

INTERNATIONAL STANDARD

**Mechanical standardization of semiconductor devices –
Part 1: General rules for the preparation of outline drawings of discrete devices**

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INTERNATIONAL STANDARD

**Mechanical standardization of semiconductor devices –
Part 1: General rules for the preparation of outline drawings of discrete devices**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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of discrete devices****FOREWORD**

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International Standard IEC 60191-1 has been prepared by subcommittee 47D: Semiconductor devices packaging, of IEC technical committee 47: Semiconductor devices.

This third edition cancels and replaces the second edition published in 2007. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) the Scope has been extended to include surface-mounted semiconductor devices with a lead count less than 8;
- b) a definition of the term "stand-off" has been added;
- c) the methods for locating the datum have been extended to be suitable for SMD-packages;
- d) the visual identification of terminal position one for automatic handling has been clarified;
- e) the rules for the drawing of terminals have been clarified;

- f) Table A.1 has been completed with symbols specifically for SMD-packages;
- g) Annex B "Standardization philosophy" has been deleted;
- h) a normative Annex with special rules for SMD-packages has been added;
- i) the examples of semiconductor device drawings have been aligned to state-of-the-art packages including SMD-packages.

The text of this standard is based on the following documents:

CDV	Report on voting
47D/886/CDV	47D/896/RVC

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60191 series, published under the general title *Mechanical standardization of semiconductor devices*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

MECHANICAL STANDARDIZATION OF SEMICONDUCTOR DEVICES –

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

1 Scope

This part of IEC 60191 gives guidelines on the preparation of outline drawings of discrete devices, including discrete surface-mounted semiconductor devices with lead count less than 8.

For the preparation of outline drawings of surface-mounted discrete devices with a lead count higher or equal to 8, IEC 60191-6 should be referred to as well.

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

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 of reference letter symbols used in this document are given in Annex A.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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, *Mechanical standardization of semiconductor devices – Part 2: Dimensions*

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

IEC 60191-6-1, *Mechanical standardization of semiconductor devices – Part 6-1: General rules for the preparation of outline drawings of surface mounted semiconductor device packages – Design guide for gull-wing lead terminals*

IEC 60191-6-3, *Mechanical standardization of semiconductor devices – Part 6-3: General rules for the preparation of outline drawings of surface mounted semiconductor device packages – Measuring methods for package dimensions of quad flat packs (QFP)*

IEC 60191-6-20, *Mechanical standardization of semiconductor devices – Part 6-20: General rules for the preparation of outline drawings of surface mounted semiconductor device packages – Measuring methods for package dimensions of small outline J-lead packages (SOJ)*

IEC 60191-6-21, *Mechanical standardization of semiconductor devices – Part 6-21: General rules for the preparation of outline drawings of surface mounted semiconductor device packages – Measuring methods for package dimensions of small outline packages (SOP)*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

device outline drawing

drawing that includes all dimensional characteristics required for the mechanical interchangeability of the complete device

Note 1 to entry: The device outline drawing includes the case or body, all terminals and the locating tab if present.

3.2

terminal

part of the semiconductor device primarily used in making an electrical, mechanical or thermal connection

EXAMPLE Flexible leads, rigid leads, pins, studs, etc.

3.3

case outline drawing

drawing that includes all dimensional characteristics required for the mechanical interchangeability of the case or body

Note 1 to entry: The case outline drawing 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 that includes all dimensional characteristics required for the mechanical interchangeability of the terminals and mechanical index

Note 1 to entry: 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 to entry: The diameter or major axis of the case outline should not be given on the base drawing.

Note 3 to entry: 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 that 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 1 to entry: 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

theoretically exact geometric reference (such as axes, planes, straight lines etc.) to which toleranced features are related

Note 1 to entry: Datums may be based on one or more datum features of a part.

[SOURCE: ISO 5459:2011, 3.4]

3.8

seating plane

seating base

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

3.9

seated height

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

Note 1 to entry: 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 that 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

3.11

stand-off

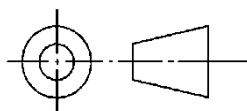
distance from the seating plane to the lowest point of a package

4 General rules for all drawings

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 title block, at the bottom of the page:
 - the projection method where there is more than one view, as indicated below:



- 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 countries involved 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: $L_{\min} = 5,77 \text{ mm}$, $L_{\max} = 5,82 \text{ mm}$); or
 - by a nominal value and maximum and minimum limits. Such a nominal value need not necessarily be the average of two limits (example: $L = 6^{+0,4}_{-0,2} \text{ mm}$).
 - ii) Untoleranced dimensions
 - Untoleranced limiting dimensions i.e.: minimum only or maximum only (example: $L_{\max} = 5,85 \text{ mm}$).
 - 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: $L_{\text{nom}} = 5,85 (*) \text{ mm}$).
- 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. Uppercase letters should be used for device outline and case outline dimensions and lowercase 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) shall be indicated immediately above the table.

NOTE Some outline drawings published in IEC 60191-2 before this document came into effect 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, in Figures E.1 to E.9.

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;
- f) datum C is the plane formed by at least three apexes at the bottom of the SMD package body that exhibit the greatest perpendicular distance from the package bottom;
- g) datum A is the plane perpendicular to Datum C and wraps one edge of the package body;
- h) datum A is the plane perpendicular to Datum C and crosses the centre line of the package body;

- i) datum B is the plane perpendicular to datum C and A and wraps one edge of the package body;
- j) datum B is the plane perpendicular to datum C and A and crosses the centre line of the package body.

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 an omitted terminal that 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 on 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. For automatic handling of SMD devices, it is essential to have an additional significant optical identification of terminal position one on the bottom side of the device.

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 (Figure 1 a, b, c) or in the right-hand half (Figure 1 d).

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 1 e), it is necessary to mark on the body with a visual index the terminal that shall be considered as the first in the clockwise numeration.

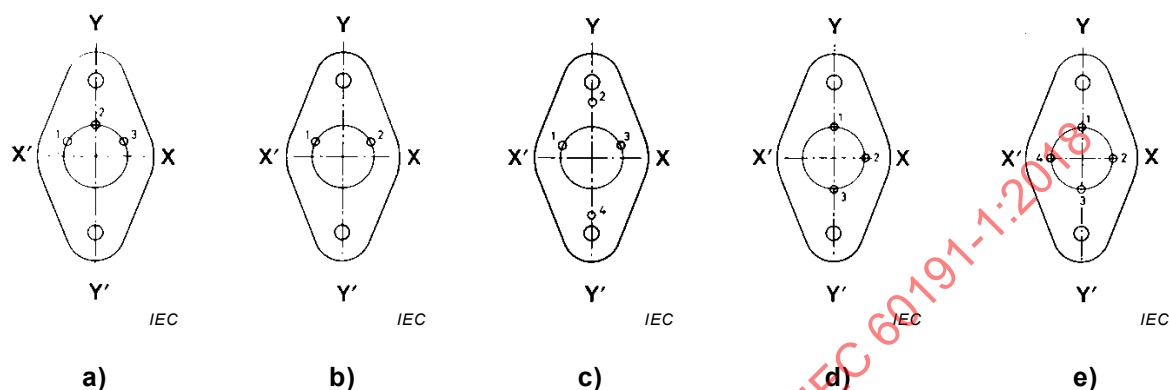


Figure 1 – Numbering of terminals for the particular case of lozenge – shaped bases

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 that 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.

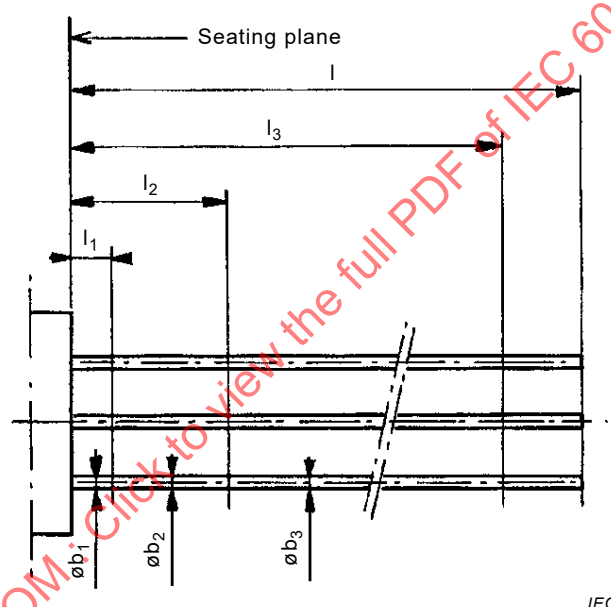
NOTE Terminals given by dotted lines, mostly to be found on older outline drawings, are terminals that could be shortened according to the application of the device. Leads of SMD-packages are not given with dotted lines.

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.

- The terminals should be numbered in accordance with 4.4.
- 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 tolerated.
- 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.
- The system as shown in Figure 2 below should be used either in total or in part to indicate the dimensions of the terminals.



$\varnothing b_1$ applies over the length l_1

$\varnothing b_2$ applies over the length $l_2 - l_1$

$\varnothing b_3$ applies over the length $l_3 - l_2$ or where appropriate $l - l_2$

Figure 2 – System to indicate the dimensions of the terminals

- The base drawings that 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 B.

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 370:1975 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 was withdrawn in May 2000. The rules, which were applied before the year 2000, are given now in Annex F.

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 Annex G.

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Annex A (informative)

Reference letter symbols

NOTE Some of these symbols such as B or C 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 Table A.1 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	Height from seating plane to top of case	min.	-	max.	P
a	Pitch circle diameter of terminals	-	nom. ^{a)}		P
A ₁	Stand-off	min.		max.	
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 Figure 2	-	-	max.	P
B ₂ , b ₂	Other diameter of terminal as shown in Figure 2	min.	-	max.	P
B ₃ , b ₃	Other diameter of terminal as shown in Figure 2	min.	-	max.	P
b _p	Terminal width of soldered part, terminal width in the projected zone of the terminal	min.	-	max.	
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
J	Seated height or mounted height	-	-	max.	P

Table A.1 (continued)

Reference letter symbol	Description of the dimension	Type of limits			Notes
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 5.2.1, d)	-	-	max.	5, P
L ₂ , l ₂	Other length of terminal as shown in the diagram in 5.2.1, d)	min.	-	-	5, P
L ₃ , l ₃	Other length of the terminal as shown in the diagram in 5.2.1, d)	min.	-	max.	2, 5, P
L _p	Length of soldered part of the terminal, projected length of the terminal	min.	-	max.	
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	terminal position tolerance			max.	
(x – x) (y – y)	Section reference, continuous				P
x – y	Section reference, not continuous				P
y	coplanarity			max.	
y ₁	flatness			max.	
Z, z	Other dimensions				S

Table A.1 (continued)

Reference letter symbol	Description of the dimension	Type of limits			Notes
α	Small angle	-	nom.	-	P
β, γ	Larger angles	-	nom.	-	P
P primary reference letter symbol (see 4.2, i) S secondary reference letter symbol (see 4.2, i) NOTE 1 Minimum dimension can be omitted where appropriate. NOTE 2 Maximum dimension can 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. can be used with reference letters B, b and C, c. NOTE 4 Reference letter symbols $C_1, c_1; C_2, c_2; C_3, c_3$ can 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. can be used. NOTE 7 Metric and/or inch thread reference. More information is provided in ISO 261 and ISO 263. ^{a)} True geometrical position.					

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Annex B (informative)

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

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

B.1.1 Interpretation of the principle of dimensioning

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

- a circular disk having a diameter $\varnothing D$;
- a set of four terminals positioned on a circle having a diameter $\varnothing a$.

a) Disk

This is a simple contour which is fully defined geometrically by assigning min. and max. limits to diameter $\varnothing D$.

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 $\varnothing b$ (i.e. $\varnothing b_{\min}$ and $\varnothing b_{\max}$);
- a position tolerance $\varnothing t_{\max}$. (See Figure B.2).

The tolerance $\varnothing t_{\max}$ is determined in the worst case conditions, i.e. when $\varnothing b = \varnothing b_{\max}$.

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 $\varnothing b_{\max}$, the tolerance $\varnothing t$ can be increased by $\varnothing b_{\max} - \varnothing b$, where $\varnothing b$ 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 $\varnothing b_{\min}$, the tolerance $\varnothing t$ can be increased by $\varnothing b_{\max} - \varnothing b_{\min}$.

Similarly, if the terminal positioning accuracy achieved during manufacture is better than that allowed on the drawing, the limit $\varnothing b_{\max}$ can be increased up to $\varnothing b_{\max} + (\varnothing t_{\max} - \varnothing t)$, where $\varnothing t$ is the actual deviation from the true geometrical position.

As a border-line case, for a perfect centring ($\varnothing t = 0$), $\varnothing b_{\max}$ can be increased up to $\varnothing b_{\max} + \varnothing t_{\max}$.

c) Superposition of disk and set of terminals

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

In fact, the permissible deviation on the position is equal to $\varnothing D_{\max} - \varnothing D$, where $\varnothing D$ is the actual diameter of the disk.

If the disk diameter was made to $\varnothing D_{\min}$, this deviation would be maximum and equal to $\varnothing D_{\max} - \varnothing D_{\min}$.

B.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 tolerance, 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 $\varnothing b$ min.,
- a smooth sleeve ground to $\varnothing D$ 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 $\varnothing b$ max. and their positions are simultaneously shifted by the maximum permissible amount (i.e. $\varnothing t$ max./2 around their true geometrical positions). The diameter of the holes shall be then equal to $\varnothing b$ max. + $\varnothing t$ max.

In addition, the set of holes shall be centred in a ring which will fit the disk even if it is made to $\varnothing D$ max (see Figure B.3).

The machining accuracy of the gauge will depend on

- tolerance on dimension $\varnothing D$ for the ring;
- tolerance on dimension $\varnothing b$ for the holes;
- tolerance $\varnothing t$ 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.

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

B.2.1 Interpretation of the principle of dimensioning

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

- a circular disk having a diameter $\varnothing D$;
- a set of four terminals positioned on a circle having a diameter $\varnothing a$;
- 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 B.1, in addition to the dimensions quoted in Clause B.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 B.4) of the pitch circle.

However, this method of dimensioning involves:

- a position gauge for the terminals and the disk as that described in B.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 $\varnothing D$ of the disk.

See the dimensioning system shown in Figure B.4.

B.2.2 Checking¹

B.2.2.1 Dimension checking

To check limits: $\varnothing b$ min.
 $\varnothing D$ min.
 j min.
 Q min. and Q max.

B.2.2.2 Position checking

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

¹ See also B.1.2.

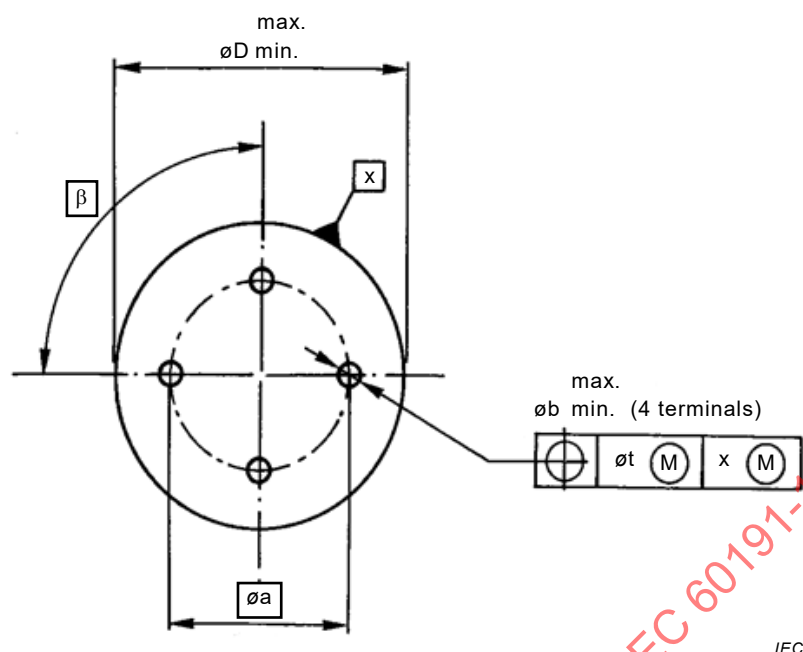


Figure B.1 – Circular base outline with no tab

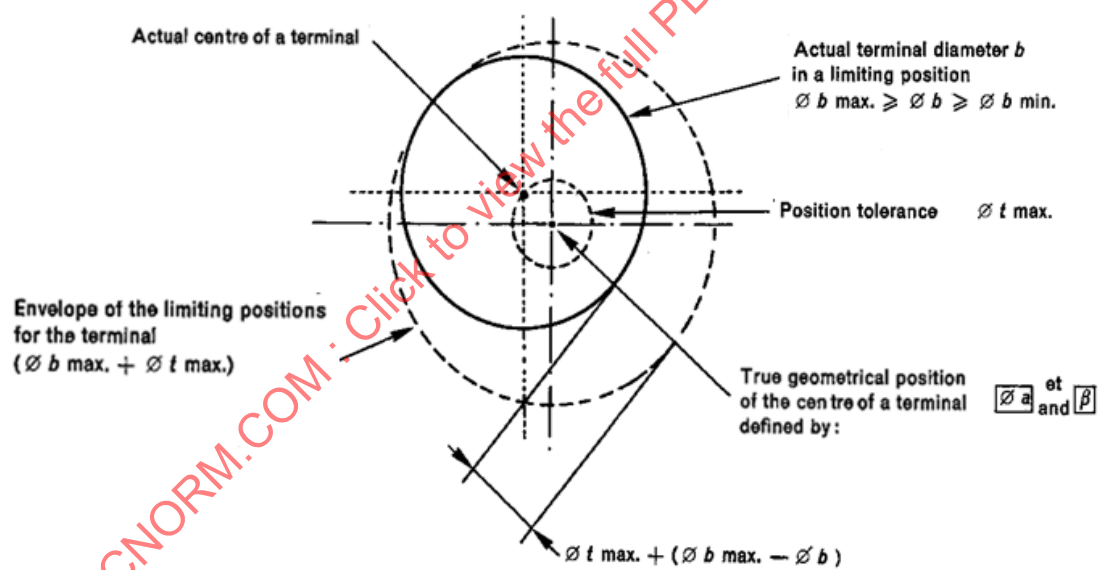
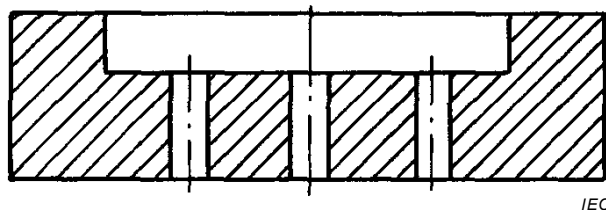


Figure B.2 – Tolerances of terminals



a) Sectional drawing

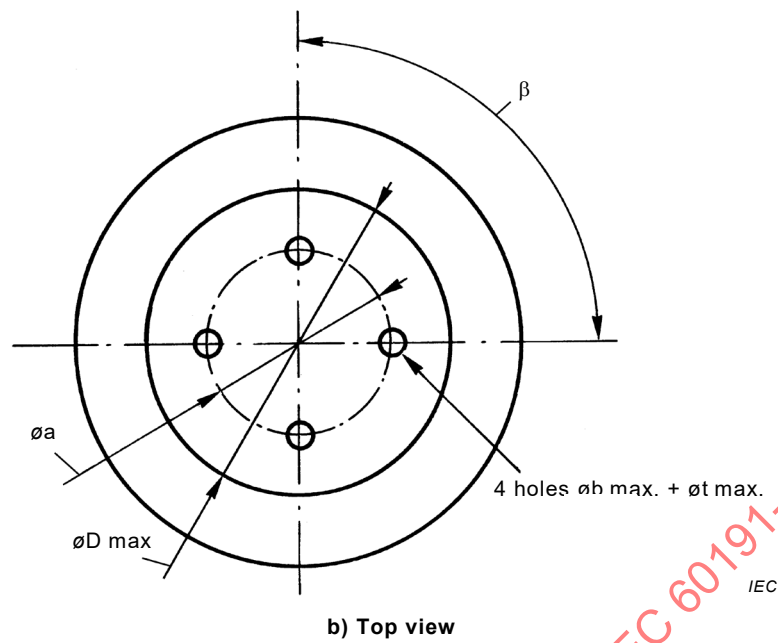


Figure B.3 – Gauge for a circular base outline with no tab

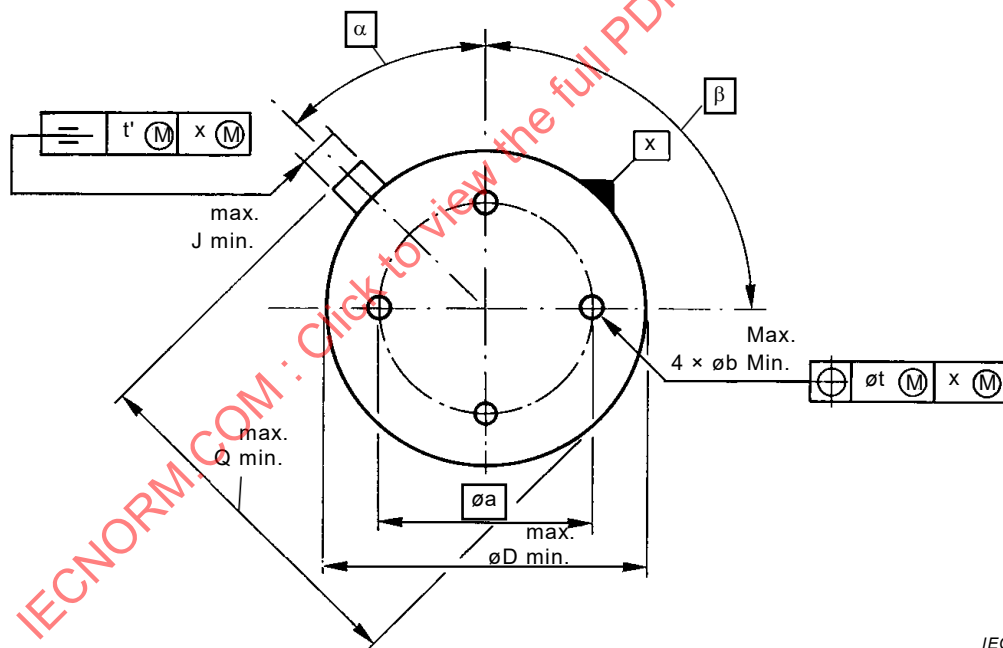


Figure B.4 – Circular base outline with tab

Annex C (normative)

General philosophy of flat base devices

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

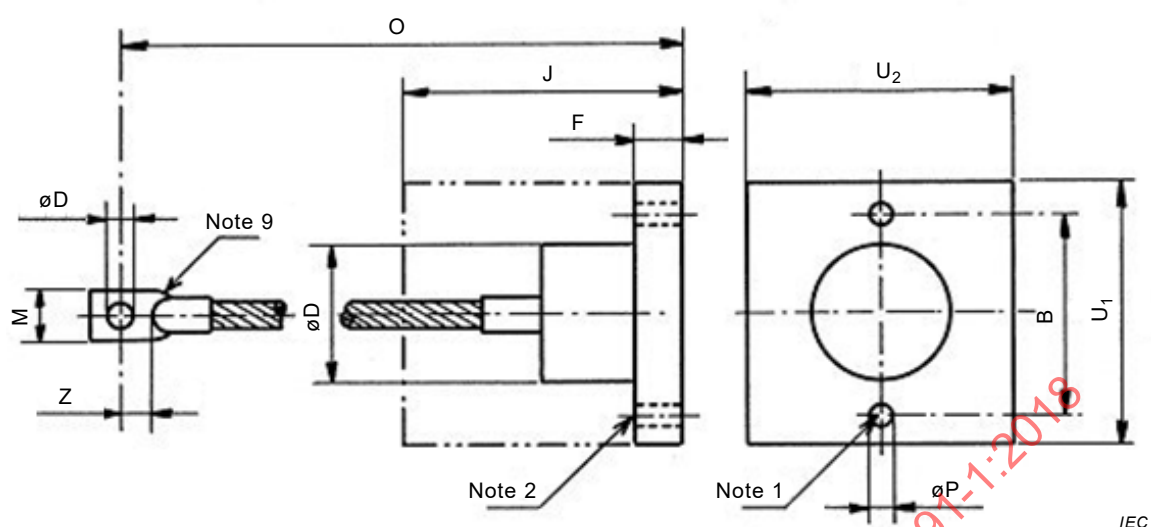
- a) The space cylinder concept shall be applied.
- b) The device and its clamping arrangement, whether detachable or integral with the device, shall be shown on a single drawing.
- c) The maximum plan view dimension(s) of the clamp, clamp zone, or fastening arrangement shall be shown to give the user 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 $\varnothing D$ (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 C.1 illustrates the application of these rules to flat base rectifier outline.

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The inch dimensions are derived from original millimetre dimensions

ref.	millimètres			inches			notes
	min.	nom.	max.	min.	nom.	max.	
B	—	48,50(*)	—	—	1,909 4 (*)	—	
ØD	—	—	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	
ØP	—	—	—	—	—	—	4
ØT	—	—	—	—	—	—	5
U ₁	—	—	65,5	—	—	2,578	6
U ₂	—	—	50,5	—	—	1,988	6
Z	11	—	—	0,44	—	—	7

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 U₁ × U₂ and length J.

7 – Minimum flat.

8 – The mounting flange lies within the rectangle U₁ × U₂. It may be detachable.

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

(*) Means true geometrical position

Figure C.1 – Example of flat base outline

Annex D (normative)

Special rules for SMD-packages

D.1 General reference

General rules for the preparation of outline drawings of surface-mounted semiconductor device packages are specified in IEC 60191-6 (all parts).

D.2 Lead terminals

The design guide for gull-wing lead terminals as given in IEC 60191-6-1 applies. For measuring methods for packages with J-leads, refer to IEC 60191-6-20.

D.3 Measuring methods

The measuring methods for package dimensions of quad flat packs (QFP) as given in IEC 60191-6-3 apply as well as those for package dimensions of small outline packages as given in IEC 60191-6-21.

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Annex E (informative)

Examples of semiconductor device drawings

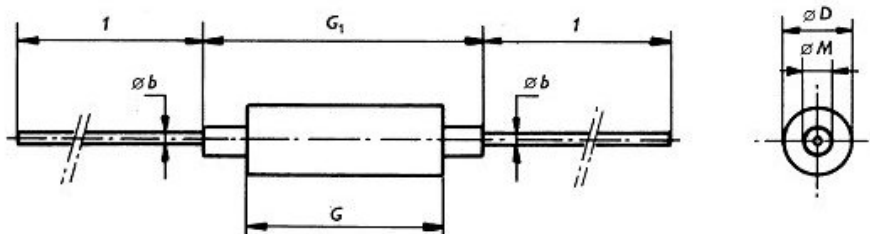


Figure E.1 – Long form package

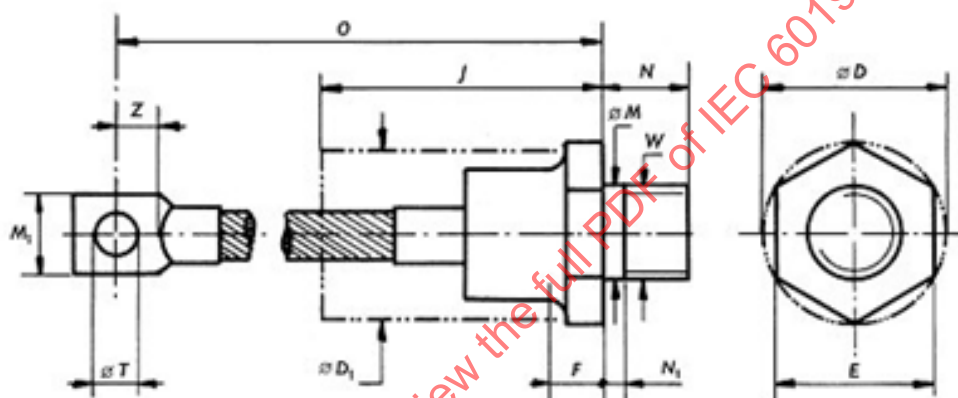


Figure E.2 – Post/stud mount package

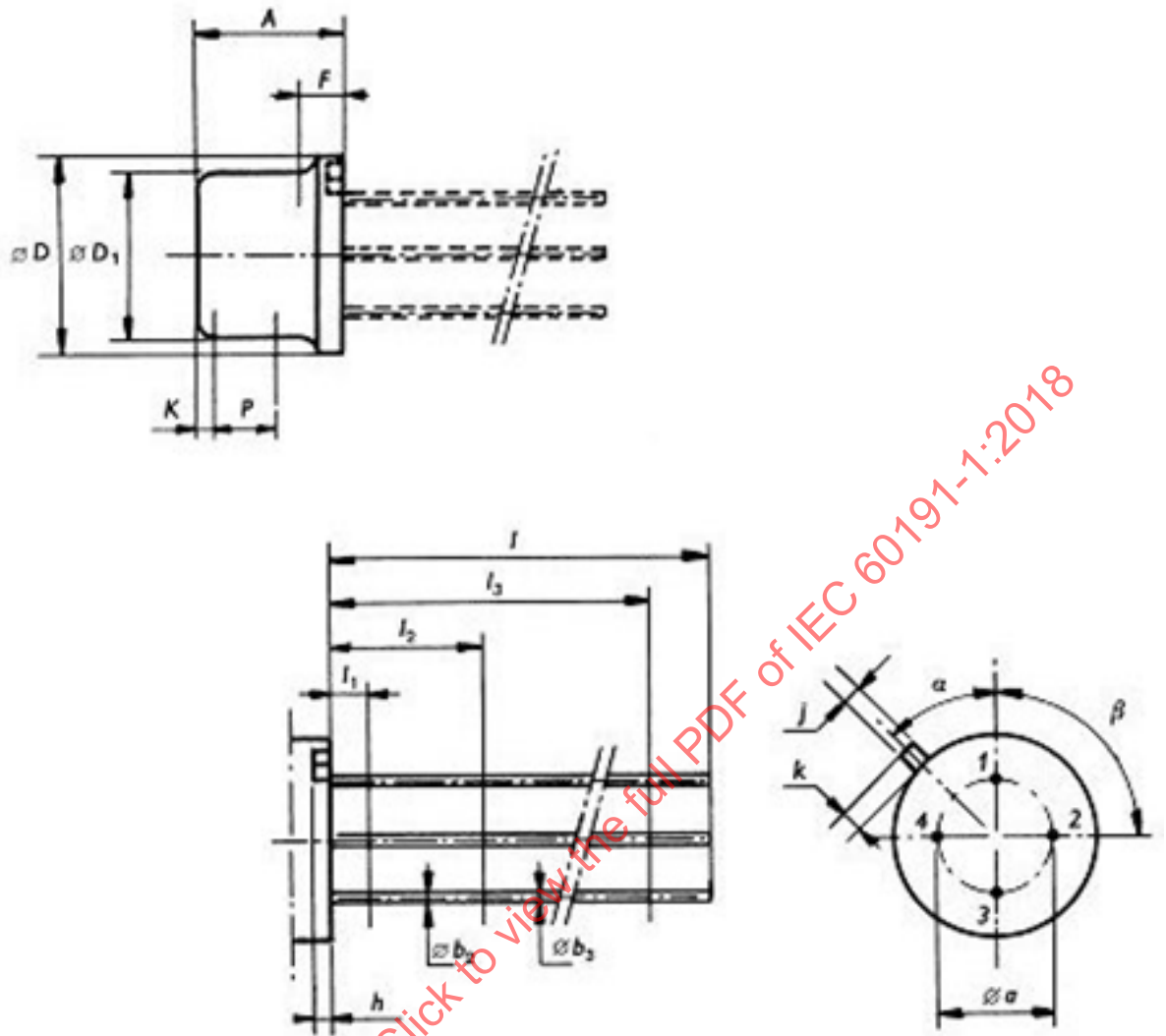


Figure E.3 – Cylindric package

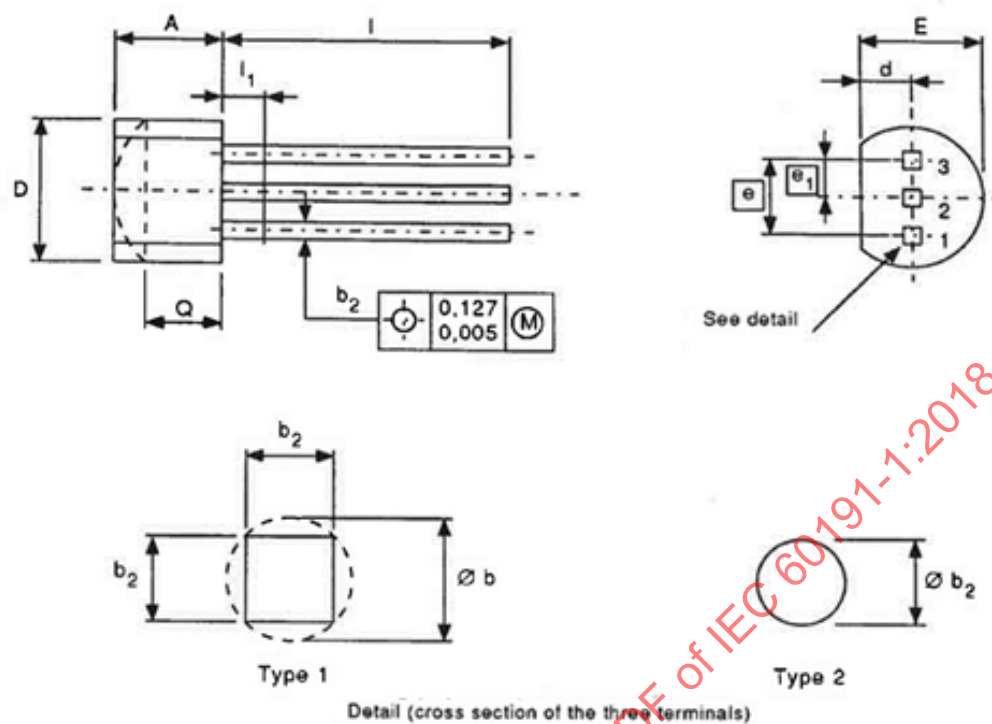


Figure E.4 – Cylindric in-line package

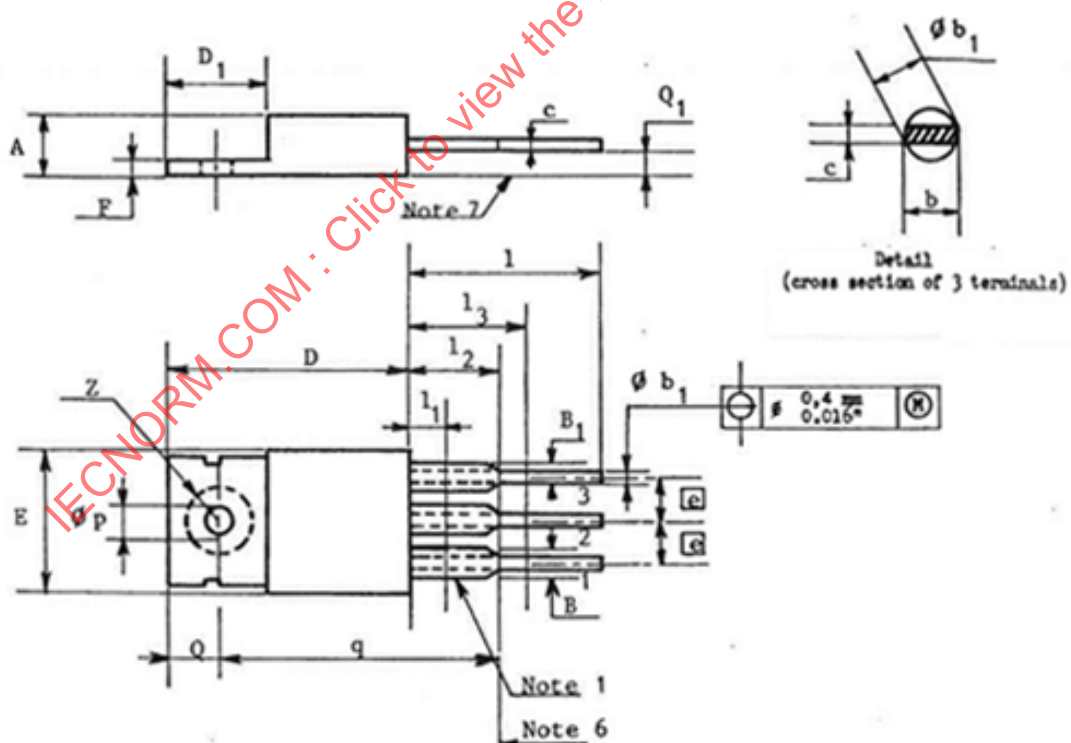


Figure E.5 – Flange-mounted in-line package

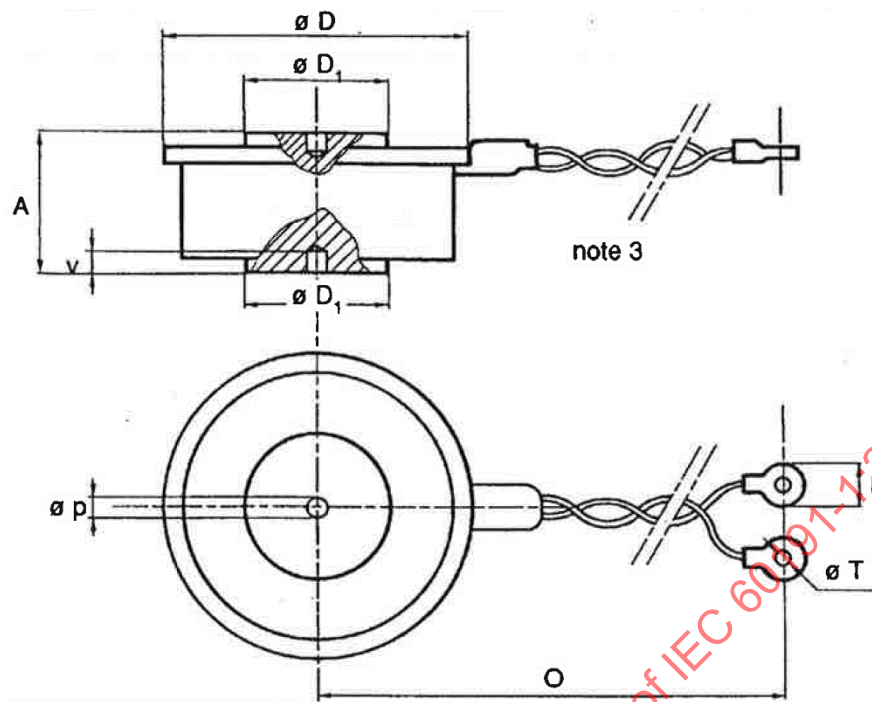


Figure E.6 – Press package

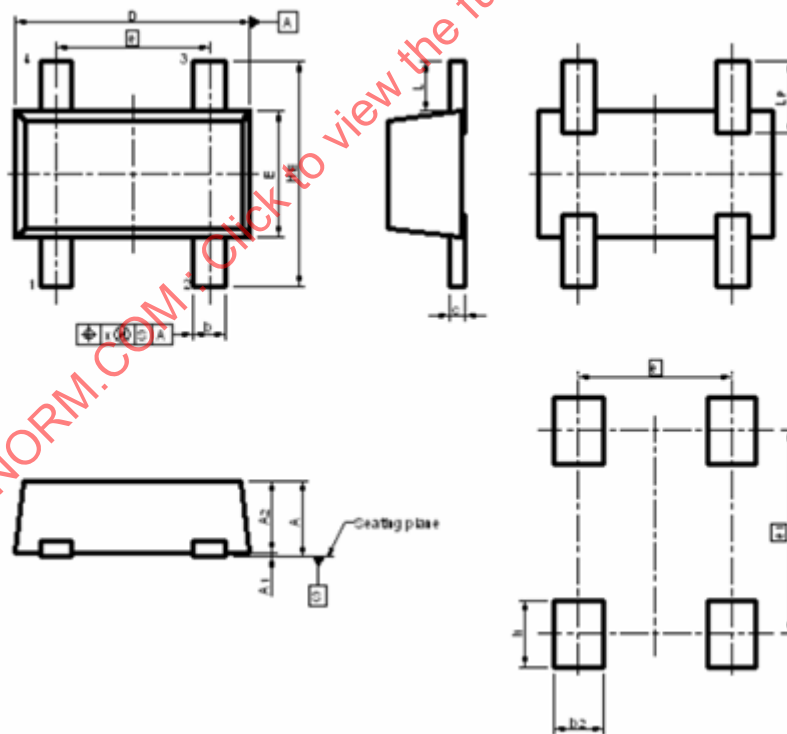


Figure E.7 – SMD-package with flat leads