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INTERNATIONAL STANDARD

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

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MECHANICAL STANDARDIZATION OF SEMICONDUCTOR DEVICES –

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

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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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

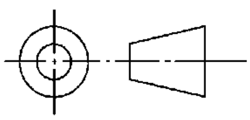
4.1 Drawing layout

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 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. 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;