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Semiconductor devices –
Part 3: Discrete devices: Signal, switching and regulator diodes
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Dispositifs à semiconducteurs –
Partie 3: Dispositifs discrets: Diodes de signal, diodes de commutation et diodes
régulatrices

IEC 60747-3:2013
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SEMICONDUCTOR DEVICES –

Part 3: Discrete devices: Signal, switching and regulator diodes

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International Standard IEC 60747-3 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

This second edition cancels and replaces the first edition published in 1985, Amendment 1:1991 and Amendment 2:1993. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) All clauses were re-edited to latest IEC publication format and style with all contents from previous publication.
- b) All clauses have been amended by suitable additions and deletions.

This standard is to be read in conjunction with IEC 60747-1:2006 and its Amendment 1 (2010).

The text of this standard is based on the following documents:

FDIS	Report on voting
47E/453/FDIS	47E/455/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

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

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

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this publication 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

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SEMICONDUCTOR DEVICES –

Part 3: Discrete devices: Signal, switching and regulator diodes

1 Scope

This part of IEC 60747 gives the requirements for the following devices:

- signal diodes (excluding diodes designed to operate at frequencies above several hundred MHz);
- switching diodes (excluding high power rectifier diodes);
- voltage-regulator diodes;
- voltage-reference diodes;
- current-regulator diodes.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary*
(available at <<http://www.electropedia.org>>)

IEC 60747-1:2006, *Semiconductor devices – Part 1: General*
Amendment 1:2010

3 Terms, definitions and graphical symbols

For the purposes of this document, the terms and definitions given in IEC 60050-521, IEC 60050-702 and IEC 60747-1, and the following, apply.

3.1 Signal and switching diodes

3.1.1

forward recovery voltage

V_{FR}

forward voltage occurring during the forward recovery time after switching from zero or a reverse voltage to a forward current

3.1.2

detector voltage efficiency

η_V

ratio of the d.c. load voltage to the peak sinusoidal input voltage under specified circuit conditions

3.1.3**detector power efficiency** η_p

ratio of the change in d.c. power in the load resistance produced by the a.c. signal, to the available power from a sinusoidal voltage generator when the diode is operated under specified conditions

3.1.4**repetitive pulse energy** E_{PR}

energy of a pulse of short duration that occurs in a repetitive series of pulses

3.1.5**total capacitance** C_{tot}

capacitance at the diode terminals, measured under specified bias conditions

3.2 Voltage reference diodes and voltage regulator diodes**3.2.1****voltage reference diode**

voltage regulator diode where the minimum and maximum voltages are both specified at the same current

[SOURCE: IEC 60050-521:2002, 521-04-16 modified – rewritten]

3.2.2**working direction**

direction of current that results when the N-type semiconductor region is at a positive voltage relative to the P-type region

Note 1 to entry: This is also the reverse direction for voltage regulator diodes.

3.2.3**regulating range**

range of working direction currents within which the voltage is maintained between specified limits

3.2.4**working current** I_Z

current within the regulating range

3.2.5**working voltage** V_Z

voltage within the regulating range

3.2.6**differential working resistance** r_z

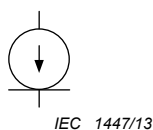
differential resistance at a working current within the regulating range

3.2.7**temperature coefficient of working voltage** α_{VZ}

the quotient of the change in working voltage between two specified values of temperatures, and the difference between these two temperatures

3.3 Current-regulator diodes

3.3.1 Graphical symbol



NOTE The arrow denotes the direction of flow of the regulator (working) current, flowing from the anode to the cathode. This is termed the forward direction for current-regulator diodes, and the terms defining the forward and reverse directions of a PN junction (IEC 60050-521:2002, 521-05-03 and 521-05-04) do not apply.

Figure 1 – Current-regulator diode graphical symbol

3.3.2 regulator voltage

V_s
voltage within the regulating range of a current-regulator diode

Note 1 to entry: “Working voltage” is no longer the preferred term.

3.3.3 limiting voltage

V_L
voltage at point I_L on the current-voltage characteristic

SEE: Figure 2.

3.3.4 knee voltage

V_k
voltage near the lower knee of the current-voltage characteristic

3.3.5 regulator current

I_s
current within the regulating range of a current-regulator diode

Note 1 to entry: “Working current” is no longer the preferred term.

3.3.6 limiting current

I_L
specified current below the regulating range

3.3.7 small-signal regulator conductance

g_s
small-signal conductance within the regulating range of a current-regulator diode

3.3.8 knee conductance

g_k
small-signal regulator conductance at the knee voltage

3.3.9 temperature coefficient of regulator current

α_{IS}
quotient of the change in regulator current between two specified values of temperature and that change of temperature

Note 1 to entry: The change in regulator current is usually expressed as a percentage of regulator current.

Note 2 to entry: "Regulator current" is now used instead of "working current", which is no longer the preferred term.

4 Letter symbols

4.1 General

The general rules and letter symbols of IEC 60747-1:2006, Clause 4 apply with the following additions.

4.2 Signal and switching diodes

4.2.1 Subscripts

A, a anode

K, k cathode

r recovery, recovered

S, s storage, stored

4.2.2 List of letter symbols

4.2.2.1 Voltages

V_F Continuous (direct) forward voltage

V_R Continuous (direct) reverse voltage

V_{RM} Peak reverse voltage

$V_{(BR)}$ Breakdown voltage

V_{FR} Forward recovery voltage

V_{FRM} Peak value of forward recovery voltage

4.2.2.2 Currents

I_F Continuous (direct) forward current

i_F Instantaneous forward current

I_{FM} Peak forward current

I_R Continuous (direct) reverse current

i_R Instantaneous reverse current

I_{RM} Peak reverse current

4.2.2.3 Switching characteristics

t_{fr} Forward recovery time

t_{rr} Reverse recovery time

i_{rr} Reverse recovery current

Q_r Recovered charge

4.2.2.4 Sundry quantities

r Differential resistance

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- η_p Detector power efficiency
- η_v Detector voltage efficiency
- E_{pr} Repetitive pulse energy

4.3 Voltage reference diodes and voltage regulator diodes

4.3.1 Subscripts

- Z, z working

4.3.2 List of letter symbols

4.3.2.1 Voltages

- V_Z Working voltage
- V_{nz} Noise voltage within the working voltage range (V_n is also acceptable if no misunderstanding is possible).

4.3.2.2 Currents

- I_Z Continuous (direct) reverse current within the working voltage range
- I_R Continuous (direct) reverse current at a voltage below the working voltage range

4.3.2.3 Sundry quantities

- r_z Differential (working) resistance
- α_{vz} Temperature coefficient of working voltage (Reserve symbol: S_z)

4.4 Current-regulator diodes (standards.iteh.ai)

See Figure 2.

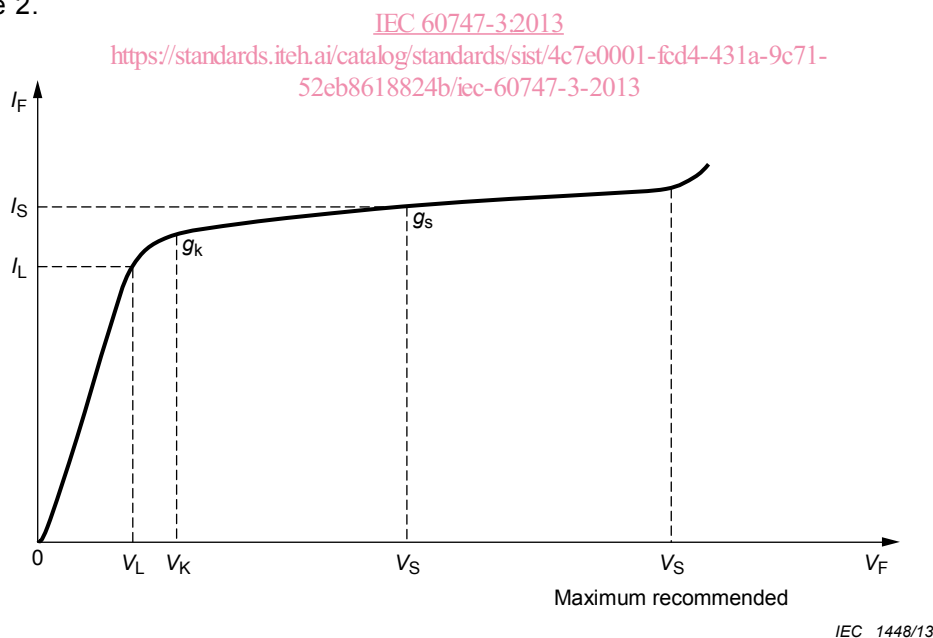


Figure 2 – Current-regulator diode characteristic with symbol identification

4.4.1 Subscripts

- S, s Regulator
- L Limiting
- K Knee

4.4.2 List of letter symbols

4.4.2.1 Voltages

V_S Regulator voltage

V_L Limiting voltage

V_K Knee voltage

4.4.2.2 Currents

I_S Regulator current

I_L Limiting current

4.4.2.3 Sundry quantities

g_s Small-signal regulator conductance

g_k Knee conductance

ΔI_S Regulator current variation

5 Essential ratings and characteristics

5.1 General

The rules of IEC 60747-1:2006, Clause 5 apply, with the following additions.

Voltage and current ratings apply over the rated range of operating temperatures. Where such ratings are temperature-dependent, this dependence should be indicated.

5.2 Signal and switching diodes IEC 60747-3:2013

5.2.1 Ratings (limiting values) <https://standards.iteh.ai/catalog/standards/sist/4c7e0001-fcd4-431a-9c71-52eb8618824b/iec-60747-3-2013>

5.2.1.1 Minimum and maximum storage temperatures (T_{stg})

5.2.1.2 Minimum and maximum operating ambient or case temperature (T_a or T_c)

5.2.1.3 Maximum continuous (direct) reverse voltage (V_R)

5.2.1.4 Maximum peak reverse voltage (V_{RM})

Under specified pulse conditions (for switching diodes).

5.2.1.5 Maximum continuous (direct) forward current (I_F)

5.2.1.6 Maximum peak forward current (I_{FM})

Under specified conditions.

5.2.1.7 Maximum total power dissipation (P_{tot} or P_C)

Where thermal resistance is not given in the characteristics, maximum total power dissipation as a function of temperature over the range of operating temperatures shall also be given.

5.2.1.8 Any special requirements for ventilation and/or mounting

5.2.2 Characteristics

5.2.2.1 Reverse current (I_R)

Maximum value at the maximum continuous (direct) reverse voltage and at a low value of reverse voltage at 25 °C and one higher temperature.

5.2.2.2 Forward voltage (V_F)

Maximum value at the rated maximum continuous (direct) forward current at 25 °C.

Minimum value at low value of continuous (direct) forward current at 25 °C.

5.2.2.3 Total capacitance (C_{tot})

Maximum value at specified low value of reverse voltage at 25 °C; the frequency shall be below that where secondary effects are significant.

5.2.2.4 Recovered charge (Q_r)

For switching diodes: maximum value when switching from a specified forward current by the application of specified reverse voltage or current and for specified circuit conditions.

NOTE See note in 5.2.2.5.

5.2.2.5 Reverse recovery time (t_{rr})

For switching diodes: maximum value when switching from a specified forward current by the application of specified reverse voltage or current and for specified circuit conditions. See Figure 3.

NOTE Recovered charge and reverse recovery time are measured between the instant when the current passes through zero, when changing from the forward direction to the reverse direction (t_0), and the instant when the reverse current is reduced from its peak value I_{RM} either to a specified low value (preferably 10 % of the peak reverse current) (t_i), or when the extrapolated reverse current reaches zero (t_{rr}). The extrapolation is carried out with respect to two specified points, preferably 90 % and 25 % of the peak reverse current.

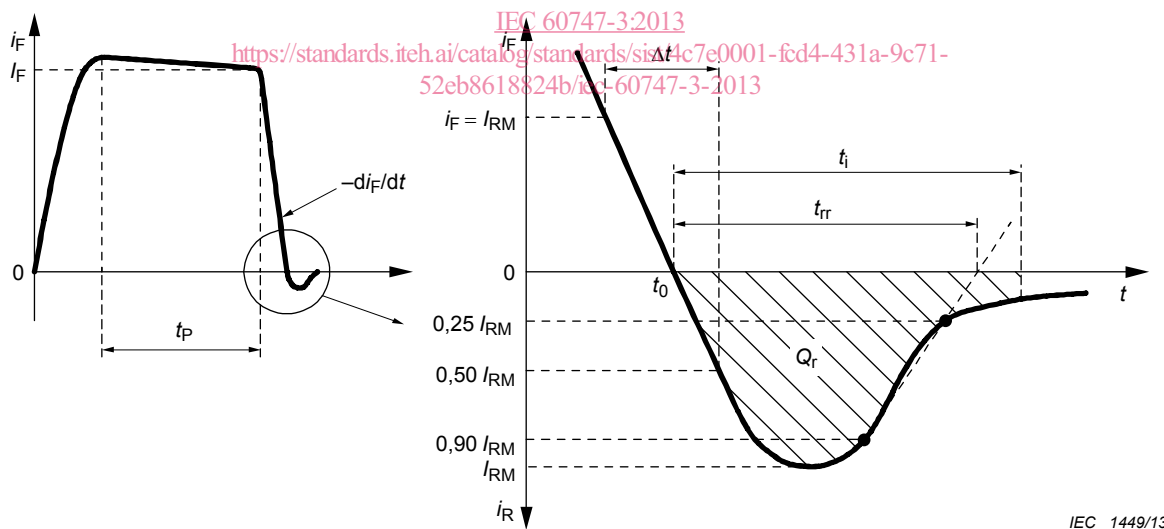


Figure 3 – Reverse recovery current waveform

5.2.2.6 Peak forward recovery voltage (V_{FRM})

Maximum value (where appropriate) when switching from a specified reverse voltage to a specified forward current.

5.2.2.7 Forward recovery time (t_{fr})

Maximum value (where appropriate), when switching from a specified reverse voltage (preferably zero) by the application of a specified forward current with a specified rise time between 10 % and 90 %.

NOTE Forward recovery time is measured between the instant when the forward voltage rises through a specified first value (preferably 10 % of the final stable value) and the instant when it falls from its peak value, either to a specified second value close to the final stable value (preferably 110 %) or when the extrapolated forward voltage reaches zero (the extrapolation is carried out with respect to two specified points, preferably 90 % and 50 % of the peak forward voltage). See Figure 4.

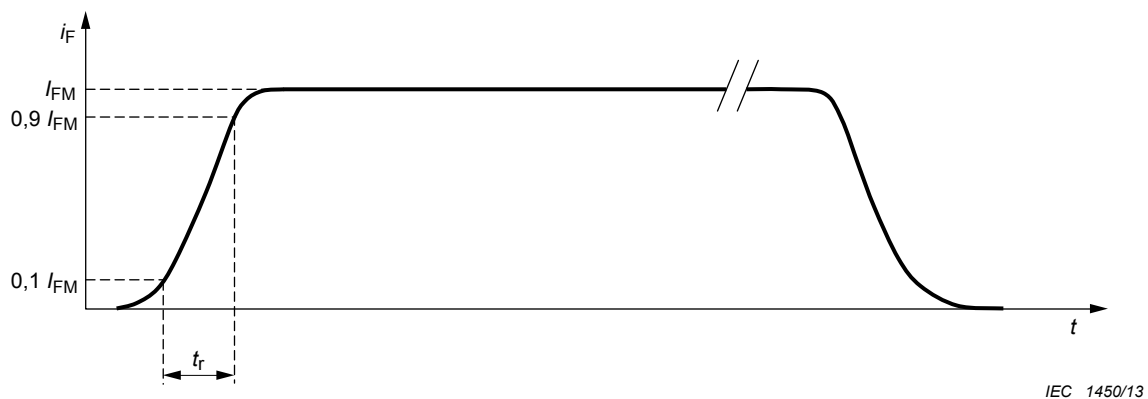


Figure 4 a) Current waveform

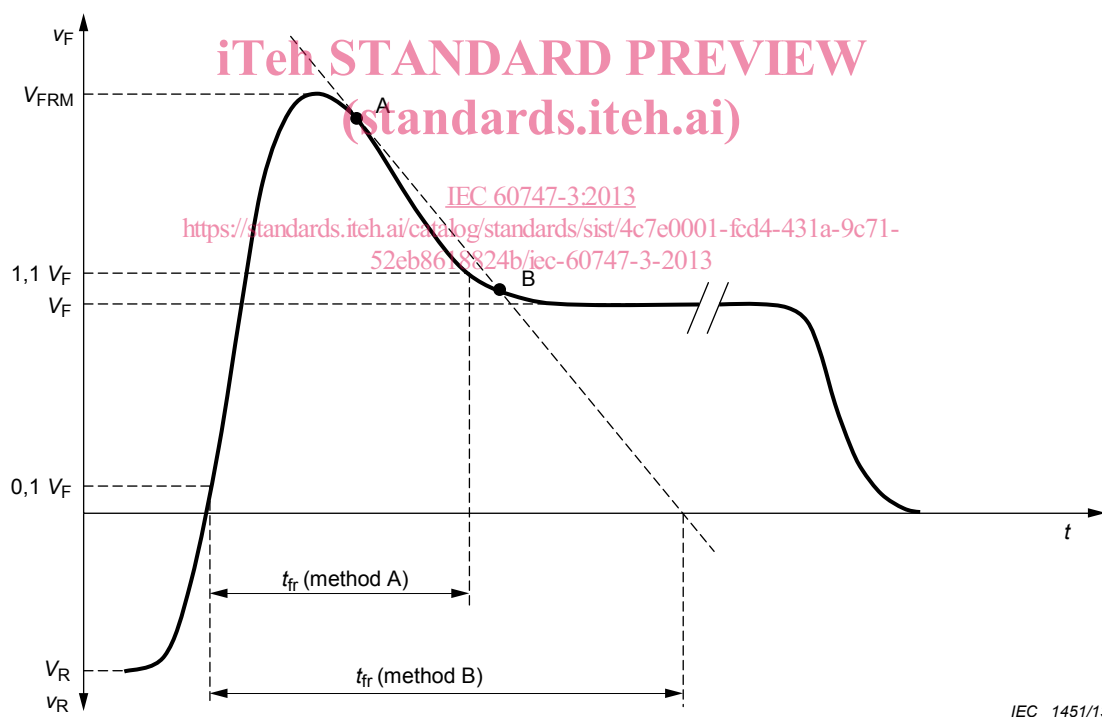


Figure 4 b) Voltage waveform

Figure 4 – Current and voltage waveforms

5.2.2.8 Detector efficiency

For diodes specified for use in detector circuits, the following characteristics shall be stated:

Either: **a) Detector voltage efficiency (η_V)**

Minimum value (for high-level RF detectors) under specified bias conditions at 25 °C. The circuit conditions and the frequency of measurement shall also be specified.