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**Characteristics and ratings of silicon PN
junction voltage clamping components used for
the protection of telecommunication
installations**

Recommendation ITU-T K.129

ITU-T

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Characteristics and ratings of silicon PN junction voltage clamping components used for the protection of telecommunication installations

Summary

Recommendation ITU-T K.129 defines the basic electrical parameters to be met by silicon PN junction voltage clamping components used for the protection of telecommunication equipment or lines from surges. Examples of equipment include those located within a telecommunication centre, customer premise, access or trunk network. It is intended that this Recommendation be used for the harmonization of existing or future specifications issued by PN diode surge protective component manufacturers, telecommunication equipment manufacturers, administrators or network operators.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Avalanche breakdown, electrical characteristics, electrical ratings, fold-back, forward conduction, overvoltage protection, punch-through, surge protective component (SPC), test methods, Zener breakdown.

* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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Recommendation ITU-T K.129

Characteristics and ratings of silicon PN junction voltage clamping components used for the protection of telecommunication installations

1 Scope

Silicon PN-junction surge protective components (SPCs) are special silicon diodes designed to limit overvoltages and divert surge currents by a voltage clamping action. This Recommendation applies to silicon PN-junction SPCs used in surge protective devices (SPDs) and telecommunication equipment ports to provide overvoltage protection for installations during lightning surges and alternating current (AC) power faults, in accordance with [b-ITU-T K.11]. Telecommunication equipment port test levels and criteria are defined by [b-ITU-T K.20], [b-ITU-T K.21] and [b-ITU-T K.45], as appropriate and are supported by [b-ITU-T K.44] with test circuit details and application guidance. In conjunction, [ITU-T K.103] should be read as it explains the parameters measured or verified in this Recommendation.

The following PN-junction component technologies are covered:

- Zener breakdown;
- avalanche breakdown;
- fold-back;
- punch-through;
- forward conduction.

This Recommendation contains information on:

- a) terminology;
- b) letter and circuit symbols;
- c) essential electrical ratings and characteristics;
- d) rating verification and characteristic measurement;
- f) mechanical requirements and identification.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T K.103] Recommendation ITU-T K.103 (2015), *Surge protective component application guide – Silicon PN junction components*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 acceptor [b-IEC IECV], definition 521-02-39: Imperfection in a crystal lattice which, when it is predominant, permits hole conduction by the acceptance of electrons.



Documents

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3.1.2 ambient temperature [b-IEC TR 62240-1]: Temperature of the environment in which a semiconductor component is operating.

3.1.3 avalanche breakdown (of a PN junction) [b-IEC IEV], definition 521-05-07: Breakdown that is caused by the cumulative multiplication of charge carriers in a semi-conductor under the action of a strong electric field which causes some carriers to gain enough energy to liberate new hole-electron pairs by ionization.

3.1.4 avalanche voltage [b-IEC IEV], definition 521-05-08: Applied voltage at which avalanche breakdown occurs.

3.1.5 bidirectional transistor [b-IEC IEV], definition 521-04-49: Transistor which has substantially the same electrical characteristics when the terminals normally designated as emitter and collector are interchanged.

3.1.6 bipolar junction transistor [b-IEC IEV], definition 521-04-47: Transistor having at least two junctions and whose functioning depends on both majority carriers and minority carriers.

3.1.7 breakdown (of a reverse-biased PN junction) [b-IEC IEV], definition 521-05-06: 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.

3.1.8 breakdown voltage, $V_{(BR)}$ [b-IEC 60747-2]: Voltage in the region where breakdown occurs.

3.1.9 case temperature [b-IEC 60747-1]: Temperature of a reference point, on or near the surface of the case.

3.1.10 conduction electron [b-IEC IEV], definition 521-02-14: Electron in the conduction band of a semiconductor, which is free to flow under the action of an electric field.

3.1.11 donor [b-IEC IEV], definition 521-02-38: Imperfection in a crystal lattice which, when it is predominant, permits electron conduction by the donation of electrons.

3.1.12 extrinsic semiconductor [b-IEC IEV], definition 521-02-08: Semiconductor in which charge carrier concentration depends upon impurities or other imperfections.

3.1.13 forward current, I_F [b-IEC 60747-2]: Current flowing through the diode in forward direction.

3.1.14 forward direction (of a PN junction) [b-IEC IEV], definition 521-05-03: Direction of current that results when the P-type semiconductor region is at a positive voltage relative to the N-type region.

3.1.15 forward recovery voltage, V_{FR} [b-IEC 60747-2]: Varying voltage occurring during the forward recovery time after instantaneous switching from zero or a specified reverse voltage to a specified forward current.

3.1.16 forward voltage, V_F [b-IEC 60747-2]: Voltage across the terminals which results from the flow of current in the forward direction.

3.1.17 hole conduction [b-IEC IEV], definition 521-02-18: Conduction in a semiconductor, in which holes in a crystal lattice are propagated through the lattice under the influence of an electric field.

3.1.18 Kelvin measurement [b-IEC 62624]: Four-wire electrical resistance technique that uses separate contacts for measuring voltage across a device from that used to apply a known current through the device.

NOTE 1 – This separation minimizes current flow through the voltage probes, which minimizes errors due to contact or lead resistance.

NOTE 2 – Used for characterization of materials with electrical resistances comparable to or lower than the leads and contacts.

3.1.19 lead temperature [b-IEC 60747-1]: Temperature of a reference point, on or near the surface of a specified component lead.

3.1.20 N-type semiconductor [b-IEC IEV], definition 521-02-09: Extrinsic semiconductor in which the conduction electron density exceeds the hole density.

3.1.21 peak pulse current (impulse discharge current) [b-IEC 61000-5-5]: Peak value of a specified current waveform.

3.1.22 PN junction [b-IEC IEV], definition 521-02-78: Junction between P and N type semiconductor materials.

3.1.23 P-type semiconductor [b-IEC IEV], definition 521-02-10: Extrinsic semiconductor in which the hole density exceeds the conduction electron density.

3.1.24 punch-through (between two PN junctions) [b-IEC IEV], definition 521-05-12: Contact between the space charge regions of two PN junctions as a result of widening of one or both of them.

3.1.25 reverse current, I_R [b-IEC 60747-2]: Current flowing through the diode when reverse voltage is applied.

3.1.26 reverse direction (of a PN junction) [b-IEC IEV], definition 521-05-04: Direction of current that results when the N-type semiconductor region is at a positive voltage relative to the P-type region.

3.1.27 reverse voltage, V_R [b-IEC 60747-2]: Constant voltage applied to a diode in the reverse direction.

NOTE – This term normally applies to the portion of the reverse characteristic before breakdown occurs.

3.1.28 space-charge region [b-IEC IEV], definition 521-02-79: Region in which the net charge density is not zero.

NOTE – The net charge is caused by electrons, holes, ionized acceptors and donors.

3.1.29 storage temperature [b-IEC 60747-1]: Temperature at which the device may be stored without any voltage being applied.

3.1.30 temperature coefficient of breakdown voltage αV_{BR} [b-IEC 61643-321]: Ratio of the change in breakdown voltage V_{BR} to changes in temperature.

NOTE – Expressed as either millivolts per degree Kelvin or per cent per degree Kelvin (mV/K or %/K).

3.1.31 thermal resistance [b-IEC IEV], definition 521-05-13: Quotient of the difference between the virtual temperature of the device and the temperature of a stated external reference point, by the steady-state power dissipation in the device.

3.1.32 total capacitance [b-IEC 60747-3]: Capacitance at the diode terminals, measured under specified bias conditions.

3.1.33 transient thermal impedance [b-IEC 60747-1]: 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.