IEC 60747-9

Edition 3.0 2019-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Semiconductor devices –
Part 9: Discrete devices – Insulated-gate bipolar transistors (IGBTs)

Dispositifs à semiconducteurs –
Partie 9: Dispositifs discrets – Transistors bipolaires à grille isolée (IGBT)

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SEMICONDUCTOR DEVICES –

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FOREWORD

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International Standard IEC 60747-9 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 2007. This edition constitutes a technical revision.

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

a) reverse-blocking IGBT and its related technical contents have been added;
b) reverse-conducting IGBT and its related technical contents have been added;
c) some parts of the previous edition have been amended, combined or deleted.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
47E/675/FDIS	47E/684/RVD

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

This document 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.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

SEMICONDUCTOR DEVICES –

Part 9: Discrete devices – Insulated-gate bipolar transistors (IGBTs)

1 Scope

This part of IEC 60747 specifies product specific standards for terminology, letter symbols, essential ratings and characteristics, verification of ratings and methods of measurement for insulated-gate bipolar transistors (IGBTs).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60747-1:2006, *Semiconductor devices – Part 1: General*
IEC 60747-1:2006/AMD1:2010

IEC 61340 (all parts), *Electrostatics*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 General terms

3.1.1
insulated-gate bipolar transistor
IGBT
transistor having a conductive channel and one PN junction in the forward direction and another PN junction in the reverse direction, the current flowing through the channel and the junction being controlled by an electric field resulting from a voltage applied between the gate and emitter terminals

Note 1 to entry: With collector-emitter voltage applied, the collector side PN junction is forward biased.

Note 2 to entry: This note applies to the French language only.

3.1.2
N-channel IGBT
IGBT that has one or more N-type conduction channels

[SOURCE: IEC 60050-521:2002, 521-04-56, modified – reworded for IGBT.]

3.1.3
P-channel IGBT
IGBT that has one or more P-type conduction channels

[SOURCE: IEC 60050-521:2002, 521-04-57, modified – reworded for IGBT.]

3.1.4
collector terminal
collector
C
for an N-channel (a P-channel) IGBT, the terminal to (from) which the collector current flows from (to) the external circuit

3.1.5
emitter terminal
emitter
E
for an N-channel (a P-channel) IGBT, terminal from (to) which the collector current flows to (from) the external circuit

3.1.6
gate terminal
gate
G
for an N-channel (a P-channel) IGBT, terminal to which a voltage is applied against the emitter terminal in order to control the collector current

3.1.7
reverse-blocking IGBT
RB-IGBT
IGBT which, for negative collector-emitter voltage, exhibits a reverse blocking state with a monolithic device structure

Note 1 to entry: This note applies to the French language only.

3.1.8
reverse-conducting IGBT
RC-IGBT
IGBT which, for negative collector-emitter voltage, conducts large currents at voltages comparable in magnitude to the forward on-state voltage with monolithic device structure

Note 1 to entry: This note applies to the French language only.

3.2 Terms related to ratings and characteristics, voltages and currents

3.2.1
collector-emitter voltage
voltage between collector and emitter

3.2.2
collector-emitter voltage with gate-emitter short-circuited
V_{CES}
collector-emitter voltage at which the collector current has a specified low (absolute) value with the gate-emitter short-circuited

3.2.3
collector-emitter sustaining voltage
$V_{\mathrm{CE*sus}}$
collector-emitter breakdown (self-clamping) voltage at relatively high values of collector current where the voltage is relatively insensitive to changes in collector current, for a specified termination between gate and emitter terminals

Note 1 to entry: The specified termination between gate and emitter terminals is indicated in the letter symbol by the third subscript '*'; see 4.2 of IEC 60747-7:2010.

3.2.4
collector-emitter breakdown voltage
$V_{\mathrm{(BR)CES}}$
voltage between collector and emitter above which the collector current rises steeply, with gate to emitter short-circuited

3.2.5
collector-emitter saturation voltage
V_{CEsat}
collector-emitter voltage under conditions of gate-emitter voltage at which the collector current is essentially independent of the gate-emitter voltage

3.2.6
gate-emitter voltage
voltage between gate and emitter

3.2.7
gate-emitter threshold voltage
$V_{\mathrm{GE(th)}}$
gate-emitter voltage at which the collector current has a specified low (absolute) value

3.2.8
electrostatic discharge voltage
voltage that can be applied to the gate terminal without destruction of the isolation layer

3.2.9
reverse voltage
V_{R}
<reverse-blocking IGBT> value of the voltage applied to an IGBT in the reverse collector-emitter direction

3.2.10
reverse-conducting voltage
V_{RC}
<reverse-conducting IGBT> value of the voltage which results from the flow of current in the reverse collector-emitter direction

Note 1 to entry: Where no ambiguity arises, V_{F} or V_{EC} may be used.

3.2.11
collector cut-off current
I_{CE}
collector current at a specific collector-emitter voltage below the breakdown region and gate off-state

3.2.12
collector current
I_{C}
direct current that is switched (controlled) by the IGBT

3.2.13
tail current
I_{CZ}
collector current during the tail time

3.2.14
gate leakage current
gate-emitter leakage current
I_{GES}
leakage current into the gate terminal at a specified gate-emitter voltage with the collector terminal short-circuited to the emitter terminal

3.2.15
reverse current
I_R
<reverse-blocking IGBT> value of the current flowing through the IGBT when the specified reverse collector-emitter voltage is applied

3.2.16
reverse-conducting current
I_{RC}
<reverse-conducting IGBT> total conductive current flowing through the IGBT when the collector-emitter reverse voltage is applied

Note 1 to entry: Where no ambiguity arises, I_F or I_E may be used.

3.2.17
reverse recovery current
I_{rr}
<reverse-blocking IGBT> reverse current that occurs during the reverse recovery time

Note 1 to entry: For the peak value of the reverse recovery current during the reverse recovery time, only the letter symbol I_{rrm} may be used.

3.2.18
forward recovery current
I_{fr}
<reverse-conducting IGBT> forward current that occurs during the forward recovery time

Note 1 to entry: For the peak value of the forward recovery current during the forward recovery time, only the letter symbol I_{frm} may be used.

3.2.19
safe operating area
SOA
collector current versus collector-emitter voltage where the IGBT is able to turn-on and turn-off without failure

Note 1 to entry: This note applies to the French language only.

3.2.19.1
forward bias safe operating area
FBSOA
collector current versus collector-emitter voltage where the IGBT is able to turn-on and is able to be on-state without failure

Note 1 to entry: This note applies to the French language only.

3.2.19.2
reverse bias safe operating area
RBSOA
collector current versus collector-emitter voltage where the IGBT is able to turn-off without failure

Note 1 to entry: RBSOA is not only for repetitive peak collector current but also for short-circuit conditions.

Note 2 to entry: This note applies to the French language only.

3.2.19.3
short-circuit safe operating area
SCSOA
short-circuit duration and collector-emitter voltage where the IGBT is able to turn-on and turn-off without failure

Note 1 to entry: This note applies to the French language only.

3.3 Terms related to ratings and characteristics

3.3.1
input capacitance
C_{ies}
capacitance between the gate and emitter terminals with the collector terminal short-circuited to the emitter terminal for alternating current

3.3.2
output capacitance
C_{oes}
capacitance between the collector and emitter terminals with the gate terminal short-circuited to the emitter terminal for alternating current

3.3.3
reverse transfer capacitance
C_{res}
capacitance between the collector and gate terminals

3.3.4
gate charge
Q_G
charge required to raise the gate-emitter voltage from a specified low to a specified high level

3.3.5
internal gate resistance
r_g
internal equivalent series resistance between the gate and the gate terminal

Note 1 to entry: Where no ambiguity arises, R_{Gint} may be used.

3.3.6
turn-on energy
E_{on}
energy dissipated inside the IGBT during the turn-on of a single collector current pulse

Note 1 to entry: The corresponding turn-on power dissipation under periodic pulse conditions is obtained by multiplying E_{on} by the pulse frequency.