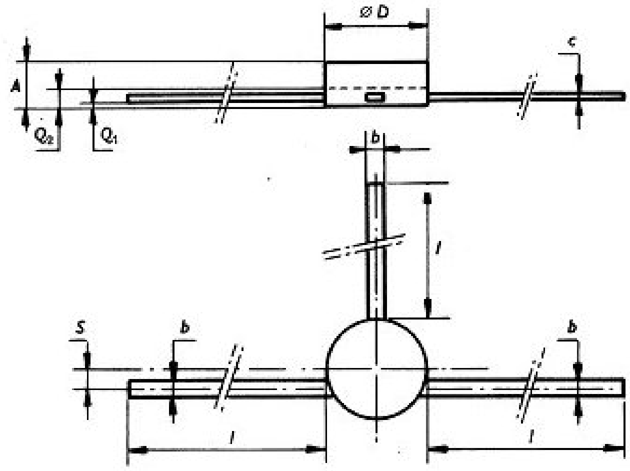


Figure E.7 – Disk button package with 3 terminations

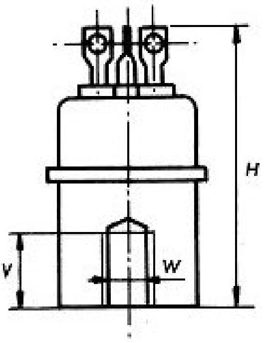


Figure E.8 – Special shape for bolt-fixture

Annex F
(informative)

Former rules for rounding off

NOTE The following rules should be applied for drawings of IEC 60191-2 given before 2000, when using either Method A or Method B of ISO 370 (withdrawn).

F.1 Toleranced dimensions

F.1.1 Maximum and minimum values of toleranced dimensions

Convert and round off, using Method B.

F.1.2 Nominal value of toleranced dimensions

Convert and round off to the same number of decimal places as used in the maximum and minimum values of the same dimension, using Method A.

F.2 Untoleranced dimensions (maximum only or minimum only)

Convert and round off, using Method B, by assuming as the original tolerance the unity of the last but one expressed order.

If the application of this rule results in incompatibility, then greater precision should be used.

Example 1:

A dimension is expressed in inches as follows: 1,934 in min.

The exact conversion to millimetres gives: 49,1236 mm.

Assume the original tolerance to be 0,01 in (i.e. the unity of the last but one expressed order), then Table I indicates a rounding off to 0,01 mm.

By applying Method B (i.e. rounding off within the tolerance), one obtains 49,12 mm min.

Example 2:

A dimension is expressed in millimetres as follows: 49,9 mm max.

An accurate conversion to inches gives: 1,9645669 in.

Assume the original tolerance to be 1 mm (i.e. the unity of the last but one expressed order), then Table II indicates a rounding off to 0,001 in.

By applying Method B (i.e. rounding off within tolerance), one obtains 1,964 in max.

F.3 Untoleranced nominal dimensions given for general information

Convert and round off, using Method A, by assuming as the original tolerance the unity of the last but one expressed order.

Example:

A dimension is expressed in millimetres as follows: 101 mm.

An accurate conversion to inches gives: 3,976 378 in.

Assume the original tolerance to be 10 mm (i.e. the unity of the last but one expressed order), then Table II indicates a rounding off to 0,01 in.

By applying Method A, one obtains 3,98 in.

F.4 Untoleranced nominal dimensions given to specify true geometrical positions

Convert and round off, using Method A, by assuming as the original tolerance the diameter of the tolerance zone around the true geometrical position to be given.

Example:

The exact conversion to millimetres of the distance from some reference to a certain point gives 36,1442 mm and there is a positional tolerance zone of 0,008 in diameter around it.

As there is a positional tolerance with a diameter of 0,008 in, Table I indicates a rounding off to 0,001 mm.

By applying Method A, one obtains 36,144 mm.

Annex G
(informative)

Former rules for coding

G.1 General

The following coding system was used before IEC 60191-4 came into effect. So some drawings of that time in IEC 60191-2 are classified according to the coding system given in G.2 to G.5.

G.2 Device outlines

Code: letter "A" followed by a serial number.

G.3 Bases

Code: letter "B" followed by a serial number.

G.4 Case outlines

Code: letter "C" followed by a serial number.

G.5 Type variants and provisional drawings

The following rules apply to type variants and provisional drawings.

a) Where type variants having inch or metric threads are shown, these should be distinguished by adding U (for inch) and M (for metric) as suffixes to the serial number.

b) Where other type variants are shown as types A, B, C, etc., these should be distinguished by adding the appropriate suffix (A, B, C, etc.) to the serial number.

   Examples:

   A13, A27M, B5A, C16, A15UB.

Bibliography

IEC 60191-6, *Mechanical standardization of semiconductor devices – Part 6: General rules for the preparation of outline drawings of surface mounted semiconductor device packages*

ISO 261, *ISO general purpose metric screw threads – General plan*

ISO 263, *ISO inch screw threads – General plan and selection for screws, bolts and nuts – Diameter range 0.06 to 6 in*

ISO 370, *Toleranced dimensions – Conversion from inches into millimetres and vice versa*[1)]

ISO 5459:1981, *Technical drawings – Geometrical tolerancing – Datums and datum-systems for geometrical tolerances*

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1) Withdrawn in 2000.

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