

Semiconductor devices: discrete devices and integrated circuits —

Part 1: Discrete devices —

Section 1.1 General

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- Electronic Components Industry Federation
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National foreword

This British Standard has been prepared under the direction of the Electronic Components Standards Committee. It is identical with IEC Publication 60747-1 “*Semiconductor devices — Discrete devices and integrated circuits — Part 1: General*”, including amendments 1:1991, 2:1993 and 3:1996, published by the International Electrotechnical Commission (IEC).

This British Standard constitutes Section 1.1 of the British Standard for semiconductor devices (BS 6493). BS 6493 is identical with IEC Publications 747, 748 and 749 and will be issued in a series of separately published Sections corresponding to the individual Parts of the IEC publications. This Section constitutes the general recommendations for discrete devices. Some of the material is also applicable to integrated circuits, the separately published Sections of which, constitute Part 2 of this standard. Further Sections of Part 1 will cover specific categories of discrete devices.

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the changeover from one numbering system to the other, publications may contain identifiers from both systems.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** **A1**. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by **A1** **A1**.

Cross references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index” or by using the “Find” facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 57 and a back cover.

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Chapter I. Scope and presentation of IEC publications 747 and 748

1 Publications 747

1.1 Scope

Publications 747 are intended to give:

- standards that are generally valid for discrete devices as well as for integrated circuits;
- additional standards to complete the set of standards for discrete devices.

1.2 Presentation

Publications 747 are made up of several parts which are issued as separate Publications 747-1, 747-2, etc. They are kept up to date by the issue of supplements, for example, Publication 747-1A.

2 Publications 748

2.1 Scope

Publications 748 should be read in conjunction with Publication 747-1 and are intended to give standards for integrated circuits.

2.2 Presentation

Publications 748 are made up of several parts which are issued as separate Publications 748-1, 748-2, etc. They are kept up to date by the issue of supplements, for example, Publication 748-2A.

Chapter II. Purpose and presentation of publication 747-1

1 Purpose

- To provide general information on scope and presentation of the Publications 747 and 748 (see Chapter I).
- To provide information on the general principles or requirements applicable to Publications 747-2, 747-3, etc., which are the standards for the various categories or sub-categories of discrete devices.

2 Presentation

The information on general principles or requirements is presented in Chapters III to IX of the present publication.

NOTE Contents of Chapters III to IX:

- Chapter III: Purpose, presentation and requirements on the contents of Publications 747-2, 747-3, etc.

Essentially, it provides a standard format for these publications.

- Chapter IV: Terminology, general.

Contains a list of basic terms and definitions that are necessary for the understanding of Publications 747 and 748.

- Chapter V: Letter symbols, general.

Provides a system of letter symbols to be used in the field of discrete devices and integrated circuits.

- Chapter VI: Essential ratings and characteristics, general.

Provides in particular:

- general clauses on electrical, mechanical and thermal requirements,
- a standard format for the presentation of published data,
- working definitions for “rating” terms,
- lists recommended temperatures, voltages and currents.

- Chapter VII: General and reference measuring methods, general.

Provides general information, especially on the necessary precautions to be taken in order to achieve reproducible and comparable results.

- Chapter VIII: Acceptance and reliability of discrete devices, general.

Provides general requirements and a prescription on the specific requirements that have to be given for the various categories or sub-categories of discrete devices.

- Chapter IX: Electrostatic-sensitive devices.

Provides requirements for handling and labelling of electrostatic sensitive devices which are valid for discrete devices and integrated circuits.

Chapter III. Purpose, presentation and requirements on the contents of publications 747-2, 747-3, etc.

1 Purpose of each part

For a particular device category, to provide such information and requirements that are valid in addition to the general standards of Publication 747-1.

2 Presentation of each part

2.1 Subdivision into chapters

The contents of each part are subdivided as follows:

- Chapter I: General.
- Chapter II: Terminology and letter symbols.
- Chapter III: Essential ratings and characteristics.
- Chapter IV: Measuring methods.
- Chapter V: Acceptance and reliability.

2.2 Subdivision into device sub-categories

The device category dealt with within a part is usually subdivided into several sub-categories. In this case, Chapters III and V (see Sub-clause 2.1) are subdivided into corresponding sections. Chapters I, II and IV are usually given without such a device-oriented subdivision.

3 Requirements on the different chapters of each part

3.1 Requirements on Chapter I, General

3.1.1 Purpose

To provide general information that, in principle, is applicable for the relevant part only, but exceeds the limited scope for each of the remaining chapters of this part.

3.2 Requirements on Chapter II, Terminology and letter symbols

3.2.1 Purpose

For the device category as a whole:

- a) to provide those special terms and definitions that are needed, in addition to those given in Publication 747-1, to understand the standards;
- b) to give the recommended letter symbols.

3.2.2 Validity of terms, definitions and letter symbols

Some of the terms defined in Chapter II may already be defined as general terms in Chapter IV of the present publication. However, the wording of such a definition given may be slightly different to better adapt it to the special properties in this device category.

In principle, the terms, definitions and letter symbols given in Chapter II are valid for all devices belonging to the relevant device category. However, further restrictions for one or more sub-categories may be necessary and are marked correspondingly.

3.2.3 Letter symbols

The letter symbols are composed according to the general rules for a system of letter symbols, given in Chapter V of the present publication.

3.3 Requirements on Chapter III, Essential ratings and characteristics

3.3.1 Purpose

To provide for each particular sub-category a list of essential ratings and characteristics that should be supplied by any manufacturer when describing his product. This list contains only the information considered to be essential for device interchangeability. A manufacturer may give additional information if he wishes.

3.4 Requirements on Chapter IV, Measuring methods

3.4.1 Purpose

For the whole of the relevant device category:

- to prescribe the principles of those measuring methods that are needed for the measurement of the required essential characteristics;
- to prescribe test methods for the verification of some selected ratings (limiting values).

3.5 Requirements on Chapter V, Acceptance and reliability

3.5.1 Purpose

To prescribe for each of the sub-categories which acceptance and/or reliability tests are applicable. All necessary details on these tests must be given in accordance with the rules established in the present publication, Chapter VIII.

Chapter IV. Terminology, general

1 Introduction

The terms and definitions contained in the present publication:

- either correspond to the general terms and definitions of IEC Publication 50: International Electrotechnical Vocabulary (IEV), using, in some cases, a specialized wording,
- or have been specifically approved for the purpose of Publications 747 and 748.

2 Physical terms

2.1 Semiconductor

A material with resistivity usually in the range between metals and insulators, in which the electrical charge carrier concentration increases with increasing temperature over some temperature range.

2.2 Extrinsic semiconductor

A semiconductor with charge carrier concentration dependent upon impurities or other imperfections.

2.3 N-type semiconductor

Extrinsic semiconductor in which the conduction electron density exceeds the mobile hole density.

2.4 P-type semiconductor

Extrinsic semiconductor in which the mobile hole density exceeds the conduction electron density.

2.5 I-type (intrinsic) semiconductor

Nearly pure and ideal semiconductor in which the electron and hole densities are nearly equal under conditions of thermal equilibrium.

2.6 Junction

A region of transition between semiconducting regions of different electrical properties.

2.7 PN junction

A junction between P and N-type semiconductor material.

2.8 Alloyed junction

A junction formed by alloying one or more materials to a semiconductor crystal.

2.9 Diffused junction

A junction formed by the diffusion of an impurity within a semiconductor crystal.

2.10 Grown junction

A junction produced during the growth of a semiconductor crystal from a melt.

A₁

2.11 Forward characteristics (of a PN junction)

2.11.1 Forward current

The current flowing from the P-type to the N-type region.

2.11.2 Forward voltage

The voltage between the P-type region and the N-type region when the P-type region is at a positive voltage relative to the N-type region.

2.11.3 Forward direction

The direction of a (positive) forward current.

2.12 Reverse characteristics (of a PN junction)

2.12.1 Reverse current

The current flowing from the N-type region to the P-type region.

2.12.2 Reverse voltage

The voltage between the N-type region and the P-type region when the N-type region is at a positive voltage relative to the P-type region.

2.12.3 *Reverse direction*

The direction of a (positive) reverse current. $\langle A_1 \rangle$

2.13 **Charge carrier (abbreviation: carrier)**

In a semiconductor, a mobile (free) conduction electron or mobile hole.

2.14 **Majority carrier (in a semiconductor region)**

The type of carrier constituting more than half of the total charge carrier concentration.

2.15 **Minority carrier (in a semiconductor region)**

The type of carrier constituting less than half of the total charge carrier concentration.

$\langle A_1 \rangle$

2.16 **Layers**

NOTE The charge-carrier attraction as referred to below may be due to a field-plate voltage as in field-effect transistors, or it may be due to charge residing in surface states, insulation layers, or surface ionic carriers.

2.16.1 *Depletion layer associated with a surface*

A surface region of a semiconductor device whose conductivity type is the same as that produced by the net fixed-charge density of ionized donors and acceptors, but whose net carrier density is insufficient for neutralization due to charge-carrier attraction.

2.16.2 *Accumulation layer, enhancement layer associated with a surface*

A surface region of a semiconductor device whose conductivity type is the same as that produced by the net fixed-charge density of ionized donors and acceptors, and whose net carrier density is higher than that necessary for neutralization due to charge-carrier attraction.

2.16.3 *Inversion layer associated with a surface*

A surface region of a semiconductor device whose conductivity type has been reversed from that produced by the net fixed-charge density of ionized donors and acceptors due to charge-carrier attraction. $\langle A_1 \rangle$

2.17 **Breakdown (of a reverse-biased PN junction)**

A phenomenon, the initiation of which is observed as a transition from a state of high dynamic resistance to a state of substantially lower dynamic resistance for increasing magnitude of reverse current.

2.18 **Avalanche breakdown (of a semiconductor PN junction)**

A breakdown that is caused by the cumulative multiplication of free charge carriers in a semiconductor under the action of a strong electric field which causes some free carriers to gain enough energy to liberate new hole-electron pairs by ionization.

2.19 **Avalanche voltage**

The applied voltage at which avalanche breakdown occurs.

2.20 **Thermal breakdown (of a semiconductor PN junction)**

A breakdown that is caused by the generation of free charge carriers owing to the cumulative interaction between increasing power dissipation and increasing junction temperature.

NOTE This effect is also known as thermal runaway in some countries.

2.21 **Zener breakdown (of a semiconductor PN junction)**

A breakdown caused by the transition of electrons from the valence band to the conduction band due to tunnel action under the influence of a strong electric field.

2.22 **Zener voltage**

The applied voltage at which Zener breakdown occurs.

2.23 **Tunnel effect**

The piercing of a potential hill by a carrier, which would be impossible according to classical mechanics, but the probability of which is not zero according to wave mechanics, if the width of the hill is small enough. The wave associated with the carrier is almost totally reflected on the first slope, but a small fraction crosses the hill.

2.24 Tunnel action (in a PN junction)

A process whereby conduction occurs through the potential barrier due to the tunnel effect and in which electrons pass in either direction between the conduction band in the N-region and the valence band in the P-region.

NOTE Tunnel action, unlike the diffusion of charge carriers, involves electrons only and for all practical purposes the transit time is negligible.

2.25 Hall effect

Non-uniformity of the electric conduction in a conductor or a semiconductor caused by magnetization normal to the current density vector. The latter, instead of being parallel to the electric field, forms an angle with it.

2.26 Hall coefficient (of a semiconductor)

(Hall constant: deprecated)

The coefficient of proportionality R in the relation:

$$\vec{E}_h = R (\vec{J} \times \vec{B})$$

where: $\vec{E}_h$ is the resulting transverse electric field

$\vec{J}$ is the current density

$\vec{B}$ is the magnetic flux density

NOTE The sign of the majority carrier charge can usually be inferred from the sign of the Hall coefficient.

2.27 Photo-electric effect

Interaction between radiation and matter resulting in the absorption of photons and the consequent generation of mobile charge carriers.

2.28 Photovoltaic effect

A photo-electric effect wherein an electromotive force is generated.

A1

2.29 Transferred-electron effect

The generation of bulk negative differential conductivity in compound semiconductor devices that have multiple energy valleys when the applied electrical field is greater than the critical value at which electrons transfer from:

- a lower energy valley in which they have greater mobility and smaller effective mass;
- a higher energy valley in which they have smaller mobility and greater effective mass.

NOTE The term “energy valley” refers to a valley in an energy versus momentum profile. **A1**

A1

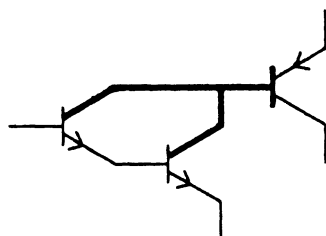
3 General terms

3.1 Terms related to structure

3.1.1 Electrode (of a semiconductor device)

An element that performs one or more of the functions of emitting or collecting electrons or holes, or of controlling their movements.

Example:



In this example of a portion of an integrated circuit, there are three electrodes in the one continuous N-region represented by the heavy line.

Figure 6

3.1.2 Wafer

A slice of flat disc, either of semiconductor material or of such a material deposited on a substrate, in which one or more circuits or devices are simultaneously processed and which may be subsequently separated into chips.

3.1.3 Chip, (die)

A separated part (or whole) of a wafer intended to perform a function or functions in a device.

3.1.4 Pad

An area on a chip (die) to which a connection to the chip (die) can be made.

3.1.5 Bonding wire

A 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.

3.1.6 Lead frame (of a package)

A metal frame providing terminals and mechanical support to align them.

3.1.7 Terminal (of a semiconductor device)

An externally available point of connection.

NOTE The usage of the term “termination” as a synonym is deprecated since that term denotes the external elements connected to the terminal.

3.1.8 Base (of a package)

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

3.1.9 Cap, can, lid, plug

The part of a cavity package that completes its enclosure.

NOTE The particular term used depends on the package design.

3.1.10 Package, case

An enclosure for one or more semiconductor chips (dice), film elements or other components, that allows electrical connection and provides mechanical and environmental protection.

3.1.11 Heat sink, (heat dissipator)

A separable element or integral part of the package that contributes to the dissipation of the heat produced within the package.

3.2 Terms related to process

3.2.1 Vapour-phase deposition technique

The deposition of conducting, insulating or semiconducting films onto solid substrates from a source material in the vapour phase by physical deposition or chemical reaction.

3.2.2 *Screen-printing technique*

The deposition of conducting, insulating or semiconducting films onto solid substrates by pressing pastes (inks) through screens.

3.3 **Anode terminal (of a semiconductor diode, excluding current-regulator diodes)**

The 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.

3.4 **Cathode terminal (of a semiconductor diode, excluding current-regulator diodes)**

The 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.

3.5 **Anode terminal (of a current-regulator diode)**

The terminal to which current flows from the external circuit when the diode is biased to operate as a current regulator.

3.6 **Cathode terminal (of a current-regulator diode)**

The terminal from which current flows into the external circuit when the diode is biased to operate as a current regulator. A_1

A_2

3.7 Concepts referring to elements and circuits

3.7.1 *Circuit*

A network providing one or more closed paths.

3.7.2 *Circuit element*

Any constituent part of a circuit that contributes directly to its operation and performs a definable function.

NOTE The definition includes interconnection means between circuit elements, or between circuit elements and terminals.

3.7.3 *Circuit parameters*

The values of physical quantities or of characteristics derived therefrom that are associated with the circuit elements.

EXAMPLES

The resistance of a resistor.

The current amplification of a transistor.

3.7.4 *Equivalent circuit*

An arrangement of circuit elements that has characteristics, over a range of interest, electrically equivalent to those of a particular circuit or device.

NOTE In many useful applications, the equivalent circuit replaces (for convenience of analysis) a more complicated circuit or device.

3.7.5 *Equivalent circuit element*

An element of the equivalent circuit.

3.7.6 *Film circuit element*

A circuit element consisting of a film or films.

3.8 Concepts referring to active and passive elements, components or devices

3.8.1 *Passive circuit element*

A circuit element primarily contributing resistance, capacitance, inductance, ohmic interconnection, wave-guiding, or a combination of these, to a circuit function.

EXAMPLES

Resistors, capacitors, inductors, passive filters, interconnections.

3.8.2 *Active circuit element*

A circuit element that contributes still 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.

3.8.3 *Passive component (of a hybrid integrated circuit)*

A component in which all circuit elements are passive.

3.8.4 *Active component (of a hybrid integrated circuit)*

A component in which at least one circuit element is an active circuit element.

3.8.5 *Passive device*

A device in which all circuit elements are passive.

3.8.6 *Active device*

A device in which at least one circuit element is an active circuit element.

3.8.7 *Parasitic circuit element*

An unwanted circuit element that is an unavoidable adjunct of one or more wanted circuit elements.

3.9 Concepts relating to components

3.9.1 *Component (of a hybrid integrated circuit)*

A material part that is mounted within the package and that contributes to the composition of the circuit.

NOTE For electronic components, distinction is made between integrated components and discrete components.

3.9.2 *Integrated component (of a hybrid integrated circuit)*

An integrated circuit, completed or partially completed, that serves as a component of the circuit.

3.9.3 *Discrete component (of a hybrid integrated circuit)*

A discrete device, completed or partially completed, that serves as a component of the device.

3.9.4 *Partially completed component (of a hybrid integrated circuit)*

A component taken uncompleted from its production line.

NOTE It cannot be used for complete assessment to the specification applicable in its normal finished state.

3.9.5 *Partially completed integrated circuit (of a hybrid integrated circuit)*

An integrated circuit taken uncompleted from its production line.

NOTE It cannot be used for complete assessment to the specification applicable in its normal finished state. 

4 Types of devices



4.1.1 *Semiconductor device (general term)*

A device whose essential characteristics are due to the flow of charge carriers within a semiconductor.

NOTE 1 The definition includes devices whose essential characteristics are only in part due to the flow of charge carriers in a semiconductor but that are considered as semiconductor devices for the purpose of specification.

NOTE 2 For specification purposes, a semiconductor device is considered either as a discrete (semiconductor) device or as an integrated circuit.

4.1.2 *Discrete (semiconductor) device*

A semiconductor device that is specified to perform an elementary electronic function and that is not divisible into separate components functional in themselves.

NOTE 1 There is no clear delimitation possible between discrete devices and integrated circuits. In principle, a discrete device consists of a single circuit element only. However, a device sold and specified as a discrete device may internally consist of more than one circuit element.

NOTE 2 If a semiconductor device is not considered to be an integrated circuit in both complexity and functionality, it is considered to be a discrete device. ^(A2)

^(A1)

4.2 Electrostatic-discharge-sensitive device

A discrete device or integrated circuit that may be permanently damaged by electrostatic potentials encountered in routine handling, testing and shipping.

The abbreviations to be used are:

- ESDS for electrostatic-discharge-sensitive device;
- ESD for electrostatic discharge.

The use of the abbreviation ESSD is deprecated. ^(A1)

4.3 Semiconductor diode, diode

A two-terminal semiconductor device having an asymmetrical voltage-current characteristic.

NOTE Unless otherwise qualified, this term usually means a device with the voltage-current characteristic typical of a single PN junction.

4.4 Semiconductor rectifier diode, rectifier diode

A semiconductor diode designed for rectification and including its associated mounting and cooling attachments if integral with it.

4.5 Semiconductor rectifier stack

A single structure of one or more rectifier diodes with its (or their) associated mounting(s), cooling attachments, if any, and connections whether electrical or mechanical.

4.6 Avalanche rectifier diode

A rectifier diode which has stated minimum breakdown voltage characteristics and is rated to dissipate power surges for a limited time in the breakdown region of its reverse characteristic.

4.7 Controlled-avalanche rectifier diode

A rectifier diode which has stated maximum and minimum breakdown voltage characteristics and is rated to operate under steady-state conditions in the breakdown region of its reverse characteristic.

4.8 Signal diode

A diode used for the purpose of extracting or processing information contained in an electrical signal which varies with time and may be either analogue or digital in nature.

4.9 Snap-off (step recovery) diode

A semiconductor diode that stores charge under forward bias and recovers from subsequent reverse-bias conduction in an abrupt (step) fashion, thereby causing an abrupt transition of its terminal impedance.

4.10 Voltage-reference diode

A diode which develops across its terminals a reference voltage of specified accuracy, when biased to operate within a specified current range.

4.11 Voltage-regulator diode

A diode which develops across its terminals an essentially constant voltage throughout a specified current range.

4.12 Current-regulator diode

A diode that limits current to an essentially constant value over a specified voltage range.

4.13 Microwave switching diode

A semiconductor diode that exhibits a fast transition from a high-impedance state to a low-resistance state and vice versa, depending on the d.c. bias voltage or current applied to the diode, thus representing at microwave frequencies a high or low impedance, respectively, which enables it to pass or interrupt microwave signals.

4.14 Microwave limiting diode

A semiconductor diode that exhibits a fast transition from a high-impedance state to a low-resistance state and vice versa, depending on the r.f. power level delivered to the diode, thus representing at microwave frequencies a high or a low impedance, respectively, which enables it to limit or suppress unwanted microwave energy.

4.15 Variable-capacitance diode

A semiconductor diode, the terminal capacitance of which varies in a defined manner as a function of applied voltage when biased in the reverse direction, and that is intended for specific applications of this capacitance-voltage relationship.

4.15.1 Tuning variable-capacitance diode

A variable-capacitance diode, the capacitance-voltage relationship of which is especially suitable for tuning high- Q resonant circuits, and that is usually characterized by a frequency of series resonance and a cut-off frequency, each much higher than the frequency of use.

4.15.2 Harmonic generation variable-capacitance diode

A variable-capacitance diode intended to be used as a frequency multiplier by means of its non-linear capacitance-voltage characteristic. The voltage swing may extend into the forward direction.

4.15.3 Parametric amplifier variable-capacitance diode

A variable-capacitance diode with a negative resistance generated by “pumping” the diode with local power and used for amplifying signals of small amplitude in low-noise parametric amplifiers.

4.15.4 Frequency up-converter variable-capacitance diode

A variable-capacitance diode with a voltage-dependent non-linear capacitance, “pumped” by local power and used as a frequency up-converter.

4.16 Avalanche transit-time diode

A diode that exhibits negative output resistance at microwave frequencies caused by the combined effects of the avalanche multiplication and the transit-time effect.

4.16.1 IMPATT diode (avalanche transit-time diode in the IMPATT mode)

A semiconductor microwave diode that, when its junction is biased into avalanche, exhibits a negative resistance over a frequency range determined by the transit time of charge carriers with saturation limited velocity through the depletion region.

NOTE The acronym “IMPATT” is derived from *Impact Avalanche and Transit Time*.

4.16.2 TRAPATT diode (avalanche transit-time diode in the TRAPATT mode)

A semiconductor microwave diode that, when its junction is biased into avalanche, exhibits a negative resistance at frequencies below the transit-time frequency range of the diode due to generation and dissipation of trapped electron-hole plasma resulting from the intimate interaction between the diode and a multiresonant microwave cavity.

NOTE 1 The acronym “TRAPATT” is derived from *Trapped Plasma Avalanche Transit Time*.

NOTE 2 The “transit-time frequency range of the diode” is the frequency range determined by the transit time of charge carriers with saturation limited velocity through the depletion region of the diode.

4.17 Tunnel diode

A diode having a PN junction in which tunnel action occurs giving rise to negative differential conductance in a certain range of the forward direction of the current-voltage characteristic.

4.18 Unitunnel diode (backward diode)

A tunnel diode whose peak and valley point currents are approximately equal.

4.19 Photoconductive cell

A device in which the photoconductive effect is utilized.

4.20 Photovoltaic cell

A device in which the photovoltaic effect is utilized.

4.21 Photodiode

A diode in which the photoelectric effect is utilized.

4.22 Phototransistor

A transistor in which the photoelectric effect is utilized.

4.23 Thyristor

A bi-stable semiconductor device comprising three or more junctions which can be switched from the off-state to the on-state or vice versa.

NOTE 1 The term "thyristor" is used as a generic term to cover the whole range of PNPN type switches.

It may be used by itself for any member of the thyristor family when such use does not result in ambiguity or misunderstanding. In particular, the abbreviated term "thyristor" is widely used for the reverse blocking triode thyristor, formerly called "semiconductor controlled rectifier".

NOTE 2 Devices having only three layers but having switching characteristics similar to those of four-layer thyristors may also be called thyristors.

A1

4.24 Transistor (see also chapter II, clause 1)

A semiconductor device capable of providing power amplification and having three or more electrodes.

NOTE Other names may be used to describe certain special types of semiconductor devices covered by this definition. **A1**

4.25 Field-effect transistor

A transistor in which the current flowing through a conduction channel is controlled by an electric field arising from a voltage applied between the gate and source terminals.

4.26 Selenium transient overvoltage suppressor

A device utilizing the steep slope of the blocking current-voltage characteristics of selenium plates for limiting transient overvoltages.

NOTE Selenium plate: basic element of a selenium transient overvoltage suppressor consisting of two metal electrodes (base plate and counter-electrode) with a polycrystalline semiconducting selenium layer between them.

Suppressors may be of two types:

a) *Polarized*:

Selenium transient overvoltage suppressor having an asymmetrical current-voltage characteristic.

b) *Non-polarized*:

Selenium transient overvoltage suppressor having a symmetrical current-voltage characteristic.

A1

4.27 Semiconductor modulator diode, modulator diode

A semiconductor diode designed for modulation.

4.28 Semiconductor detector diode, detector diode

A semiconductor diode designed for demodulation. **A1**

A2

4.29 Transferred-electron diode

A semiconductor microwave diode that exhibits negative differential resistance arising from the transferred-electron effect.

4.29.1 Gunn diode

A transferred-electron diode operating at a frequency determined by the transit time of charge packets or domains that are formed due to the transferred-electron effect.

4.29.2 LSA diode (LSA = Limited Space-charge Accumulation)

A transferred-electron diode similar to the Gunn diode, except that it is intended to operate at frequencies that are determined by the microwave cavity in which the diode is mounted and that are several times higher than the transit-time frequency so that the formation of charge packets (or domains) is limited.

NOTE Compared to the Gunn diode, higher output power at higher frequency is achievable. **A2**

5 Terms related to ratings and characteristics

NOTE When several forms of a letter symbol exist, the most commonly used form is given in this clause.

A1

5.1 Currents and voltages

5.1.1 *Forward characteristics (of a semiconductor diode, excluding current-regulator diodes)*

5.1.1.1 *Forward current, anode current*

The current flowing from the external circuit into the anode terminal.

5.1.1.2 *Forward voltage*

The voltage between the anode and the cathode terminals when the anode terminal is at a positive voltage relative to the cathode terminal.

5.1.1.3 *Forward direction*

The direction of a (positive) forward current. **A1**

5.1.2 *Reverse characteristics (of a semiconductor diode, excluding current-regulator diodes)*

5.1.2.1 *Reverse current, cathode current*

The current flowing from the external circuit into the cathode terminal.

5.1.2.2 *Reverse voltage*

The voltage between the cathode and the anode terminals when the cathode terminal is at a positive voltage relative to the anode terminal.

5.1.2.3 *Reverse direction*

The direction of a (positive) reverse current.

5.1.3 *Floating voltage* (V_{fl})

The voltage between an open-circuited terminal and the reference point when a specified voltage is applied to any of the other terminals.

5.1.4 *Breakdown voltage* (V_{BR})

The reverse voltage at which the reverse current through a junction becomes greater than a specified value.

A1

5.1.5 *Leakage current* (I_{lk})

The current through a terminal that results from the application of an external voltage between that terminal and another terminal of a device that would preferably be non-conductive in the circumstances under consideration.

NOTE 1 This general term should be used only if no other adequate and more specific term (e.g. dark current, reverse current, cut-off current) is standardized and applicable.

NOTE 2 In general, this term should not be used for current that consists chiefly of minority carrier current that is necessary for the function of the device. However, exceptions may be made if, for uniformity, the same term is used for different technologies, e.g. the term “leakage current” used for analogue signal switching circuits in any technology.

NOTE 3 The subscript “lk” should be added to other subscripts only if the latter are insufficient to identify the current as leakage current. **A1**

5.2 Temperatures

A1

5.2.1 *Reference-point temperature* (T_{r})

The temperature at a specified reference point on or within a device.

5.2.2 *Case temperature* (T_{c})

The temperature measured by a specified method of a specified reference point, preferably on the case of the device.

NOTE For smaller devices, if the specified reference point is not located on the case but somewhere else on the device (e.g. 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”.

5.2.3 *Storage temperature* (T_{stg})

The temperature at which the device is stored without any voltage being applied.