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Edition 3.0 2016-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Semiconductor devices –
Part 2: Discrete devices – Rectifier diodes

Dispositifs à semiconducteurs –
Partie 2: Dispositifs discrets – Diodes de redressement

IEC 60747-2:2016-04(en-fr)

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CONTENTS

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SEMICONDUCTOR DEVICES –

Part 2: Discrete devices – Rectifier diodes

FOREWORD

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International Standard IEC 60747-2 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

This third edition cancels and replaces the second edition published in 2000. This edition constitutes a technical revision.

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

a) Schottky barrier diodes and its properties are added;
b) Clauses 3, 4, 5 and 7 were amended with some deletions of information no longer in use or already included in other parts of the IEC 60747 series, and with some necessary additions;
c) Clause 6 was moved and added to Clause 7 of this third edition;
d) some parts of Clause 7 were moved and added to Clause 7 of this third edition;

e) Annex A was deleted.

This standard is to be used in conjunction with IEC 60747-1:2006 and Amendment 1: 2010.

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

FDIS	Report on voting
47E/531/FDIS	47E/537/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 website 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- withdrawn,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.

SEMICONDUCTOR DEVICES –

Part 2: Discrete devices – Rectifier diodes

1 Scope

This part of IEC 60747 provides standards for the following categories or sub-categories of rectifier diodes, including:

- line rectifier diodes;
- avalanche rectifier diodes;
- fast-switching rectifier diodes;
- Schottky barrier 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 60050-521, *International Electrotechnical Vocabulary – Part 521: Semiconductor devices and integrated circuits* (available at http://*www.electropedia.org*)

IEC 60747-1:2006, *Semiconductor devices – Part 1: General*
IEC 60747-1:2006/AMD1: 2010

IEC 60749-23, *Semiconductor devices – Mechanical and climatic test methods – Part 23: High temperature operating life*

IEC 60749-34, *Semiconductor devices – Mechanical and climatic test methods – Part 34: Power cycling*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60747-1, in IEC 60050-521 (except for definitions 521-05-18, 521-05-25, 521-05-26) and the following apply.

3.1 General terms and definitions

3.1.1
forward direction
direction of the flow of continuous (direct) current in which a semiconductor diode has the lower resistance

3.1.2
reverse direction
direction of the flow of continuous (direct) current in which a semiconductor diode has the higher resistance

3.1.3
anode terminal
<semiconductor rectifier diode> terminal to which forward current flows from the external circuit

3.1.4
cathode terminal
<semiconductor rectifier diode> terminal from which forward current flows to the external circuit

3.2 Voltages

3.2.1
forward voltage
V_F
voltage across the terminals which results from the flow of current in the forward direction

3.2.2
peak forward voltage
crest forward voltage
V_{FM}
voltage across the terminal which results from a π times higher current than the specified mean current

3.2.3
forward recovery voltage
V_{fr}
varying voltage occurring during the forward recovery time after instantaneous switching from zero or a specified reverse voltage to a specified forward current

3.2.4
reverse voltage
V_R
constant voltage applied to a diode in the reverse direction

3.2.5
repetitive peak reverse voltage
V_{RRM}
highest instantaneous value of the reverse voltage, including all repetitive transient voltages, but excluding all non-repetitive transient voltages

Note 1 to entry: See Figure 5.

3.2.6
non-repetitive peak reverse voltage
peak transient reverse voltage
V_{RSM}
highest instantaneous value of any non-repetitive transient reverse voltage

Note 1 to entry: The repetitive voltage is usually a function of the circuit and increases the power dissipation of the device. A non-repetitive transient voltage is usually due to an external cause and it is assumed that its effect has completely disappeared before the next transient arrives.

3.2.7
breakdown voltage
$V_{(BR)}$
voltage in the region where breakdown occurs

3.3 Currents

3.3.1
forward current
I_F
current flowing through the diode in forward direction

3.3.2
mean forward current
$I_{F(AV)}$
value of the forward current averaged over the full cycle

3.3.3
r.m.s. forward current
$I_{F(R.M.S.)}$
r.m.s value of the forward current over one complete cycle of the operating frequency

Note 1 to entry: Where no ambiguity arises, $I_{F(RMS)}$ may be used.

3.3.4
peak forward current
I_{FM}
maximum value of forward current time function

3.3.5
repetitive peak forward current
I_{FRM}
peak value of the forward current including all repetitive transient currents

Note 1 to entry: See Figure 6.

3.3.6
non-repetitive surge forward current
I_{FSM}
forward current pulse of short time duration and specified waveshape, whose application causes or would cause the maximum rated junction temperature to be exceeded, but which is assumed to occur rarely and with a limited number of such occurrences during the service life of the device and to be a consequence of unusual circuit conditions (for example a fault)

Note 1 to entry: See Figure 6.

3.3.7
reverse current
I_R
current flowing through the diode when reverse voltage is applied

3.3.8
reverse recovery current
I_{rr}
part of the reverse current which occurs during the reverse recovery until quasi static conditions have been reached

3.3.9
I^2t value
integral of the square of a surge forward current over the duration of the current surge

3.3.10
peak case non-rupture current
I_{RSMC}
peak value of reverse current that should not be exceeded in order to avoid bursting of the case or the emission of a plasma beam under specified conditions of current, waveshape and time

Note 1 to entry: This definition implies that a fine crack in the case might be found in a device subjected to the peak case non-rupture current, provided that no plasma beam was emitted. Parts of the case shall not break away, nor shall the device melt externally or burst into flames.

3.4 Power dissipation

3.4.1
total power dissipation
P_{tot}
sum of the dissipations due to current in the forward and reverse direction and during switching

3.4.2
forward power dissipation
P_F
power dissipation due to the flow of forward current

3.4.3
mean forward power dissipation
$P_{F(AV)}$
mean value of the product of the instantaneous forward voltage and the instantaneous forward current averaged over a full cycle

3.4.4
reverse power dissipation
P_R
power dissipation resulting from the flow of reverse current

3.4.5
forward recovery dissipation
P_{fr}
power dissipated within the diode during the change between reverse voltage and forward current when the diode is switched from a reverse voltage to a forward current

3.4.6
reverse recovery dissipation
P_{rr}
power dissipated within the diode during the change between forward current and reverse voltage when the diode is switched from a forward current to a reverse voltage

3.4.7
surge reverse power dissipation
P_{RSM}
<avalanche rectifier diodes> power which is dissipated within the diode resulting from surges occurring when it is operating in the reverse direction

3.4.8
repetitive peak reverse power dissipation
P_{RRM}
<avalanche rectifier diodes> power which is dissipated within the diode resulting from repetitive peak currents when it is operating in the reverse direction

3.4.9
mean reverse power dissipation
$P_{R(AV)}$
<avalanche rectifier diodes> power which is dissipated within the diode resulting from constant reverse current or as a mean value of a periodical function when it is operating in the reverse direction

3.5 Switching characteristics

3.5.1
forward recovery time
t_{fr}
time interval between the instant when the forward voltage rises through a specified first value and the instant when it falls from its peak value V_{frm} to a specified second value close to the final stable value of forward voltage (as shown in Figure 1), or when the extrapolated forward voltage reaches zero (as shown in Figure 2), upon the application of a specified step of forward current following a zero-voltage or other specified reverse-voltage condition

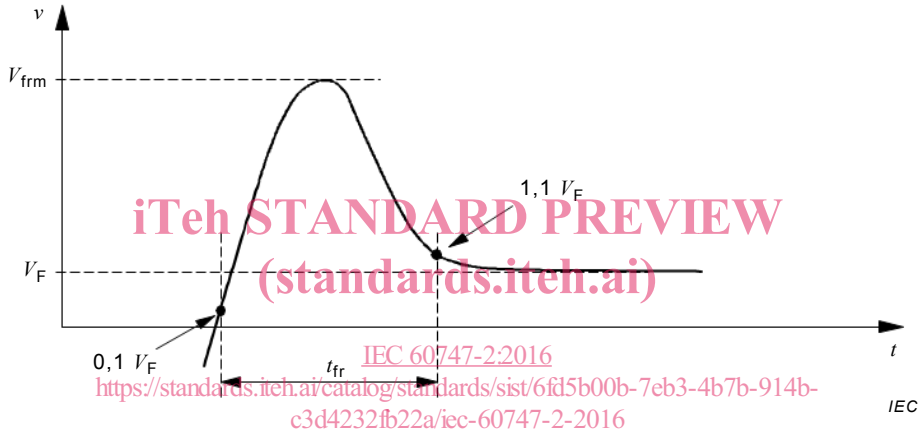

Figure 1 – Voltage waveform during forward recovery, specification method I

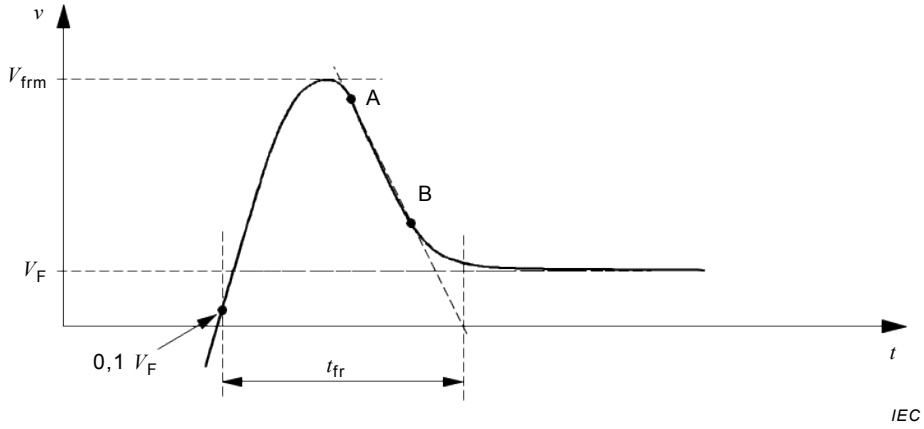

Figure 2 – Voltage waveform during forward recovery, specification method II

Note 1 to entry: Specification method I: The specified first and second values referred to in the definition are usually 10 % and 110 %, respectively, of the final stable value (V_F in Figure 1).

Note 2 to entry: Specification method II: The extrapolation is carried out with respect to specified points A and B where A and B are usually 90 % and 50 % of V_{frm} as shown in generalized form in Figure 2.

Note 3 to entry: Method I is preferred for V_{frm} values up to about 10 V; method II for values considerably higher.

[SOURCE: IEC 60050-521:2002, 521-05-25, modified — revised to relate only to forward voltage; notes to entry and figures added]

3.5.2
reverse recovery time

t_{rr}

time interval between the instant when the current passes through zero, when changing from the forward direction to the reverse direction, and the instant when the extrapolated reverse current reaches zero (as shown in Figure 3)

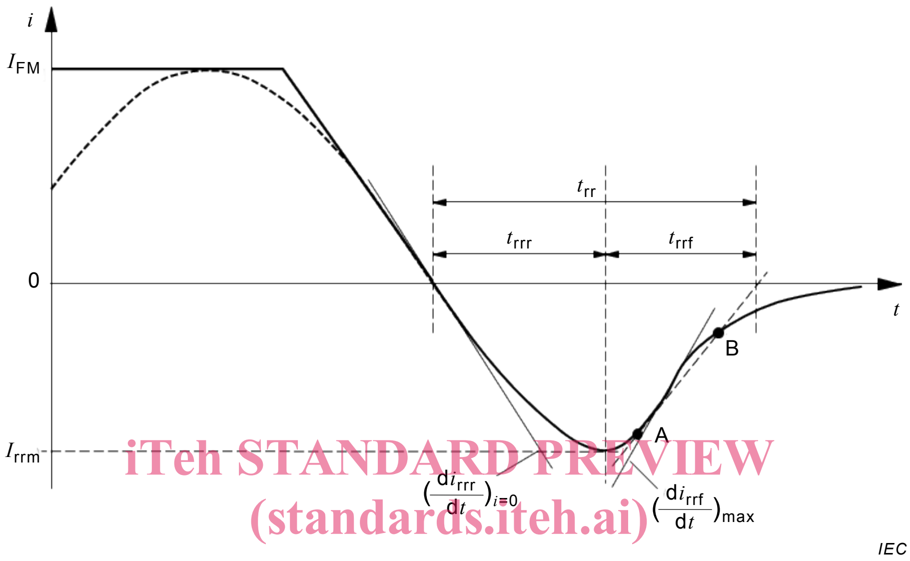

Figure 3 – Current waveform during reverse recovery

Note 1 to entry: The extrapolation is carried out with respect to specified points A and B as shown in generalised form in Figure 3. Point A is often specified at 90 % of I_{rrm}, and point B at 25 % of I_{rrm}.

[SOURCE: IEC 60050-521:2002, 521-05-26, modified — revised to relate only to current with specified limits of the time function; notes to entry and figures added]

3.5.3
reverse recovery current rise time

t_{rrr}

time interval between the beginning of the reverse recovery time and the instant when the reverse recovery current reaches its peak value after instantaneous switching from a specified forward current to a specified reverse voltage

3.5.4
reverse recovery current fall time

t_{rrf}

time interval between the instant when the reverse recovery current reaches its peak value and the end of reverse recovery time after instantaneous switching from a specified forward current to a specified reverse voltage

3.5.5
recovered charge

Q_r

total charge recovered from the diode during a specified integration time after switching from a specified forward current condition to a specified reverse condition:

$$Q_r = \int_{t_0}^{t_0+t_i} i \cdot dt$$

where

t_0 is the instant when the current passes through zero;

t_i is the specified integration time from t_0 to a time where i_{rr} has fallen to 2 % of I_{rrm} (as shown in Figure 4).

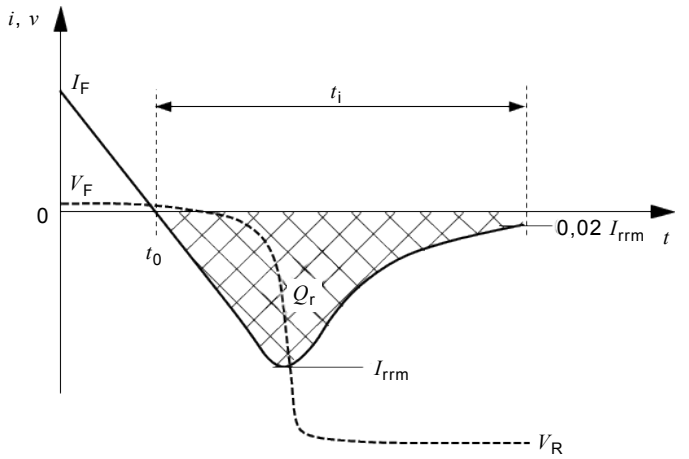

Figure 4 – Diode turn-off, voltage, current and recovered charge

Note 1 to entry: This charge includes components due to both carrier storage and depletion layer capacitance.

[SOURCE: IEC 60050-521:2002, 521-05-18, modified – revised to relate only to diode and added integration time; formula and figure added]

3.5.6
capacitive charge
Q_C
<Schottky barrier diodes> the charge required to raise the cathode-anode voltage from zero to a specified value

3.5.7
reverse recovery energy
E_{rr}
switching energy which results from the integration of the product from device voltage and current during the integration time t_i of recovered charge

Note 1 to entry: t_i is shown in Figure 4.

3.5.8
reverse recovery softness factor
S_{rr}
absolute value of the ratio of the rate of rise of the reverse recovery current when passing through zero to the maximum rate of fall of the recovery current

$$S_{rr} = \left| \frac{(di_{rrr}/dt)_{i=0}}{(di_{rrf}/dt)_{max}} \right|$$

Note 1 to entry: (di_{rrr}/dt) and (di_{rrf}/dt) are shown in Figure 3.