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Edition 2.1 2010-08
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Semiconductor devices –
Part 1: General

Dispositifs à semiconducteurs –
Partie 1: Généralités

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INTERNATIONAL
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SEMICONDUCTOR DEVICES –

Part 1: General

FOREWORD

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60747-1 edition 2.1 contains 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.

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- withdrawn,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
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
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 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]

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

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".

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

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

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).

3.3.7
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.

3.3.8
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

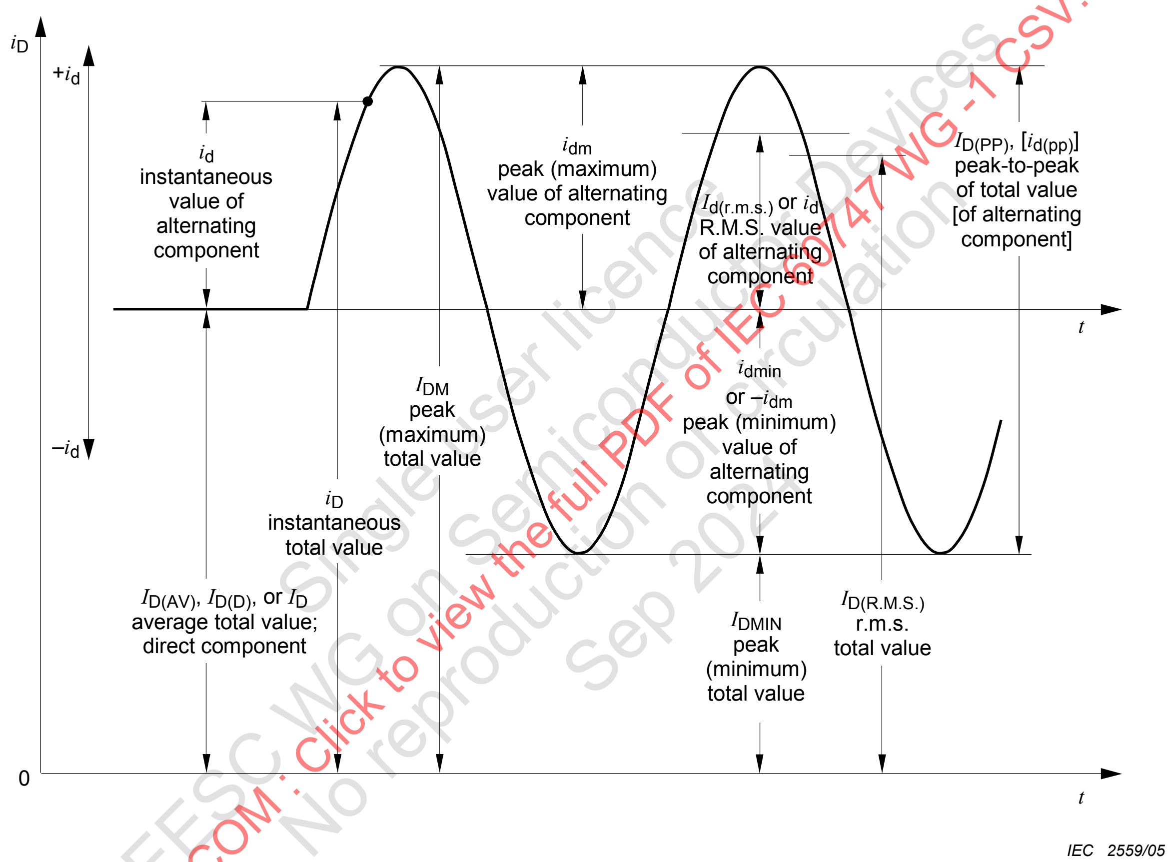
This clause provides a system of letter symbols for the properties used in the field of discrete devices and integrated circuits. Additional letter symbols, for specific categories may be given in Clause 4 of the other parts of IEC 60747 and IEC 60748. Where there is any conflict, the symbols given in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

4.2.5 Subscripts for supply voltages or supply currents

Repeating the appropriate terminal subscript shall indicate supply voltages and supply currents, for example: V_{CC}, I_{EE}.

If it is necessary to indicate a reference terminal, this should be done by a third subscript, for example: V_{CCE}.

4.2.6 Subscripts for devices having more than one terminal of the same kind

If a device has more that one terminal of the same kind, the subscript is formed by the appropriate letter for the terminal followed by a number. In the case of multiple subscripts, hyphens may be necessary to avoid misunderstandings, for example:

I_{B2} = continuous (d.c.) current flowing in the second base terminal;

$V_{B2\text{-}E}$ = continuous (d.c.) voltage between the second base terminal and the emitter terminal.

4.2.7 Subscripts for multiple devices

For multiple devices, the subscripts are modified by a number preceding the letter subscript. In the case of multiple subscripts, hyphens may be necessary to avoid misunderstandings, for example:

I_{2C} = continuous (d.c.) current flowing into the collector terminal of the second transistor;

$V_{1C\text{-}2C}$ = continuous (d.c.) voltage between the collector terminals of the first and the second transistors.

4.2.8 Indication of the polarity of currents and voltages

4.2.8.1 Unsigned letter symbol

When neither the letter symbol nor the value is preceded by a minus, this denotes either a voltage that has a positive value with respect to a reference terminal, or a conventional current that has a positive value and which flows from the external circuit into the device terminal, for example:

V_{XY} = voltage applied to terminal X is positive with respect to terminal Y;

I_X = conventional current flowing into terminal X from an external source.

4.2.8.2 Negated letter symbol

The negation sign may precede either the letter symbol or the value, for example, $-V_{XY}$, $-I_X$ denote values that are of the opposite polarity to V_{XY}, I_X. It follows, by the application of algebraic rules, that V_{XY} = –5 V can be expressed as $-V_{XY}$ = 5 V.

Where the definition itself denotes a reversal of the polarity and there is no ambiguity, the negation may be omitted, for example, V_F = 2 V, V_R = 10 V.

4.3 Letter symbols for signal ratios expressed in dB

dB = the logarithm to the base of ten of the ratio of two powers multiplied by 10.

dB(V) = the logarithm to the base of ten of the ratio of two voltages multiplied by 20

dB(I) = the logarithm to the base of ten of the ratio of two currents multiplied by 20

Examples:

n = 10 log (P_1/P_2) dB

n = 20 log (V_1/V_2) dB (V)

n = 20 log (I_1/I_2) dB (I)

In the latter two cases, when, **and only when**, the resistances appertaining to V_1 and V_2 (or I_1 and I_2) are equal or of negligible difference, the numerical value of n will be the same as that of the first case, and the subscripts (V) and (I) may be omitted.

4.4 Letter symbols for other electrical properties

This clause applies to elements of electrical equivalent circuits, electrical impedances, admittances, inductances and capacitances.

4.4.1 Basic letters

Z, z = impedance

R, r = resistance

X, x = reactance

Y, y = admittance

G, g = conductance

B, b = susceptance

C = capacitance

L = inductance

4.4.2 Letters for matrix parameters

H, h = hybrid parameter

S, s = s-parameter

Z, z = impedance parameter

Y, y = admittance parameter

The real and imaginary parts of the impedance and admittance parameters are identified using the appropriate letters given in 4.4.1. If it is necessary to distinguish in the letter symbol between the real and imaginary parts of the hybrid or s-parameters, the notation Re( ) and Im( ) should be used, for example:

Re(h_{11b}) = real part of a hybrid parameter;

Im(s_{21e}) = imaginary part of an s-parameter.

NOTE Alternatively, the numerical value may include either real and imaginary values or magnitude and angle values.

4.4.3 Use of upper-case or lower-case letters

Where both upper-case and lower-case letters are shown in 4.4.1 and 4.4.2, upper-case letters shall be used for the representation of

a) elements of external circuits in which the device may form only a part;

b) all inductances and capacitances.

Lower-case letters shall be used for the representation of circuit elements inherent in the device (with the exception of inductance and capacitance).

4.4.4 List of subscripts

d	=	differential	
F, f	=	forward; forward transfer	
I, i	=	input	
O, o	=	output	
R, r	=	reverse; reverse transfer	
T	=	depletion layer	
11	=	input	applicable to matrix parameters only.
22	=	output	
12	=	reverse transfer	
21	=	forward transfer	
1	=	input	Not applicable to matrix parameters
2	=	output	

4.4.5 Additional subscript

A further subscript may be used for the identification of the circuit configuration (for example, for the terminal or reference terminal, see 4.2.4). When no confusion is possible, this further subscript may be omitted.

NOTE Without these further subscripts, the initial letter suffixes for matrix parameters do not define the circuit configuration, and the numeric suffixes do not define either the circuit configuration or whether the value is small-signal or static, for example:

h_{21E} or h_{FE}	=	static value of forward current transfer ratio in common-emitter configuration;
h_{21e} or h_{fe}	=	small-signal value of the short-circuit forward current transfer ratio in common-emitter configuration;
$Z_e = R_e + jX_e$	=	small-signal value of the external impedance;
r_B	=	d.c. value of the internal base resistance.

4.4.6 Use of upper-case and lower-case subscripts

Where both upper- and lower-case subscripts are shown in 4.4.4 or used as shown in 4.4.5, the upper-case subscript shall be used for the representation of the total value (the large signal value), and the lower-case subscript shall be used for the small signal value. If more than one subscript is used, subscripts for which both styles exist shall be either all upper-case or all lower-case. Subscripts for terminals shall follow the same case rule, for example: h_{FE}, y_{RE}, h_{fe}, but C_{Te} (T has no lower-case variant).

4.5 Letter symbols for other properties

4.5.1 Time-related properties

t = time, duration

f = frequency

For example: t_r = rise time;

f_{max} = maximum frequency of oscillation.

4.5.2 Time subscripts

d = delay

f = fall

on = turn on

off = turn off

p = pulse duration

r = rise

s = carrier storage

w = average pulse duration

4.5.3 Thermal properties

T = temperature, indicating either Celsius or Kelvin temperature, for example: T_a = 25 °C, T_o = 295 K.

NOTE 1 The use of the lower-case letter, *t*, is strongly deprecated.

NOTE 2 In the case where distinctive letter symbols are needed for Celsius temperature and Kelvin temperature, the letter symbol *T* with the unit in brackets denoting Celsius temperature *T* (°C) or Kelvin temperature *T* (K) should be used.

NOTE 3 Differences between two temperatures are expressed using the same unit as that used for the two temperatures. This results from the pertinent magnitude equation, for example: T_2 (°C) – T_1 (°C) = ΔT (°C).

$R_{th(x-y)}$, $R_{th(X-Y)}$. = thermal resistance;

$Z_{th(x-y)}$, $Z_{th(X-Y)}$. = transient thermal impedance;

$Z_{thp(x-y)}$, $Z_{thp(X-Y)}$. = transient thermal impedance under pulse conditions.

NOTE In the letter symbols given above, the letters x, y or X, Y stand for the subscripts that denote the points or regions between which the thermal resistance or impedance extends. These subscripts should be taken from the list given in 4.5.4.

4.5.4 Subscripts for thermal properties

j, J = junction (channel) (note 1)

vj, VJ = virtual junction (channel) internal equivalent (notes 1 and 2)

c, C = case (note 3)

ch = channel (note 1)

r, R = reference point (note 3)

a, A = ambient (note 3)

s, S = heat sink

f, F = cooling fluid, other than air

sb = substrate

stg = storage

sld = soldering

op = operating (note 4)

th, θ = thermal

NOTE 1 The subscripts j (or J)and vj (or VJ) may be used instead of ch to indicate “channel”.

NOTE 2 In data sheets, specifications always refer to the virtual junction (channel) temperature. Therefore, the letter v in the subscript may be omitted.

NOTE 3 The use of the longer subscripts “case”, “ref” and “amb” is deprecated. If they are used for thermal resistances or impedances, the subscripts shall be separated by hyphens and put in brackets as shown in the following example: $R_{\mathrm{th(j\text{-}amb)}}$.

NOTE 4 In letter symbols for operating temperatures, for example, as in T_{aop} for “operating ambient temperature”, the subscript "op" is usually omitted in data sheets if no ambiguity is likely to occur.

4.5.5 Sundry other properties

The following letter symbols are recommended:

K_{t} = thermal derating factor;

$\overline{F}$ or F_{AV} = average noise figure, average noise factor;

F = spot noise figure, spot noise factor;

N = output noise ratio r;

T_{n} = noise temperature;

$T_{\mathrm{o}}/T_{\mathrm{no}}$ = reference noise temperature.

4.6 Presentation of limit values

4.6.1 General

The limit values of a range of values may be presented using either one of two different conventions. Unless otherwise stated, the absolute magnitude convention is used for discrete semiconductors. The use of the algebraic convention for integrated circuits is detailed in IEC 60748.

4.6.2 Absolute magnitude convention

The following letter symbols are added following the letter symbol or value:

max = the higher limit value of a range, regardless of polarity;

min = the lower limit value of a range, regardless of polarity.

Where a range of values includes both positive and negative values, both limits are maximum, with an implied minimum limit of zero. Exceptionally, in these standards, where the polarity is not known, ‘min’ may be used to indicate ‘the more negative limit’; but, in this case, the letter symbol shall not be negated.

NOTE To avoid ambiguities, where a range of values includes both positive and negative values, the negation should be shown in the letter symbol (see examples in Table 1).

4.6.3 Algebraic convention

The following subscripts are added to the letter symbol:

A = the most positive value;

B = the most negative value.

NOTE 1 The use of 'max' and 'min' in the algebraic convention is deprecated, as their meaning, when combined with negative values, conflicts with the meaning in the absolute magnitude convention.

NOTE 2 To avoid ambiguities, negation, where present, should preferably be shown in the value (see example 3 in Table 1).

Table 1 – Presentation of limit values with the two conventions

<table>
<tr><th rowspan="2">Example</th><th rowspan="2">Range</th><th colspan="3">Absolute magnitude convention</th><th colspan="3">Algebraic convention</th></tr>
<tr><th>Symbol</th><th>max</th><th>min</th><th>Symbol</th><th>A</th><th>B</th></tr>
<tr><td>1</td><td>--------------------------------------|///////////////////|----->
0 2 6 X</td><td>X</td><td>6</td><td>2</td><td>X</td><td>6</td><td>2</td></tr>
<tr><td>2</td><td>-----------------------------|///////////////////|-------------->
–2 0 4 X</td><td>X
-X</td><td>4
2</td><td>note 1</td><td>X</td><td>4</td><td>-2</td></tr>
<tr><td>3</td><td>----------------------|///////////////////|---------------------->
–6 –2 0 X</td><td>X
-X</td><td>-6
6</td><td>-2
2</td><td>X
-X</td><td>-2
6</td><td>-6
2</td></tr>
<tr><td>4</td><td>-------------------------------------|///////////////////|------->
(position of "0" not known) a b X</td><td>X
Note 2</td><td>b</td><td>a</td><td>X
Note 2</td><td>b</td><td>a</td></tr>
<tr><td colspan="8">NOTE 1 In example 2, the implied minimum is zero, not customarily shown.
NOTE 2 IEC 60747 and IEC 60748 use the example 4 format when neither the values nor the polarities are known. Once known (for example, in a data sheet), the appropriate form as in examples 1-3 should be used.</td></tr>
</table>

5 Essential ratings and characteristics

5.1 General

The ratings and characteristics prescribed in IEC 60747 and IEC 60748 are the minimum that should be quoted by a manufacturer when describing his product for general use. Published data should be presented in accordance with 5.3.

There are, however, products that perform well in specific circuits without all these ratings and characteristics being specified. The data for such products may not include all the requirements of this clause.

5.2 Relationship between conditions of use, ratings and characteristics

5.2.1 General

Semiconductor ratings are the limiting conditions of use that all conforming devices will withstand but beyond which damage to the device may occur.

Operating conditions of use are the conditions at which the specified characteristics are valid but beyond which the characteristics may not remain within the specified limits.

Measuring conditions are those in which a characteristic is measured when being tested.

NOTE 1 Limiting conditions may be either maxima or minima and are known as maximum ratings and minimum ratings, respectively.

NOTE 2 IEC 60134 explains the rating systems in general use and, in particular, the division of responsibility between the manufacturer of semiconductor devices and circuit designers.

NOTE 3 Many ratings and characteristics can be interchanged but never under the same conditions in the same data sheet. For example, the limiting point on the reverse characteristic curve of a diode may be defined as either $I_R$max (characteristic) at $V_R$max (rating), or V_{BR}min (characteristic) at $I_R$max (rating), but not both.

However, $I_R$max (characteristic) at $V_R$max (rating), and V_{BR}min (characteristic) at I_{RM}max (rating) is permissible, as I_{RM} is time restricted while V_R is continuous.

Other points below the limit on the same curve may be given independently, for example, I_{R2}max (characteristic) at specified V_R (operating condition).

5.2.2 Usage under unspecified conditions.

Users should consult the device manufacturer before applying to a device any condition that is not covered in the manufacturer's data, for example, the application of solvents or ultrasonics during equipment assembly.

5.2.3 Production spread and compliance

There is no tolerance on the limit values of ratings and characteristics given in published data. However, in commercial dealings involving bulk transactions, the acceptable proportion of devices which may fail to meet the above criteria and the methods of verification are a matter for agreement between the supplier and the purchaser. Such methods may permit a percentage of failed devices to be included in the supplied lots.

For semiconductor devices marketed under the IECQ scheme, these methods and values are prescribed in the relevant parts of IEC 60747 and IEC 60748.

5.3 Standard format for the presentation of published data

Published data should contain information on the items listed below. The requirements to be met by devices supplied under the IECQ system are fully prescribed in the parts of IEC 60747 and IEC 60748 related to the IECQ system.

a) Manufacturer’s type number.

b) Category of the device according to the relevant part of these publications (IEC 60747 or IEC 60748), the semiconductor material (for example, silicon) and, where appropriate, the polarity (for example, PNP or NPN).

c) Information on outlines, terminal identification and connections, case material (glass, ceramic, metal, plastic, etc.) and the finish of leads.

d) Electrical and thermal ratings. Where appropriate, the position of the reference points for temperature and high-current-low-voltage measurements shall be stated.

e) Electrical and thermal characteristics and associated information.

f) Mechanical data.

g) Environmental data and/or reliability data.

h) Curves, for example, graphical representation of characteristics.

5.4 Type identification

Where the manufacturer's type number is not clearly marked on the device, the method of type identification should be indicated, for example, colour coding, using a double-width band for the first digit.

5.5 Terminal and polarity identification

5.5.1 General

The function of each terminal should be identifiable, either from the outline drawing, or by means of terminal marking.

Any electrical connection between an electrode and the case should be stated.

If there is a possibility of the colour code at the cathode end of diodes in very small envelopes being confused with a type marking, then the latter may be omitted.

5.5.2 Examples of terminal marking

a) Colour coding

Anode	Cathode	Gate	Collector	Emitter	Base
Blue or black	Red (or white for diodes)	Yellow or white	Red	Blue	Yellow

b) The rectifier diode graphical symbol points towards the cathode terminal.

c) The type-number coloured bands are placed nearer to the cathode terminal.

5.6 Electrical ratings and characteristics

All electrical ratings and characteristics should be stated with reference to externally available connections.

5.7 Cooling conditions

5.7.1 General

Semiconductor devices are specified either as ambient-rated (mode A), case-rated (mode C) or both ambient- and case-rated devices. As an exception, they may be specified as forced-cooling rated (mode F) devices, which, apart from the cooling conditions, are categorized in IEC 60747 and IEC 60748 as ambient rated devices, or as heat-sink rated devices which are categorized in these publications as case-rated devices.

NOTE Where virtual junction temperature is given as a rating, this is for calculation purposes only, as it is only partially under the control of the user. (When dissipating power, the junction temperature depends on the device thermal capacity and resistivity characteristics.)

5.7.2 Ambient temperature conditions

Where devices are specified as ambient-rated devices, this signifies that the device characteristics apply under natural air-cooling conditions (air under conditions of natural convection) (unless otherwise stated, see 5.7.4).

5.7.3 Case-temperature conditions

Where devices are specified as case-rated devices, this signifies that the device characteristics apply under the conditions of conduction cooling through a defined area of the case.

NOTE Where thermal resistance or impedance characteristics are quoted, they apply to an equivalent circuit approximation of the device thermal characteristics that assumes all heat flows through a specified reference point in the above area.

Information should be given concerning the means of obtaining good thermal contact between the device and a heat dissipator, including where appropriate, method of attachment, the preparation of contact surfaces to improve thermal and electrical contact, and recommendations on suitable thermally conductive compounds or washers.

5.7.4 Forced cooling temperature conditions

Where devices are specified as forced cooling devices, this signifies that the device characteristics apply under the conditions of forced fluid cooling.

Information should be given concerning the type of fluid (air, freon, water, oil, etc.), the position and orientation of the device relative to the flow of the fluid, and the velocity and pressure of the fluid at the inlet.

5.7.5 Heat-sink temperature conditions

Where devices are specified as heat-sink rated devices, this signifies that the device characteristics apply when the device is mounted on an external heat-sink in accordance with the manufacturer's specified mounting conditions. The case temperature is that of a specified point thermally close to the device case surface, either on the surface or within the external heat-sink.

NOTE The thermal characteristics of the interface between the device and the external heat-sink are included in the specified device thermal characteristics of heat-sink rated devices.

5.7.6 Mixed mode devices

Some ambient rated devices can be provided subsequently with a fin or with a fastening clip. Since the major part of the heat dissipated by the device is then removed by conduction towards this clip or this fin, the device should then be treated as a case-rated device.

5.8 Recommended temperatures

It is recommended that ratings and characteristics be stated at 25 °C and at one (or more) other temperature(s).

5.9 Recommended voltages and currents

When electrical characteristics are required at reference voltages or currents, the values of the R10 series taken from ISO 3 are recommended. In order of preference, these are:

1st preference:	1,0			2,0				5,0			10,0
2nd preference:	1,0		1,6		2,5		4,0		6,3		10,0
3rd preference:	1,0	1,25	1,6	2,0	2,5	3,2	4,0	5,0	6,3	8,0	10,0

These figures can be multiplied by 10^n, where n can be a positive or a negative integer.

When electrical characteristics are required at reference voltages equal to, or higher than, 200 V values may be rounded off.

5.10 Mechanical ratings (limiting values)

5.10.1 General

In the following subclauses on mechanical ratings, the preferred method of stating the information required should be in accordance with the relevant section of IEC 60068.

5.10.2 Mounting constraints

Where appropriate, any significant conditions and/or any restrictions should be stated, for example:

a) horizontal or vertical mounting position;
b) the minimum distance from the body at which a flexible lead may be bent at right angles;
c) for stud-mounted devices, the maximum torque and, where appropriate, the minimum torque, which may be applied under specified conditions;
d) for press-pack devices, the maximum pressing force that may be applied and, where appropriate, the minimum pressing force that shall be applied under specified conditions;
e) for heat-sink rated devices, the mounting requirements, the interface material and flatness of the external heat-sink over the contact area.

5.10.3 Ratings for terminations

a) Stress ratings

   A statement of any restrictions on the stresses that may be applied should be given.

b) Temperature ratings

   The maximum temperature of the terminations at a specified distance from the body for a specified time, together with any other limiting conditions, should be given as appropriate to the intended method(s) of attachment (for example, soldering, welding, etc.).

When these ratings are significantly dependent on the initial temperature of the device, any information on derating should be given.

5.10.4 Additional ratings

Where appropriate, for certain applications, additional information may need to be given, for example, limiting values for acceleration, shock and vibration, environmental conditions, etc.

5.11 Mechanical characteristics

5.11.1 Dimensions

Either: refer to a standard IEC outline drawing and base drawing where appropriate (see IEC 60191-2);

or: give an outline drawing (and base drawing, where appropriate) showing dimensions with appropriate tolerances.

The type of termination (for example, wire-ended, strip, stud, etc.) should be indicated.

The function of each terminal and where appropriate, of the case (for example, anode, gate, collector) should be stated.

5.11.2 Additional characteristics

Where appropriate, for certain applications, additional information may need to be given, for example, the weight of the device.

5.12 Multiple devices having a common encapsulation

5.12.1 General

The following applies to multiple devices having a common encapsulation, in which the individual devices can be measured and may be used separately.

The individual devices should be identified and any common terminal stated.

5.12.2 Electrical ratings

a) Ratings for each individual device in accordance with IEC 60747-2, IEC 60747-3, etc.

b) Maximum isolation voltage between the individual devices.

c) The maximum total power dissipation for each individual device and the maximum total power dissipation of the multiple device, under the same conditions of case or ambient temperature as for each individual device.

5.12.3 Electrical characteristics

a) Characteristics for each individual device in accordance with the relevant part of IEC 60747-2, IEC 60747-3, etc.

   NOTE Where these values are temperature-dependent, there should be no significant dissipation in the internal devices not being measured unless this is otherwise specified.

b) Where appropriate, maximum leakage current between the individual devices.

c) Where appropriate, biasing magnitude and polarity required for isolation.

d) The nature and magnitude of any electrical cross-coupling effect (for example, capacitance), under the intended conditions of operation.

e) Where multiple devices are supplied with the intention of having matched characteristics, the degree of matching of the specified characteristics and the conditions of use that apply.

   NOTE The degree of matching should be stated at 25 °C and at one higher temperature.

5.12.4 Thermal characteristics

a) Where appropriate, the maximum thermal resistance of that part of the heat path to case or ambient which is common to all devices, should be stated under the same conditions as for each device separately.

This represents the thermal coupling resistance between devices.

b) Where appropriate, the maximum thermal resistance between each individual device and the hot end of the common heat path should be stated.

This represents the decoupled part of the thermal resistance of each device.

6 Measuring methods

6.1 General

The measuring methods described in IEC 60747 and IEC 60748 outline the principles employed but not the detailed techniques for practical application. They describe methods that are considered to give the most accurate results, and as such, are sometimes referred to as reference methods.

Wherever possible, for each characteristic, there should be only one basic method. Where more than one method of measuring is described, it is implied that each method is suitable, although under a specified range of conditions of use, one of the methods may be more appropriate than another.

6.2 Alternative methods of measurement

Any variation or alternative method of measurement may be used, provided that allowances are made for the measurement accuracy. For example, the measurement of temperature-dependent characteristics before temperature stability has been reached shall include an allowance for any expected characteristic change with temperature.

A characteristic specified under steady-state conditions may only be measured before thermal equilibrium has been reached or by a pulse method, provided that an allowance is made for any change in the measured value that would have occurred if steady-state conditions had been used.

NOTE If a pulse method is chosen, it must be ensured that there are no electrical or thermal transient phenomena that may affect the accuracy of the measurement.

6.3 Measurement accuracy

Allowance shall be made in the actual measured values of characteristics for any measuring accuracy tolerances. Measurements taken by, or on behalf of, the supplier shall lie within the published limit values by at least this tolerance, and measurements taken by, or on behalf of, the purchaser shall lie outside the published values by at least this tolerance.

The actual values applied to the device to verify ratings by, or on behalf of, the supplier, shall lie sufficiently outside the published values to allow for the accuracy of the verification method. Values applied by, or on behalf of, the purchaser shall lie sufficiently within the published values for similar reasons.

The measurement accuracy shall take into account both the electrical and the environmental conditions.

Wherever possible, methods giving a direct answer are preferable, as calculated results are based on equivalent circuits that may not be valid under all conditions.

NOTE 1 The specified conditions of measurement should align with those given in the essential ratings and characteristics clauses.

NOTE 2 The manufacturer may, at his discretion, add additional tolerances. (To allow, for example, for drift of the characteristics during the life of the device.)

6.4 Protection of devices and measuring equipment

6.4.1 General

The precautions described in this clause are generally valid for discrete devices and integrated circuits. Special precautions for particular device categories are given together with the measuring methods in the relevant part of these publications for the category.

NOTE Electrostatic sensitive devices should be handled as described in IEC 61340.

6.4.2 Limiting values

The test conditions for all characteristics measurements should be such that the limiting values of the device (the maximum ratings) are not exceeded. Circuits may, for example, include clamping diodes or resistors to limit maximum instantaneous currents and voltages.

It is recommended that devices should not be inserted into or removed from a circuit while it is energized.

6.4.3 Measuring instruments and power supplies

It is advisable to protect the meters and power supplies against overloads arising from faulty semiconductor devices or incorrect connection.

6.5 Thermal conditions for measuring methods

6.5.1 General

The following recommendations for the control of thermal conditions should be observed whenever such control is required. This degree of control will usually only be needed if the characteristic being measured is significantly temperature-dependent.

Thermal equilibrium may be considered to have been achieved if doubling the time between the application of power and the measurement causes no change in the indicated result within the expected error.

6.5.2 Ambient rated devices

For measurement purposes, natural air-cooling conditions apply when the ambient temperature is measured below a semiconductor device that is supported by its leads in an enclosure of a substantially uniform air temperature.

The ambient temperature T_a shall be measured below the case of the device at a distance from this case equal to about five times its diameter, but not less than 10 mm.

The support points of the device should not be less than 10 mm ($^3/_8$ in) from the body of the device, except for devices having very short leads, in which case the location of the support points shall be specified. The supports shall be at a temperature no less than that of the ambient temperature.

The measurements should be carried out in a chamber of suitable dimensions with non-reflective walls, so constructed that no region where the devices may be placed is heated by direct radiation and where natural air convection is not materially affected.

The chamber should be capable of maintaining, in any region where the devices may be placed, a temperature which is within a tolerance of ±2 °C, or less if required, of a specified temperature.

It is permissible to stir gently the air inside the chamber, provided that this does not cool the devices, and provided that the same results would be obtained in a larger chamber having only normal convection.

NOTE The reproducibility of measurements for ambient rated devices depends largely on the chamber design.

6.5.3 Case-rated devices

For measurement purposes, conduction-cooling conditions apply when the case temperature is measured at a specified point on, or thermally near, the external surface of the device and when heat is conducted evenly over the whole of the defined cooling area of the device.

Measurements shall be carried out under such conditions that the case-ambient thermal resistance is as small as possible, compared with the junction-case thermal resistance.

NOTE This condition may be achieved, for example, by mounting the device in or on a large mass of metal that is thermostatically controlled, or by mounting it in an oil bath that is thermostatically controlled.

6.5.4 Force cooled devices

For measurement purposes, forced cooling applies when the temperature is measured at a specified point in front of the device in the path of the flow.

Measurements shall be carried out in strict compliance with the data sheet specified conditions.

6.6 Accuracy of measuring circuits

6.6.1 Power supplies

Power-supply ripple should not affect the desired accuracy of the measurements.

6.6.2 Constant current source

A current source should be considered constant if a two-to-one increase in the load impedance does not produce a change in the value being measured that is greater than the permitted error of measurement.

6.6.3 Constant voltage source

A voltage source should be considered constant if a two-to-one decrease in the load impedance does not produce a change in the value being measured that is greater than the permitted error of measurement.

6.6.4 Circuit conditions

If low currents are measured, suitable precautions should be taken to ensure that parasitic circuit currents or external leakage currents are small compared with the current being measured.

Care should be taken to ensure that stray capacitance and inductance values have no effect on the measurement result within the desired accuracy, or alternatively that the effects of stray capacitance and inductance are taken into account in the result.

Coupling or bypassing capacitors should present effective short circuits at the measurement frequency. Where r.f. decoupling is important, the necessary components and/or mounting conditions of the device should be as specified.

Care should be taken to minimize spurious oscillations or distortions likely to affect the accuracy of the measurement.

6.6.5 Open circuit

A circuit should be considered as an open circuit if a two-to-one decrease in its impedance does not produce a change in the value being measured that is greater than the permitted error of measurement.

6.6.6 Short circuit

A circuit should be considered short-circuited if a two-to-one increase in its impedance does not produce a change in the value being measured that is greater than the permitted error of measurement.

6.6.7 Lighting conditions

When a characteristic is known to be light-sensitive, the effect of lighting conditions should be taken into account.

6.6.8 Measuring instruments

For any device carrying large currents, separate current-carrying and voltage-measuring contacts should be used. When this is not possible, corrections may have to be made to the measured values of inter-terminal voltages.

In addition, for high-current devices, residual inductance should be as low as possible.

The input and output waveforms of rectifying and converting circuits may be distorted from sinusoidal. Conventional sinusoidal conversion factors are not applicable to distorted waveforms, for example, from average to r.m.s. or crest values.

Therefore, allowance should be made in the measuring process. Allowance must be made for the voltage drop across current-measuring circuits and for the current taken by voltage-measuring circuits, if these are significant.

6.6.9 Small signal

A signal should be considered small if a two-to-one increase in its magnitude does not produce a change in the value being measured that is greater than the permitted error of measurement.

6.6.10 Pulse measurements

For measurements using pulse technique, when duty factor, pulse duration and repetition frequency are not specified, these should be so chosen that the change in the value being measured is not greater than the permitted error of measurement when each of the following is independently applied:

a) the pulse duty factor is doubled;
b) the pulse duration is doubled;
c) the pulse repetition frequency is halved.

7 Acceptance and reliability of discrete devices

7.1 General

Acceptance and reliability testing may be used where appropriate to augment, but not to replace, adequate manufacturing process control. ISO 9000 details minimum quality requirements.

For devices supplied under the IECQ system, this testing is prescribed in the relevant parts of these publications.

NOTE 1 The endurance tests given in 7.2 and many of the mechanical and climatic test methods included in IEC 60749 are suitable for use for acceptance and reliability purposes.

NOTE 2 For the presentation of reliability information resulting from tests on semiconductor devices, see IEC 60319.

7.2 Electrical endurance tests

7.2.1 General

Appropriate endurance tests, the failure-defining characteristics and the failure criteria are specified in the relevant part of these publications for each category of device. This clause contains the general requirements applicable to all device categories.

When applied for more than 200 h, the tests are considered to be destructive.

NOTE These tests should not be confused with "burn-in" which is sometimes applied 100 % as part of the device manufacturing process.

7.2.2 Mode of operation

The device shall be operated under steady-state (d.c., a.c. or dynamic, as appropriate) conditions in the specified circuit configuration. In some cases, intermittent or other modes of operation may be specified.

7.2.3 Mounting conditions

7.2.3.1 Ambient-rated devices

The free lead length between case and electrical contacts or support(s) should be preferably not less than 5 mm for single-ended or for double-ended devices. Devices with lead lengths less than 5 mm shall be mounted in accordance with the manufacturers' recommendations. The support(s) shall be maintained at a temperature within the ambient operating temperature tolerance.

7.2.3.2 Case-rated devices

The devices shall be mounted so that the specified case temperature is maintained.

7.2.4 Operating temperature

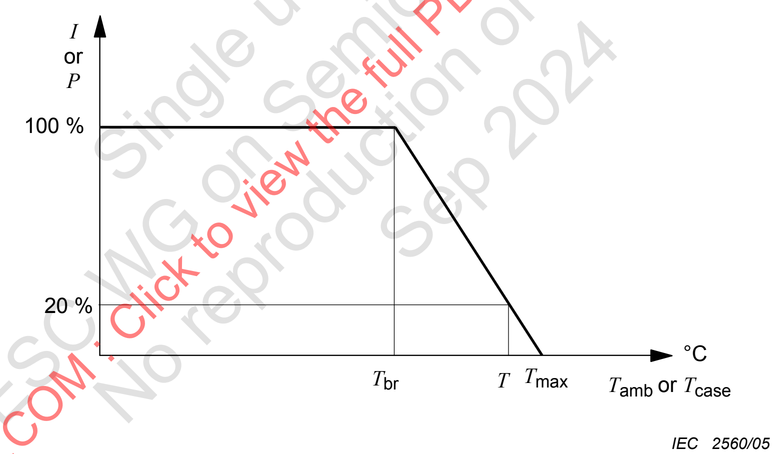


Figure 2 – Derating curve

The operating temperature shall be specified at a point between T_{br} and T (see Figure 2). Temperature ~~I~~ T corresponds to the 20 % point as shown in Figure 2.

The operating temperature shall be maintained within ±5 °C for ambient-rated devices. For case-rated devices, the average of the temperatures of the cases shall be maintained within ±5 °C and any individual case temperature shall be maintained within ±10 °C of the specified operating temperature.

NOTE This operating temperature may be reached partly by dissipation of the device and partly by the ambient temperature.

7.2.5 Operating voltage

The operating voltage should be that recommended in the relevant part of IEC 60747 and IEC 60748. Initial tolerances and any variations during operation shall be within ±5 % for d.c. voltages and ±10 % for a.c. or pulse voltages.

7.2.6 Power dissipation or current

The devices under test shall be operated with power dissipation or current according to the derating curve (see Figure 2), except in the case of the high-temperature blocking or reverse bias test. Initial tolerances and any variations during operation shall be within ±5 % for d.c. power or current and ±10 % for a.c. or pulse power or current.

7.2.7 Additional tests

If an indication of the variation in failure rate with operating conditions is needed, the combinations of voltage and power dissipation or current shown in Table 2 are recommended.

Table 2 – Failure rate operating conditions

Operating voltage	Power dissipation or current
100 %	50 % 20 %
50 %	100 % 50 % 20 %
20 %	100 % 50 %

NOTE 1 The 100 % values refer to those recommended in the relevant publication part for the category of device.

NOTE 2 Some stress combinations listed above cannot be safely applied to some device classes or types. Any specified test conditions should be chosen to be within the safe operating area (avoiding thermal runaway and/or second breakdown) for the category of device under test.

7.2.8 Duration of test

The duration of the test should be selected from the following list:

160^{+8}_{-0} h	$1\,000^{+36}_{-30}$ h
336^{+16}_{-20} h	$2\,000$ h $^{+84}_{-84}$
	$5\,000$ h $^{+84}_{-84}$
672^{+20}_{-30} h	$10\,000$ h $^{+84}_{-84}$

If intermediate measurements are made, they should also be performed at the times given in the above list and the test conditions should be re-applied within 8 h. The duration of the measurements should not be included in the duration of the test.

Where the duration is defined by a number of cycles, the sequence 1, 2 or 5 × 10^n, where n is an integer (including zero) shall be used.

Final measurements should be measured within 96 h of removal of the devices from the test.

7.2.9 Measurements

Measurements shall be made at an ambient or reference-point temperature of 25 ± 5 °C.

Characteristics shall be measured in the sequence in which they are listed, as the changes of characteristics caused by some failure mechanisms may be wholly or partly masked by the influence of other measurements.

For attributes testing, data may be taken by making measurements on a go/no-go basis (measured values are compared with failure criteria, and each device is considered to have passed or failed). For variables testing, the devices shall be individually identified and the value of each specified characteristic of each device shall be measured.

7.2.10 Definition of failure

A device, which after test does not meet the limits specified for one or more of the characteristics for its device category, is considered to be a failure. In presenting the data, the number of short-circuited and open-circuited devices should be given in addition to the total number of failures.

A short-circuited device is a device that no longer performs its required function and exhibits a quasi-resistive low-impedance characteristic.

NOTE The particular limit value which defines a short-circuit failure should be given in the data sheet. Manufacturers may at their own discretion insert any test limits applied before carrying out acceptance tests, to ensure that the devices meet their published data sheet limits after the acceptance test has been applied.

7.2.11 Precautions

7.2.11.1 Loss or removal of bias during test

Bias voltages and/or currents shall be supplied to devices for a total time equal to the specified test time (within the allowed tolerance). It is preferable that voltage bias(es) continue to be applied to devices until they have cooled to room temperature, unless it can be established for the given device type and test conditions that no significant change of characteristics occurs when the device is cooled with the bias removed.

7.2.11.2 Over-temperature of ovens or other heat sources

Devices may be destroyed or damaged if heat-source temperature controls fail during a test; therefore, heat sources should be equipped with redundant over-temperature controls to limit the maximum temperature.

7.2.11.3 Static-electricity discharges and electromagnetic fields

Precautions should be taken regarding apparatus and personnel to avoid devices being destroyed or damaged by high electrostatic voltages and large electromagnetic fields.

7.2.11.4 Oscillation suppression and current limiting

Devices may be destroyed or damaged by oscillations in the circuit while under test. The presence of oscillations may be detected by the use of a wideband oscilloscope. These oscillations may be suppressed by adding shunt capacitor(s) and/or series inductor(s) and resistor(s) to the test circuits.

Devices may also be destroyed or damaged by thermal runaway occurring during a test. Such damage may be avoided by providing fixed resistor(s) that will limit the device dissipation during runaway. Such resistor(s) should be provided for each device rather than for groups of devices, so that bias will not be removed from or reduced on all devices in a group if one device becomes a short circuit. When such resistor(s) are placed close to device terminals, they will frequently function also as oscillation suppressors.

When any resistance is included in the circuit for any purpose, the bias at the device terminals shall be as specified when the device is at thermal equilibrium under the specified test conditions.

7.2.12 Procedure in case of a testing error

The results of tests carried out using inaccurate or faulty test equipment or where operator error is suspected, shall not be included for the purpose of device assessment.

8 Electrostatic-sensitive devices

The definitive standard for the handling of electrostatic sensitive devices is IEC 61340.

This clause provides requirements for labelling of electrostatic sensitive devices and packaging. They are applicable to discrete devices and integrated circuits.

8.1 Label and symbol

A distinctive symbol to be used for those electrostatic sensitive devices that require special handling is shown in Figure 4a. The symbol or label should be used at the innermost practical level of packaging and on the device itself if space permits. It may also be used on device data sheets, on storage bins, and on special protective wrapping materials. The symbol is intended for use where available space does not permit the use of a label.

8.1.1 Device marking

If space does not permit the full symbol to be used, the device may be marked with the simplified version of the symbol shown in Figure 4b. When used as a device marking, monochromatic reproduction in any colour that contrasts with the background may be used. Wherever possible, the colour red for the symbol should be avoided as red suggests a personnel hazard. If used elsewhere, the symbol should be black on a yellow background.

8.1.2 Label

The label comprises the symbol with the words: “ATTENTION – Observe precautions for handling – ELECTROSTATIC SENSITIVE DEVICES”. The symbol and lettering should be black on a yellow background.

Figure 3a – Basic symbol

Figure 3b – Simplified version for extreme reduction

Figure 3 – Symbol to be used for the electrostatic sensitive devices that require special handling

8.2 Test methods for semiconductor devices sensitive to voltage pulses of short duration

A number of types of semiconductor device are sensitive to voltage pulses of short duration such as those caused by electrostatic discharge occurring during normal handling.

The test method described in IEC 60749-26 may be used to determine whether the devices are sensitive to the degree that they require special handling precautions and the use of a label and symbol.

The test is regarded as destructive.

9 Product discontinuance notification

9.1 Definitions

9.1.1 Product

A type of semiconductor (for example, packaged semiconductor, wafer, die, etc.).

9.1.2 Product discontinuance

To cancel the supply of a product.

9.1.3 Affected customer

A customer that has placed a purchase order with a supplier within the preceding two years for a product which is to be discontinued, or that has indicated formally to the supplier within the past year the intention to use product in an application, or a customer that has an agreement with the supplier to receive all discontinuation notifications.

9.2 General aspects for discontinuation

The affected customers should receive notification that requires acknowledgement (active information) and can place a last purchase order, to assure a stock for future use of the product.

Distributors receive notification as affected customers and can purchase a stock for continued supply or can give discontinuance notification to their customers.

Contract manufacturers receive notification as affected customers and shall inform their customer to decide on replacement or on a last purchase order.

Last purchase orders are different from normal orders: a last purchase order is irrevocable, and, in case of quality problems, there is no guarantee of replacement products.

9.3 Information for the discontinuance notification

The following information is required.

a) Date when the supply will be discontinued.
b) Date for the last purchase order. The period between the date of notification and the date for the last purchase order is at least 6 months.
c) Delivery time limit: a delayed delivery of maximum 6 months following the date of the last purchase order is possible on request from the customer.
d) Type number of product to be discontinued.
e) Reason for planned product discontinuance. Indicates whether a product will no longer be manufactured, or whether it is simply no longer being marketed in a given geographical area.
f) The contact person of the supplier of the discontinued product for information about the discontinuation.

The following additional information may be given.

g) Where known, the type number for the replacement product and its supplier.
h) Possibility for affected customers to buy the rights of manufacturing and design.

9.4 Notification

9.4.1 Active information

The discontinuance notification shall be communicated direct by the supplier to the agreed contact person of each affected customer. For each customer, the customer part number will be indicated, where applicable.

9.4.2 Passive information

The manufacturer should provide the product discontinuance notifications on the Internet. This should include downloadable lists of discontinued products.

9.5 Retention

Product information (including discontinuance notifications) shall be kept for at least three years after the last sales date.

Annex A
(informative)

Presentation of IEC 60747 and IEC 60748

IEC 60747 covers semiconductor devices, primarily discrete ones but also contains some information relevant to integrated circuits. IEC 60748 covers integrated circuits. Each publication consists of a number of separately issued parts: IEC 60747-1, IEC 60747-2, etc, and IEC 60748-1, IEC 60748-2 etc, and each part either provides the standard for a defined category of semiconductor device or mandatory specifications for use in the IECQ system for quality assessment of semiconductor devices (or both).

A.1 Scope of the parts of IEC 60747

A.1.1 IEC 60747-1

(For details, refer to Clause 1.)

A.1.2 The majority of the subsequent parts (IEC 60747-2, IEC 60747-3, etc)

These are the standards for the various categories of discrete semiconductor device, (for example, diode, transistor, etc.), and each provides information and requirements that are valid for that category in addition to the general requirements given herein. They contain the information considered a necessary minimum for device use and interchangeability.

Occasionally, a part is divided into separately published subparts identified with a second suffix, for example, IEC 60747-2-1.

A.1.3 The remaining parts of IEC 60747

These are dedicated to the IECQ quality assessment system. They include the Generic Specification for all semiconductor devices and the Sectional and Blank Detail Specifications for discrete semiconductors. These parts do not necessarily follow the presentation rules given in Clause A.3. Unlike the parts described in A.1.2, these parts are mandatory minimum requirements for devices in the IECQ system. See QC 001002.

NOTE These standards can be recognized by the use of the word "specification" in the title.

A.2 Scope of the parts of IEC 60748

A.2.1 IEC 60748-1

This provides information and requirements that are valid for all integrated circuits in addition to the general requirements given herein.

A.2.2 The majority of the subsequent parts of IEC 60748

These contain the standards for the various categories of integrated circuit (for example, digital, interface, etc.) and each provides information and requirements that are valid for that category in addition to the general requirements given herein.