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INTERNATIONAL STANDARD

Semiconductor devices –
Part 17: Magnetic and capacitive coupler for basic and reinforced insulation

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SEMICONDUCTOR DEVICES –

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FOREWORD

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International Standard IEC 60747-17 has been prepared by subcommittee SC 47E: Discrete semiconductor devices, of IEC technical committee TC 47: Semiconductor devices.

This first edition cancels and replaces IEC PAS 60747-17:2011. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC PAS 60747-17:2011:

a) introduced lifetime safety factors for improved life time consideration, to comply with widely recognized aging mechanisms of silicone dioxide (TDDB) and thin film polymer isolation layers;
b) significantly improved "end of life testing" paragraph and statistical life time consideration by adding detailed description on process, safety factors, methods of generating data points and respective lifetime interpolations as well as being specific on minimum amount of samples required;

c) introduced concept of certification by similarity, including Annex A, giving guidance on qualification considerations and required certification process;

d) alternative pulse shape allowed for surge pulse testing, to avoid issues due to surge tester availability;

e) various improvements throughout the standard: definitions, for example type of coupler have been improved, introduction of surge impulse V_{IMP} rating, usage of glass transition temperature, pre-conditioning have been redefined for improved usability and better compatibility with today's design and functionality of couplers, available mold compounds, etc.

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

FDIS	Report on voting
47E/711/FDIS	47E/715/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 17: Magnetic and capacitive coupler for basic and reinforced insulation

1 Scope

This part of IEC 60747 specifies the terminology, essential ratings, characteristics, safety test and the measuring methods of magnetic coupler and capacitive coupler.

It specifies the principles and requirements of insulation and isolation characteristics for magnetic and capacitive couplers for basic insulation and reinforced insulation.

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 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-14:2009, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-20:2008, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-58:2015, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60068-2-67:1995, *Environmental testing – Part 2: Tests – Test Cy: Damp heat, steady state, accelerated test primarily intended for components*

IEC 60112:2003, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60216-1:2013, *Electrical insulating materials – Thermal endurance properties – Part 1: Ageing procedures and evaluation of test results*

IEC 60216-2:2005, *Electrical insulating materials – Thermal endurance properties – Part 2: Determination of thermal endurance properties of electrical insulating materials – Choice of test criteria*

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60672-2:1999, *Ceramic and glass insulating materials – Part 2: Methods of test*

IEC 60695-11-5:2016, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 62539:2007, *Guide for the statistical analysis of electrical insulation breakdown data*

3 Terms and definitions

3.1
details of outline and encapsulation
information related method of encapsulation and terminal connections within the coupler's isolation system

3.1.1
outline drawing
drawing or sketch restricted to line to describe the shape of objects or circuitry

3.1.2
method of encapsulation
encapsulating materials used forming part of the isolation system

3.1.3
terminal identification
terminal identification and indication of any connection between a terminal and the case

3.2
type of coupler
internal construction and insulation method of coupler to achieve basic or reinforced insulation

3.2.1
SiO_2 isolator
isolator with an internal insulation construction utilizing silicon dioxide based material

3.2.2
thin film polymer isolator
isolator with an internal insulation construction, utilising a thin film polymer insulation

3.3
isolation
ability to reject electrical and magnetic interference or noise

3.4
insulation
part of an electromechanical product which galvanically separates the conducting parts at different electrical potentials

3.4.1
reinforced insulation
insulation of hazardous-live-parts which provides a degree of protection against electric shock equivalent to double insulation

Note 1 to entry: Reinforced insulation may comprise several layers which cannot be tested singly as basic insulation or supplementary insulation.

[SOURCE: IEC 60664-1:2007, 3.17.5]

3.4.2
basic insulation
insulation providing a basic safeguard against electric shock

3.5
isolation side
all terminals of side 1 which are isolated from all terminals of side 2 by an isolation barrier, forming a two-terminal device

3.6
isolation capacitance
C_{IO}
total capacitance between the terminals on side 1 of the isolation barrier connected together and the terminals on side 2 of the isolation barrier connected together forming a two-terminal device

Note 1 to entry: See IEC 60747-5-5:2007, 4.3.

3.7
isolation resistance
R_{IO}
resistance between the terminals on side 1 of the isolation barrier connected together and all the terminals on side 2 of the isolation barrier connected together forming a two-terminal device

3.8
isolation resistance at safety limiting temperature
R_{IO_S}
resistance at safety limiting temperature T_S between the terminals on side 1 of the isolation barrier connected together and all the terminals on side 2 of the isolation barrier connected together forming a two-terminal device which should be larger or equal to 1E9 Ω

3.9
isolation voltage
voltage between any specified terminals connected together on side 1 of the isolation barrier and any terminals connected together on side 2 of the isolation barrier

3.10
logic state match
condition in which an output logic state matches the associated input logic state

3.11
logic state transition match
condition in which an output logic state change follows the associated input logic state change

3.12
common mode transient immunity
CMTI
maximum tolerable rate-of-rise (or fall) of a common-mode voltage

Note 1 to entry: The common mode transient immunity is given in volts per second. CMTI should include the amplitude of the common-mode voltage that can be tolerated.

3.12.1
common mode transient immunity at logic high output
$|CM_H|$
common mode transient immunity of the coupler with logic at high output

3.12.2
common mode transient immunity at logic low output
$|CM_L|$
common mode transient immunity of the coupler with logic at low output

3.12.3
common mode transient immunity at logic dynamic output
$|CM_D|$
maximum slew rate of a common-mode voltage (V_{CM}) at which the coupler transmits the data without missing the transition or creating unexpected transitions for all combinations of slew rate polarity and data edges

Note 1 to entry: The data transition shall occur in the specified time frame, and invalid data in terms of delay times, transitions or number of transitions, or magnitude (not meeting minimum logic V_{OH} or maximum logic low V_{OL} specifications) will be construed as a failure.

3.12.4
CMTI performance
dV_{CM}/dt
maximum slew rate of a common mode voltage at which the output of the coupler remains at the specific logic level and at the specified timing

3.12.5
common mode voltage
V_{CM}
common mode voltage at which the slew rate is measured

3.13
propagation delay
t_{pLH} , t_{pHL}
time required for a change in the input state of a digital coupler to propagate to the corresponding output

Note 1 to entry: The propagation delay from LOW to HIGH is expressed by t_{pLH}.

Note 2 to entry: The propagation delay from HIGH to LOW is expressed by t_{pHL}.

3.14
pulse width distortion
$|t_{pLH} - t_{pHL}|$
PWD
unintentional and generally undesired change in the form of a signal causing the signal input pulse width to differ from signal output pulse width

3.15
supply voltage
V_{DD}
supply voltages supplied on input and output side of coupler

Note 1 to entry: The supply voltage is also commonly expressed by V_{CC}.

3.16
integrated circuit
IC
microcircuit in which all or some of the circuit elements are inseparably associated and electrically interconnected so that it is considered to be indivisible for the purpose of construction and commerce on side 1 and side 2

[SOURCE: IEC 60050-521:2002, 521-10-03, modified – The words "on side 1 and side 2" have been added.]

3.17
input and output terminal
I/O
side 1 and side 2 terminals of an integrated circuit providing signal conditioning to the internal coupling element

3.18
ground potential
GND
reference potential for any side of a coupler

3.19
input voltage
V_I
input voltage, either V_{IL}, V_{IH} or analog level

3.20
output voltage
V_O
output voltage, either V_{OL}, V_{OH} or analog level

3.21
maximum ambient operating temperature
$T_{op\ max}$
maximum ambient operating temperature allowed during operation of coupler

3.22
reference-point temperature
T_{REF}
temperature defined by the manufacturer to refer to a defined point such as junction temperature, case temperature, etc.

3.23
characteristic lifetime
t63
refers to characteristic lifetime (t63 %) when applying Weibull distribution to determine the mean lifetime

Note 1 to entry: In general, lifetime reliability is defined as the mean lifetime (t50 %) at which cumulative failure rate reaches 50 %. When Weibull distribution is used, a characteristic lifetime (t63 %) is considered for the mean lifetime. This is referred to as t63 in the statistical lifetime consideration.

3.24
general safety ratings of couplers for basic and reinforced insulation
thermal and mechanical operating conditions that exceed the specified ratings (limiting values) for normal operation, and to which the specified safety requirements refer

Note 1 to entry: The couplers may become permanently inoperative when safety ratings are applied.

3.25
electrical safety ratings of couplers for basic and reinforced insulation
electrical requirements that have to be met and maintained after the couplers have been subjected to specified safety ratings, to ensure protection against electrical shock

Note 1 to entry: The couplers may become permanently inoperative when safety ratings are applied.

[SOURCE: IEC 60747-5-5:2007, 5.2, modified – In the term, the word "requirements" has been replaced with "ratings", and "isolation" with insulation. In the definition, the word "photocoupler" has been replaced by "couplers".]

3.25.1
partial discharge
PD
localized electrical discharge which occurs in the insulation between all terminals of the side 1 and all terminals of side 2 of the coupler

3.25.2
apparent charge
q_{pd}
electrical discharge caused by a partial discharge in the coupler

3.25.3
threshold apparent charge
$q_{pd(TH)}$
specified value of apparent charge that is as small as technically feasible, which determines the partial-discharge extinction voltage.

Note 1 to entry: A threshold apparent charge of 5 pC was found to be a practicable criterion for couplers. Otherwise, it should be defined on each individual device design. Smaller threshold values are desirable but not required if accurate measurement in a production environment is not practical. This threshold shall not be exceeded at any time.

Note 2 to entry: In actual testing, this criterion applies to the apparent charge pulse with the maximum value.

Note 3 to entry: The term "specified discharge magnitude" (see 6.1.3.5.4.1 of IEC 60664-1:2007) is synonymous with "threshold apparent charge".

3.26
test voltage
$V_{pd(t)}$
voltage applied during the test period of the partial discharge test between all terminals of side 1 (connected together) and all terminals of side 2 (connected together) to the coupler under test

3.26.1
initial test voltage for partial discharge
$V_{pd(ini)}$
test voltage applied during the initial test time t_{ini}

3.26.2
initial test voltage for partial discharge, method a
$V_{pd(ini),a}$
value of the voltage applied at the beginning of the measurement, for a specified time t_{ini}, which is intended to simulate the occurrence of a transient overvoltage

Note 1 to entry: Refer to Figure 1, method a.

3.26.3
initial test voltage for partial discharge, method b
$V_{pd(ini),b}$
isolation test voltage applied between all terminals of side 1 (connected together) and all terminals of side 2 (connected together) at routine test (method b) which is equal or higher to the manufacturer's maximum transient voltage rating

3.27
multiplying factor
F
multiplying factor applied for method a and method b

Note 1 to entry: See Table 5 for more information.

3.28
apparent charge measuring voltage
$V_{pd(m)}$
test voltage at which apparent charge is measured

Note 1 to entry: Specified values of this voltage may be expressed as multiple of the specified value of the rated repetitive peak isolation voltage: $V_{pd(m)} = F \times V_{IORM}$. Refer to 3.27.

Note 2 to entry: This is a test voltage where the apparent charge shall be equal or less than the specified value.

3.29
partial-discharge inception voltage
$V_{pd(I)}$
lowest peak value of an AC test voltage at which the apparent charge is greater than the specified threshold apparent charge, if the test voltage is increased from a lower value where no partial discharge occurs

3.30
partial-discharge extinction voltage
$V_{pd(e)}$
lowest peak value of an AC test voltage at which the apparent charge is smaller than the specified threshold apparent charge, if the test voltage is reduced from a higher value where such discharge occurs

Note 1 to entry: The equivalent RMS value of an AC test voltage may also be used.

3.31
reference voltage for lifetime determination
V_{REF}
maximum predicated voltage which is determined by the end of life (EOL) test according 5.5.5.8

3.32
lifetime safety factor
lifetime safety factor applied to V_{REF} to reflect safety consideration on coupler lifetime

3.33
time intervals
duration and sequence of test voltages for partial discharge measurements as shown in Figure 1