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INTERNATIONAL STANDARD





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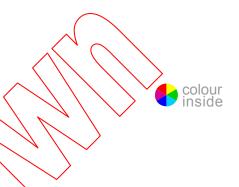
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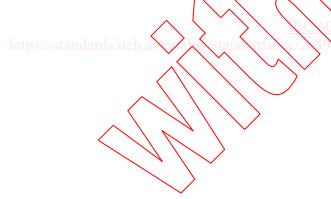


Discrete semiconductor devices -

Part 15: Isolated power semiconductor devices

Dispositifs discrets à semiconducteurs -

Partie 15: Dispositifs de puissance à semiconducteurs isolés



INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

DISCRETE SEMICONDUCTOR DEVICES -

Part 15: Isolated power semiconductor devices

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60747-15 has been prepared by subcommittee 47E, Discrete semiconductor devices of IEC technical committee 47: Semiconductor devices.

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This bilingual version (2013-05) corresponds to the monolingual English version, published in 2003-06.

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

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		FDIS	Report on voting
/"/,	>	47E/236/FDIS	47E/238/RVD
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Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

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

The committee has decided that the contents of this publication will remain unchanged until 2006. At this date, the publication will be

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

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DISCRETE SEMICONDUCTOR DEVICES -

Part 15: Isolated power semiconductor devices

1 Scope

This part of IEC 60747 gives the product specific standards, requirements and test methods for isolated power semiconductor devices. These requirements are added to those given in other parts of IEC 60747, IEC 60748 and IEC 60749 for the corresponding non-isolated power devices.

2 Normative references

The following referenced documents are indispensable for the application 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 60068-2-6, Environmental testing – Part 2-6; Tests / Test Fc: Vibration (sinusoidal)

IEC 60068-2-7, Environmental testing Part 2-7: Tests – Test Ga and guidance: Acceleration, steady state

IEC 60068-2-14, Environmental testing Part 2-14. Tests - Test N: Change of temperature

IEC 60068-2-20, Environmental testing - Part 2-20, Tests - Test T: Soldering

IEC 60068-2-27, Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock

IEC 60068-2-47, Environmental testing — Part 2-47: Test methods — Mounting of components, equipment and other articles for vibration, impact and other similar dynamic tests

IEC 60068-2-48, Environmental testing – Part 2-48: Test methods – Guidance on the application of the tests of IEC 60068 to simulate the effects of storage

IEC 60068-3-4: Environmental testing – Part 3-4: Supporting documentation and guidance – Damp heat tests

IEC 60191-4:1999, Mechanical standardization of semiconductor devices – Part 4: Coding system and classification into forms of package outlines for semiconductor device packages

IEC 60270:2000, High voltage test techniques – Partial discharge measurements

IEC 60319, Presentation and specification of reliability data for electronic components

IEC 60664-1:1992, Insulation coordination for equipment within low-voltage systems – Principles, requirements and tests

IEC 60721-3-3:1994, Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weather-protected locations

IEC 60747-1:1983, Semiconductor devices – Discrete devices and integrated circuits – Part 1: General

Amendment 1 (1991)

Amendment 3 (1996)

IEC 60747-2:2000, Semiconductor devices – Discrete devices and integrated circuits – Part 2: Rectifier diodes

IEC 60747-6:2000, Semiconductor devices – Part 6: Thyristors

IEC 60747-7:2000, Semiconductor devices – Part 7: Bipolar transistors

IEC 60747-8:2000, Semiconductor devices – Part 8: Field effect transistors

IEC 60747-9:1998, Semiconductor devices – Discrete devices – Part 9. Insulated-gate bipolar transistors (IGBTs)

IEC 60749-5: Semiconductor devices – Mechanical and climatic test methods – Part 5: Steady-state temperature humidity bias life test

IEC 60749-6: Semiconductor devices – Mechanical and climatic test methods – Part 6: Storage at high temperature

IEC 60749-10: Semiconductor devices - Mechanical and climatic test methods - Part 10: Mechanical shock

IEC 60749-12: Semiconductor devices — Mechanical and climatic test methods — Part 12: Vibration, variable frequency

IEC 60749-14: Semiconductor devices - Mechanical and climatic test methods - Part 14: Robustness of terminations (lead integrity)

IEC 60749-15: Semiconductor devices - Mechanical and climatic test methods - Part 15: Resistance to soldering temperature for through-hole mounted devices 1

IEC 60749-21: Semiconductor devices – Mechanical and climatic test methods – Part 21: Solderability¹

IEC 60749-25: Semiconductor devices – Mechanical and climatic test methods – Part 25: Rapid change of temperature (air, air)¹

IEC 60749-26: Semiconductor devices – Mechanical and climatic test methods – Part 26: Rapid change of temperature (air, air)¹

IEC 60749-36: Semiconductor devices – Mechanical and climatic test methods – Part 36: Acceleration, steady-state

IEC 61287-1:1995, Power convertors installed on board rolling stock – Part 1: Characteristics and test methods²

ISO 1302:2002, Geometrical Product Specifications (GPS) – Indication of surface texture in technical product documentation

ISO 2768-2:1989, General tolerances – Part 2: Geometrical tolerances for features without individual tolerance indications

¹ In preparation.

² A new edition is being prepared.

3 Terms and definitions

For the purposes of this part of IEC 60747, the following definitions apply.

3.1

isolated power semiconductor device

semiconductor device that contains an integral electrical insulator between cooling surface or base plate (envelope) and any isolated circuit elements

NOTE 1 Included are solid-state relays (SSRs) incorporating opto-isolated driving units (see IEC 60747-5-1, IEC 60745-5-2 and IEC 60745-5-3), monolithically integrated ICs with power stages and isolated cooling surface, i.e. intelligent power devices and isolated discrete plastic encapsulated packages that have an isolated cooling surface.

NOTE 2 The surface of the package transferring the heat to a heat sink or ambient is referred to as "base plate". The surface of the package not transferring the heat is referred to as "envelope".

3.2

constituent parts of the isolated power semiconductor device

3.2.1

circuit element

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

NOTE Examples include rectifier diodes, thyristors, bipolar transistors, MOSFETs, IGBTs affixed on metallized isolator substrates and integrated driver and protection circuits.

3.2.2

interconnection

internal connection between circuit elements and between circuit elements and terminals (see subclause 3.7.2 of IEC 60747-1)

NOTE They are considered to be parts of their associated circuit elements.

3.2.3

base plate

metallic or metallized cooling surface part of the package that transfers the heat from inside to a heat sink outside.

3.2.4

terminals

externally available points of connection, isolated from base plate

3.2.4.1

main terminals

terminals having the high potential of the power circuit and carrying the main current

3.2.4.2

control terminals

terminals having only low current capability for the purpose of control function to which the external control signals are applied or from which sensing parameters are taken

3.2.4.3

high-voltage control terminals

terminals having the high potential of the power circuit, but carrying only low current for control function

NOTE Examples include current shunts and collector sense terminals having the high potential of the main terminals.

3.2.4.4

low-voltage control terminals

terminals at a low potential against base plate having a control function, and isolated from the "main terminals" as well as from high voltage control terminals

NOTE Examples include the terminals of isolated temperature sensors and isolated gate driver inputs, etc.

3.3

classification of categories of isolated power devices

isolated power semiconductor devices are classified as follows:

3.3.1

chip content: types according to their main functional circuit elements

3.3.1.1

thyristor module

isolated power semiconductor device containing thyristor chips

3.3.1.2

diode module

isolated power semiconductor device containing diode chips

3.3.1.3

bipolar transistor module

isolated power semiconductor device containing pipolar transistor chips and their inverse diode chips

3.3.1.4

IGBT module

isolated power semiconductor device containing isolated gate bipolar transistor (IGBT) chips and their inverse diode chips

3.3.1.5

MOSFET module

isolated power semiconductor device containing MOSFET chips

3.3.2

circuit configuration: types according to their main functional circuit

3.3.2.1

single switch

one functional checuit element, the "semiconductor switch", in one case (as the most simple functional device) (see Annex D, Figure D.2a)

NOTE 1 Examples include epoxy isolated discrete semiconductors with metallic cooling surface.

NOTE 2 "Switch" is here a commonly used synonym for "functional circuit elements".

3.3.2.2

dual switch

two switches in one case, series connected, forming a "half bridge" circuit, a phase leg of a single-phase bridge or three-phase bridge circuit arrangement (see Annex D, Figure D.2b)

NOTE Examples include "brake chopper" circuit with a high side switch or a low side switch and the freewheeling diode on the other position, see Annex D, Figure D.2c and D.2d.

3.3.2.3

H - bridge

four switches in one case, two half bridges forming a "full bridge", a single-phase bridge (see Annex D, Figure D.2e)

3.3.2.4

sixpack

six switches in one case, three half bridges forming a "three-phase bridge" (see Annex D, Figure D.2f)

3.3.2.5

sevenpack

seven switches in one case, three half bridges forming a three-phase bridge circuit and in addition a brake chopper circuit (see Annex D, Figures D.2g and D.2h)

NOTE Above circuit configurations are mainly used for transistor inverter circuits producing a.c. output of fixed or variable frequency from d.c. input voltage, using pulse width modulation (PWM), see Annex D, Figure D.2i (CIB-converter-inverter-brake chopper devices).

3.3.2.6

bridge rectifier

single-phase bridge converter circuit of 4 diodes in one case (see Annex D. Figure D.1) circuit B2U, two pulse bridge uncontrolled)

3.3.2.7

half controlled bridge rectifier

single-phase bridge converter circuit of 2 diodes and 2 thyristors in one case (see Annex D, Figure D.1: B2HK)

3.3.2.8

fully controlled bridge rectifier

single-phase bridge converter circuit of 4 thyristors in one case (see Annex D, Figure D.1: B2C, two pulse bridge controlled)

3.3.2.9

three phase bridge rectifier

three-phase bridge converter circuit of 6 diodes in one case (see Annex D, Figure D.1: B6U, six pulse bridge uncontrolled)

3.3.2.10

half controlled three phase bridge rectifier

three-phase bridge converter circuit of 3 diodes and 3 thyristors in one case (see Annex D, Figure D.1: B6HK)

3.3.2.11

fully controlled three phase rectifier

three-phase bridge converter circuit of 6 thyristors in one case (see Annex D, Figure D.1: B6C, six pulse bridge controlled)

3.3.2.12

a.c. controller

single-phase (or three-phase) proportional controller of two (or six) inverse-parallel connected thyristors producing a proportional a.c. output voltage from a.c. input voltage using phase angle control (see Annex D, Figure D.1: W1C or W3C)

NOTE 1 Above rectifier (or respectively controller) circuits are mainly used as input converters producing a fixed or – if thyristor controlled – proportional d.c. (or respectively a.c.) output voltage from a.c. input voltage, using phase-angle control. (See also JESD 14.)

NOTE 2 IEC 60971 provides details. Examples include circuits designated "B2U",..... "B6C",...... "W1C", "W3C".

3.3.3

other circuit configurations and combinations

for other circuit configurations and combinations for the above circuits, see Annex D

3.4

functionality: types according to additional functions

such as for measurement, protection and control, including SSRs:

circuits as in 3.2.3, but with enhanced functionality by:

- · current shunts or sensors
- temperature sensors
- overcurrent or overvoltage protection
- driver with or without integrated power supply
- further control circuitry
- · opto-coupler and auxiliary circuits
- other functions

NOTE Such devices are called intelligent power modules (IPM) on the market. IRM and SMART power devices are specific names of such specific products.

3.5

solid-state relays

SSRs

isolated power semiconductor devices that incorporate an opto-isolated electronic driving unit using an input section, fully isolated from the power output side and the metallic or metallized isolated cooling surface or base plate, performing a switch-on/switch-off function as an electronic relay producing a non-proportional output

NOTE For SSRs, IEC 60747-5-1, IEC 60747-5-2 and IEC 60747-5-3 also apply.

3.6

isolation voltage

 $V_{\rm iso}$

isolation breakdown withstand voltage between terminals and base plate (or external heat sink) over a specified time

NOTE Subclause 1.3.9 of NEC 60664-1 defines 'rated insulation voltage' as r.m.s. withstand voltage value assigned by the manufacturer to the equipment or to a part of it, characterizing the specified isolation voltage withstand capability of its insulation.

3.7

partial discharge inception voltage

V.

voltage between main terminals and base plate at which partial discharges occur when the applied voltage is gradually increased from a lower value

NOTE 1 IEC 60270 defines inception voltage as greater than the extinction voltage.

NOTE 2 Subclause 1.3.18.4 of IEC 60664-1 defines 'partial discharge inception voltage', $U_{\rm i}$, as the lowest peak value of the test voltage at which the apparent charge becomes greater than the specified discharge magnitude when the test voltage is increased above a low value for which no discharge occurs.

3.8

partial discharge extinction voltage

 V_{e}

voltage between main terminals and base plate at which partial discharges disappear when the applied voltage is gradually decreased from a higher value

NOTE 1 IEC 60270 defines the extinction voltage as lower than the inception voltage.

NOTE 2 Subclause 1.3.18.5 of IEC 60664-1 defines 'partial discharge extinction voltage', $U_{\rm e}$, as the lowest peak value of the test voltage at which the apparent charge becomes less than the specified discharge magnitude when the test voltage is reduced below a high level where such discharges have occurred.

3.9

creepage distance along surface

 d_{s}

shortest distance along the surface of the insulating material between two conductive parts at different potentials

NOTE See subclause 1.3.3 of IEC 60664-1 (IEV 151-15-50).

3.10

clearance distance in air

d,

shortest distance in air between two conductive parts at different potentials

NOTE See 1.3.2 of IEC 60664-1.

3.11

peak case non-rupture current

peak current that will not lead to a rupture of the package, ejecting plasma and massive particles under specified conditions

NOTE The value indicated depends on the type of the device, e.g. thyristor, diode, IGBT, and the packaging technology, e.g. whether wire bonded.

3.11.1

peak case non-rupture current for diodes and thyristors

 I_{RSMC}

peak reverse current of a half sine wave, when the device has lost its reverse blocking capability, that should not be exceeded in order to avoid bursting of the case or emission of a plasma beam or massive particles under specified conditions

NOTE Specified in IEC 60747 2 for diode devices, respectively IEC 60747-6 for thyristor devices.

3.11.2

peak case non-rupture current for bipolar transistors, IGBT and MOSFETs

CNR

peak collector current that should not be exceeded in order to avoid bursting of the case or emission of a plasma beam or ejection of massive particles under specified conditions

3.12

parasitic stray inductance between main terminals

 L_{P}

inner wiring stray inductance, effective in the main current path between the main terminals

NOTE 1 $L_{\rm P}$ of a half-bridge module (dual switch) is the effective parasitic stray inductance $L_{\rm CE}$ between the power terminal (+) (top collector) and power terminal (-) (bottom emitter).

NOTE 2 Parasitic stray inductance $L_{\rm P}$ will cause a voltage spike at switch-off (above the continuous d.c. voltage $V_{\rm CC}$) on chip level, higher than the voltage, measured between the terminals.

3.13

parasitic stray capacitance between switching circuit elements and case

 C_{D}

coupling capacitance between all terminals connected together and the base plate (or heat-sink surface)

NOTE This capacitance can serve as a bypass for parasitic high frequency currents that can cause electromagnetic interference (EMI).

3.14

power cycling (load) capability

 $N_{\mathsf{f}\cdot\mathsf{r}}$

number of power cycles $N_{\rm f;p}$ until failure of the cumulative percentage p (=percentile) of a device population