IEC 60747-1

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Semiconductor devices –
Part 1: General

Dispositifs à semiconducteurs –
Partie 1: Généralités

IEC 60747-1:2006+A1:2010

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICES –

Part 1: General

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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This consolidated version of IEC 60747-1 consists of the second edition (2006) [documents 47/1841/FDIS and 47/1848/RVD], its amendment 1 (2010) [documents 47/2015A/CDV and 47/2038A/RVC] and its corrigendum of September 2008. It bears the edition number 2.1.

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience. A vertical line in the margin shows where the base publication has been modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through.

International Standard IEC 60747-1 has been prepared by IEC technical committee 47: Semiconductor devices.

The main changes with respect to the previous edition are listed below.

a) The terminology which is now given in the IEV (or which was in conflict with the IEV) has been omitted.
b) There has been a general revision of guidance on essential ratings and characteristics.
c) The distinction between general and reference methods of measurement has been removed.
d) A clause on product discontinuation notice has been added.

This bilingual version, published in 2009-11, corresponds to the English version.

The French version of this standard has not been voted upon.

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

A list of all the parts in the IEC 60747 series, under the general title *Semiconductor devices*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site 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.

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SEMICONDUCTOR DEVICES –

Part 1: General

1 Scope

This part of IEC 60747 gives the general requirements applicable to the discrete semiconductor devices and integrated circuits covered by the other parts of IEC 60747 and IEC 60748 (see Annex A).

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 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60050-521, *International Electrotechnical Vocabulary (IEV) – Part 521: Semiconductor devices and integrated circuits*

IEC 60050-702, *International Electrotechnical Vocabulary (IEV) – Part 702: Oscillations, signals and related devices*

IEC 60068 (all parts), *Environmental testing*

IEC 60191-2, *Mechanical standardization of semiconductor devices – Part 2: Dimensions*

IEC 60747 (all parts), *Semiconductor devices*

IEC 60748 (all parts), *Semiconductor devices – Integrated circuits*

IEC 60749-26, *Semiconductor devices – Mechanical and climatic test methods – Part 26: Electrostatic discharge (ESD) sensitivity testing – Human body model (HBM)*

IEC 61340 (all parts), *Electrostatics*

QC 001002 (all parts), *IEC Quality Assessment Systems for Electronic Components (IECQ) – Rules of procedure*

ISO 9000, *Quality management systems – Fundamentals and vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-521 and IEC 60050-702, as well as the following, apply.

3.1 Device structure

3.1.1
pad
area on a chip (die) to which a connection to the chip (die) can be made

3.1.2
bonding wire
wire that is bonded to a chip (die) bonding pad in order to connect the chip (die) to any other point within the device package

3.1.3
base (of a package**)**

part of the package on which a chip (die) can be mounted

3.1.4
cap, can, lid, plug
part of a cavity package that completes its enclosure

NOTE The particular term used depends on the package design.

3.1.5
anode terminal (of a semiconductor diode, excluding current-regulator diodes)
terminal connected to the P-type region of the PN junction or, when more than one PN junction is connected in series with the same polarity, to the extreme P-type region

NOTE For voltage-reference diodes; if temperature-compensating diodes are included, these are ignored in the determination of the anode terminal.

3.1.6
cathode terminal (of a semiconductor diode, excluding current-regulator diodes**)**
terminal connected to the N-type region of the PN junction or, when more than one PN junction is connected in series with the same polarity, to the extreme N-type region

NOTE For voltage-reference diodes; if temperature-compensating diodes are included, these are ignored in the determination of the cathode terminal.

3.1.7
anode terminal (of a current-regulator diode)
terminal to which current flows from the external circuit when the diode is biased to operate as a current regulator

3.1.8
cathode terminal (of a current-regulator diode)
terminal from which current flows into the external circuit when the diode is biased to operate as a current regulator

3.2 Elements and circuits

3.2.1
~~**passive circuit element**~~
~~circuit element primarily contributing resistance, capacitance, inductance, ohmic interconnection, wave guiding, or a combination of these, to a circuit function~~

~~NOTE For example, resistors, capacitors, inductors, passive filters, interconnections.~~

passive
pertaining to an electrical network or device which requires no source of energy other than the input, but excluding semiconductor diodes

[IEC 60050-702:1992, 702-09-07, modified]

3.2.2
~~**active circuit element**~~
~~circuit element that contributes other qualities to a circuit function than a passive circuit element, for example, rectification, switching, gain, conversion of energy from one form to another~~

~~NOTE 1 Examples for devices with active circuit elements are diodes, transistors, active integrated circuits, light-sensing or light-emitting devices.~~

~~NOTE 2 Active physical circuit elements may also be used to act as passive physical circuit elements only, for example, to contribute resistance and/or capacitance to a circuit function temperature.~~

active
pertaining to an electrical network or device which cannot function without a source of energy other than the input, but also including semiconductor diodes

NOTE Active circuit elements can also be used to act as passive circuit elements only, for example, to contribute resistance and/or capacitance to a circuit.

[IEC 60050-702:1992, 702-09-06, modified]

3.2.3
circuit element
constituent part of a circuit that contributes directly to its operation and performs a definable function

NOTE The term may include the interconnection means to other circuit elements, or to the terminals.

3.3 Thermal ~~characteristics~~ properties

3.3.1
virtual (equivalent) junction temperature
virtual temperature of the junction or channel of a semiconductor device

[IEC 60050-521:2002, 521-05-15, modified]

~~**3.2.3**~~ **3.3.2**
reference-point temperature
temperature at a specified point on, near or within a device

~~**3.2.4**~~ **3.3.3**
case temperature
temperature of a reference point, on or near the surface of the case

NOTE For smaller devices, if the specified reference point is not located on the case but somewhere else on the device (for example, on one of the terminals), then the temperature at this place may be called the "reference-point temperature". However, devices rated with reference to this temperature are still called "case-rated devices".

~~3.2.5~~ 3.3.4
storage temperature
temperature at which the device may be stored without any voltage being applied

~~3.3.1~~ 3.3.5
thermal derating factor
factor by which the power dissipation rating must be reduced with increase of reference point temperature

~~3.3.2~~ 3.3.6
equivalent thermal network
theoretical equivalent circuit that simulates the thermal resistances, thermal capacitances and sources of heat flow of a semiconductor device (or integrated circuit), which gives a representation of thermal conditions and temperature behaviour under electrical load and which may be used for temperature calculations

NOTE 1 It is assumed that the total heat flow, caused by the power dissipation, is flowing through this equivalent thermal network.

NOTE 2 Where heat is generated at more than one point in a device, the equivalent thermal networks will need to include each source if the heat flow is to correspond to the total power dissipation occurring in the semiconductor device (or integrated circuit).

~~3.3.3~~ 3.3.7
transient thermal impedance
quotient of

a) the change in temperature difference between two specified points or regions at the end of a time interval, and

b) the step-function change in power dissipation beginning at that time interval which causes the change in temperature difference

NOTE The term used in practice must indicate the two specified points or regions, for example, as in "junction-case transient thermal impedance". The use of the shortened term "transient thermal impedance" is permitted only if no ambiguity is likely to occur.

~~3.3.4~~ 3.3.8
thermal impedance under pulse conditions
quotient of

a) the difference between the maximum virtual temperature caused by the pulse power and the temperature of a specified external reference point, and

b) the amplitude of the power dissipation in the device produced by a specified periodic sequence of rectangular pulses

NOTE 1 The initial transient phenomena are ignored and zero continuous power dissipation is assumed.

NOTE 2 The thermal impedance under pulse conditions is given as a function of the duration of the pulses with the duty factor as a parameter.

3.4 Noise

3.4.1
reference-noise temperature
absolute temperature (in kelvins) to be assumed as a noise temperature at the input ports of a network when calculating certain noise parameters, and for normalizing purposes

NOTE It has not been possible to achieve a consensus on a single standard reference noise temperature, although no values below 290 K or above 300 K were found to be in use.

3.4.2
overall average noise figure (of a mixer diode and an I.F. amplifier)
average noise figure of the cascaded combination of a mixer and an I.F. amplifier

3.4.3
standard overall average noise figure (of a mixer diode and an I.F. amplifier)
overall average noise figure, when the average noise figure of the I.F. amplifier is a specified standard value (usually 1,5 dB) and the passband of the I.F. amplifier is sufficiently narrower than that of the mixer so that the mixer conversion loss and output noise temperature are essentially constant over the I.F. passband

3.4.4
output noise ratio
ratio of the noise temperature of an output port to the reference noise temperature, when the noise temperature of all input terminations is at the reference noise temperature at all frequencies that contribute to the output noise

3.4.5
equivalent input noise voltage (of a two-port)
voltage of an ideal voltage source (having an internal impedance equal to zero) in series with the input terminals of the device that represents the part of the internally generated noise that can properly be represented by a voltage source

NOTE In the definition, the equivalent input noise current, which would be needed for a complete and precise description of the device noise, is neglected. If the external source impedance is zero, the noise voltage represents the total noise.

3.4.6
equivalent input noise current (of a two-port)
current of an ideal current source (having an internal impedance equal to infinity) in parallel with the input terminals of the device that represents the part of the internally generated noise that can properly be represented by a current source

NOTE In this definition, the equivalent input noise voltage, which would be needed for a complete and precise description of the device noise, is neglected. If the external source impedance is infinite, the noise current represents the total noise.

3.5 Conversion loss

3.5.1
conversion loss (of a mixer, mixer diode or harmonic generator)
ratio of available input power at a single-signal frequency to the available single-signal frequency output power, not including intrinsic mixer noise or power converted from other than the signal-input frequency

3.5.2
conversion insertion loss (of a mixer, mixer diode or harmonic generator)
ratio of available input power at a single-signal frequency to the delivered single-signal frequency output power, not including intrinsic mixer noise or power convened from other than the signal-input frequency

3.6 Stability of characteristics

3.6.1
drift
difference between the final value of a characteristic at the end of a specified long period and the initial value, all other operating conditions being held constant

NOTE The use of the term "drift" to refer to the immediate change of a characteristic in direct response to changed operating conditions (for example, temperature) is deprecated.

3.6.2
relative drift
ratio of

– drift of the characteristic, to

– initial value of the characteristic

NOTE See note to 3.6.1.

3.6.3
instability range
difference between the extreme values of the characteristic observed either continuously or repeatedly during a specified period, all other operating conditions being held constant

3.6.4
relative instability range
quotient of

– the instability range of the characteristic, and

– the initial value of the characteristic

3.7 Pulse switching times

NOTE 1 The input and output signal measurement units should be specified, eg. current, voltage.

NOTE 2 Delay time, rise time, and fall time are defined in IEC 60050-521 (Terms IEC 60050-521-05-21, IEC 60050-521-05-22, and IEC 60050-521-05-24).

3.7.1
turn-on time
time interval between a step function change of the input signal level and the instant at which the magnitude of the signal at the output terminals reaches a specified upper limit when the semiconductor device is being switched from its non-conducting to its conducting state

3.7.2
turn-off time
time interval between a step function change of the input signal level and the instant at which the magnitude of the signal at the output terminals reaches a specified lower limit when the semiconductor device is being switched from its conducting to its non-conducting state

3.7.3
carrier storage time
synonym for delay time at turn-off

[IEC 60050-521:2002, 521-05-23, modified]

4 Letter symbols

4.1 General

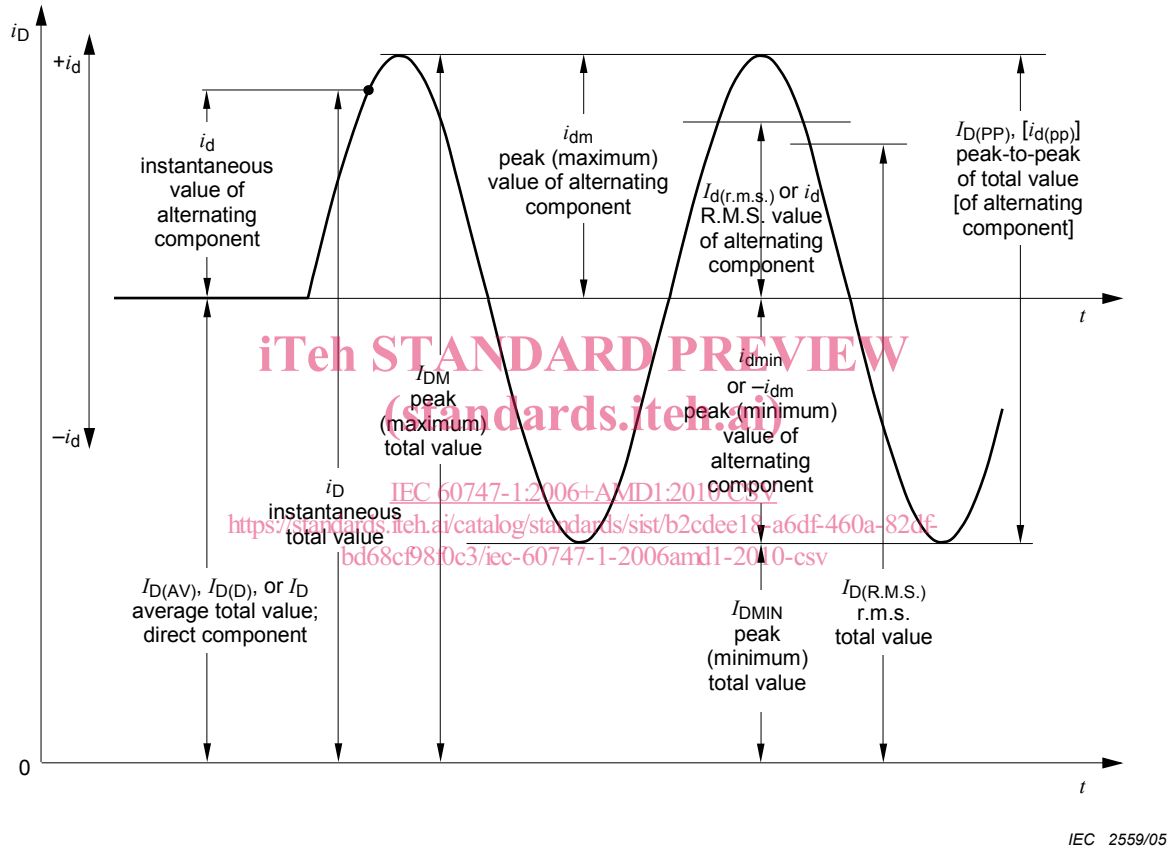
This clause provides a system of letter symbols for the properties used in the field of discrete devices and integrated circuits. Additional letter symbols, for specific categories may be given in Clause 4 of the other parts of IEC 60747 and IEC 60748. Where there is any conflict, the symbols given in the latter parts apply within the part.

The general standards given in IEC 60027 are applicable, except where this clause differs, in which case this clause should be followed. Some letter symbols or rules for composing complex letter symbols have been specifically approved for the purposes of IEC 60747 and IEC 60748.

NOTE Definitions of the terms used in this clause can be found in Clause 3 of this or the other parts of IEC 60747 and IEC 60748.

4.2 Letter symbols for currents, voltages and powers

4.2.1 Use of upper-case or lower-case letters and subscripts



NOTE D,d = Drain terminal

Figure 1 – Example of the application of the rules to a periodic current

Where both upper- and lower-case letters and subscripts are shown for currents, voltages or powers, upper-case letters shall be used for the representation of the total value (the large signal value), and lower-case letters shall be used for values related to the alternating component (the small signal value). If more than one subscript is used, subscripts for which both styles exist shall either be all upper-case or all lower-case.

Exceptionally, cases are used in combination to save otherwise necessary parentheses, for example, V_{CEsat}

Figure 1 gives an example. It represents the drain current of an FET that consists of a direct component (the average value) and an alternating component.

4.2.2 Basic letters

The basic letters to be used are:

I, i = current
V, v = voltage
P, p = power

NOTE IEC 60027 recommends the letters V and v only as reserve symbols for voltage; however, in the field of semiconductor devices, these are so widely used that in this publication they are preferred to U and u.

4.2.3 List of subscripts

(AV) = average value
(BR) = breakdown
(cr), cr = critical
(D) = direct
F, f = forward
M, m = peak (maximum) value with respect to time
MIN, min = peak (minimum) value with respect to time (see note 3)
n noise
O, o = open circuit
(OV) = overload
(PP), (pp) = peak-to-peak, value
R, r = repetitive, recovery, reverse
(R.M.S.), (r.m.s.) = root-mean-square value
S,s = short-circuit, surge
(tot), tot = total value

NOTE 1 Where no ambiguity arises, subscripts may be omitted, for example:

I_B or $I_{B(D)}$ = direct base current.

I_b or $I_{b(rms)}$ = instantaneous root-mean-square value base current.

NOTE 2 For other recommended subscripts, see Clause 4 in the other relevant parts of these publications.

NOTE 3 "MIN, min" should be used with caution, as it can be confused with the lower limit of a ranges of values.

4.2.4 Subscripts denoting terminals

Where it is necessary to indicate the terminal carrying a current after which the current is named or to indicate the voltage at that terminal, this shall be done by a single subscript.

The terminal relative to which the voltage is measured or, if required, out of which the current flows (the reference terminal) shall be indicated by a second subscript.

A third subscript may be used to indicate the external connection between a third (input) terminal and the reference terminal, for example:

I_{CES} collector current of a transistor with the base short-circuited to the emitter;

$V_{(BR)CEO}$ collector-emitter breakdown voltage of a transistor with base open-circuit.