

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Semiconductor devices – Discrete devices –
Part 5-5: Optoelectronic devices – Photocouplers**
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**Dispositifs à semiconducteurs – Dispositifs discrets –
Partie 5-5: Dispositifs optoélectroniques – Photocoupleurs**
<https://standards.iteh.ai/catalog/standards/sist/4c09518c-c7d0-461c-b754-7e068ca61d1e/iec-60747-5-5-2007>



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IEC 60747-5-5

Edition 1.0 2007-09

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Partie 5-5: Dispositifs optoélectroniques – Photocoupleurs**
7e068ca61d1e/iec-60747-5-5-2007

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE XA
CODE PRIX

ICS 31.080.01; 31.260

ISBN 2-8318-8643-0

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**SEMICONDUCTOR DEVICES –
DISCRETE DEVICES –****Part 5-5: Optoelectronic devices –
Photocouplers**

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International Standard IEC 60747-5-5 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

This standard replaces the clauses for photocouplers (or optocouplers) described in IEC 60747-5-1, IEC 60747-5-2 and IEC 60747-5-3, including their amendments.

The contents for phototransistors and photothyristors in IEC 60747-5-1, IEC 60747-5-2 and IEC 60747-5-3, including their amendments, will be considered obsolete as of the effective date of publication of this standard.

NOTE Photocouplers that are certified to the previous version of the photocoupler standard, namely IEC 60747-5-1/2/3, are to be considered in compliance with the requirements and provisions of IEC 60747-5-5.

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

FDIS	Report on voting
47E/332/FDIS	47E/340/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.

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SEMICONDUCTOR DEVICES – DISCRETE DEVICES –

Part 5-5: Optoelectronic devices – Photocouplers

1 Scope

This part of IEC 60747 gives the terminology, essential ratings, characteristics, safety tests as well as the measuring methods for photocouplers (or optocouplers).

NOTE The word “optocoupler” can also be used instead of “photocoupler”.

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 60065:2001, *Audio, video and similar electronic apparatus – Safety requirements*

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*

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

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

IEC 60068-2-78:2001, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60068-2-6:—, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)¹*

IEC 60068-2-14:1984, *Environmental testing – Part 2: Tests – Test N: Change of temperature*

IEC 60068-2-17:1994, *Basic environmental testing procedures – Part 2: Tests – Test Q: Sealing*

IEC 60068-2-27:—, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock and bump²*

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

IEC 60068-2-58:2005, *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 60112:2003, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

¹ To be published (replacing the sixth edition)

² To be published (replacing the third edition)

IEC 60216-1:2001, *Electrical insulating materials – Properties of thermal endurance – 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 60695-11-5:2004, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

3 Photocoupler

Optoelectronic device designed for the transfer of the electrical signals by utilizing optical radiation to provide coupling with electrical isolation between the input and the output

NOTE Different types of photocouplers include ambient-rated or case-rated photocouplers, for signal-isolation applications.

3.1 Semiconductor material

- Input diode: Gallium Arsenide, Gallium Aluminium Arsenide, etc.
- Output: Silicon, etc.

3.2 Details of outline and encapsulation

3.2.1 IEC and/or national reference number of the outline drawing

3.2.2 Method of encapsulation: glass/metal/plastic/other

3.2.3 Terminal identification and indication of any connection between a terminal and the case

3.3 Type of photocouplers

3.3.1 DC input photocoupler

Photocoupler consisting at the input of a photoemitter to which d.c. current is applied

3.3.2 AC input photocoupler

Photocoupler consisting at the input of antiparallel photoemitters to which a.c. current is applied

3.3.3 Phototransistor photocoupler

Photocoupler whose photo sensitive element is a phototransistor

NOTE Phototransistor is a transistor in which the current produced by the photoelectric effect in the neighbourhood of the emitter-base junction acts as base current, which is amplified.

3.3.4 Photodarlington photocoupler

Photocoupler whose photo sensitive element is a Darlington phototransistor

NOTE A base terminal may or may not be provided.

3.3.5 Photothyristor photocoupler

Photocoupler whose photo sensitive element is a photothyristor

NOTE 1 Photothyristor is a thyristor that is designed to be triggered by optical radiation.

NOTE 2 Gate terminal may or may not be provided.

3.3.6 Phototriac photocoupler

Photocoupler whose photo sensitive element is a phototriac.

NOTE A phototriac is a triac that is designed to be triggered by optical radiation.

3.3.7 IC photocoupler

Photocoupler whose photo-sensitive element is a photodiode/phototransistor and an integrated circuit

3.3.8 FET photocoupler

Photocoupler with one or more field-effect transistors (FETs) in the output stage

NOTE A FET is activated by photo emitter by direct optical radiation.

3.3.9 Photodiode photocoupler

Photocoupler whose photosensitive element is a photodiode

3.3.10 IC input photocoupler

Photocoupler whose input element consists of an integrated circuit and an photoemitter.

3.3.11 Solid state opto relay

Photocoupler whose photo sensitive element is phototriac and output is triac.

4 Terms related to ratings and characteristics for photocouplers

4.1 Current transfer ratio

4.1.1 Static value of the (forward) current transfer ratio $h_{F(ctr)}$

The ratio of the d.c. output current to the d.c. input current, the output voltage being held constant.

[IEC 60747-5-5:2007](http://standards.iteh.ai/catalog/standards/siv/4e6938a-c7d6-4bfc-b754-7e068ca61d1e/iec-60747-5-5-2007)

NOTE The abbreviation CTR (d.c.) is sometimes used instead of a symbol.

4.1.2 Small-signal short-circuit (forward) current transfer ratio $h_{f(ctr)}$

The ratio of the a.c. output current to the a.c. input current, the output being short-circuited to a.c.

NOTE The abbreviation CTR (a.c.) is sometimes used instead of a symbol.

4.2 Cut-off frequency f_{co}

The frequency at which the modulus of the small-signal current transfer ratio has decreased to $1/\sqrt{2}$ of its low-frequency value.

4.3 Input-to-output capacitance C_{IO}

The total capacitance between all input terminals connected together and all output terminals connected together.

4.4 Isolation resistance R_{IO}

The resistance between all input terminals connected together and all output terminals connected together.

4.5 Isolation voltage

The voltage between any specified input terminal and any specified output terminal.

4.5.1 DC isolation voltage V_{IO}

The value of the constant isolation voltage

4.5.2 Repetitive peak isolation voltage V_{IORM}

The highest instantaneous value of the isolation voltage including all repetitive transient voltages, but excluding all non-repetitive transient voltages.

NOTE A repetitive transient voltage is usually a function of the circuit. 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 non-repetitive voltage transient arrives.

4.5.3 Surge isolation voltage V_{IOSM}

The highest instantaneous value of an isolation voltage pulse of specified wave shape with short time duration

4.6 Terms related to photocouplers with phototriac output and/or solid state opto-relay with triac output**4.6.1 Repetitive peak voltage****4.6.2 Repetitive peak off-state voltage V_{DRM}**

Maximum applicable repetitive peak forward voltage between anode and cathode in off-state under specified gate conditions.

NOTE The repetitive voltage has a slew rate of less than the specified critical rate of rise of off-state voltage (dv/dt).

4.6.3 Repetitive peak reverse voltage V_{RRM}

Maximum applicable repetitive peak reverse voltage between anode and cathode in off-state under specified gate conditions.

4.6.4 RMS on-state current $I_{T(RMS)}$

Maximum applicable root-mean-square forward current between anode and cathode in on-state under specified gate conditions.

4.6.5 Peak off-state current I_{DRM}

Forward leakage current between the off-state output terminals under specified conditions

4.6.6 Peak on-state voltage V_{TM}

Peak forward voltage between on-state output terminals under specified conditions

4.6.7 DC off-state current I_{BD}

Forward leakage current between off-state output terminals under specified conditions

4.6.8 DC on-state voltage V_T

The d.c. forward voltage between on-state output terminals under specified conditions, when the specified forward current is applied between on-state output terminals

4.6.9 Holding current I_H

The minimum on-state current in output to maintain the on-state under specified conditions

4.6.10 Critical rate of rise of off-state voltage dV/dt

The rate of rise of off-state voltage just before the transition from off-state to on-state under the specified operating conditions

4.6.11 Trigger input current I_{FT}

The minimum input forward current to switch from off-state to on-state in output under specified conditions

4.7 Common mode transient immunity CMTI

The common mode transient immunity (CMTI), also sometimes referred to as the common mode rejection (CMR) or the common mode rejection ratio (CMRR), is the maximum tolerable rate-of-rise (or fall) of a common mode voltage (V_{CM}). The CMTI specification or the CMR or CMRR specification should include the amplitude of the common mode pulse (V_{CM}). This common mode pulse (V_{CM}) that is applied across the two grounds across the optocoupler should not exceed the maximum rated transient isolation voltage specification of the photocoupler as defined by the V_{IOTM} .

5 Terms for photocoupler providing protection against electrical shock

This clause covers terms for a photocoupler after it has been subjected to operating conditions (safety ratings) that exceed the specified ratings (limiting values) for normal operation.

5.1 Safety ratings of a photocoupler for reinforced isolation

Electrical, thermal, and mechanical operating conditions that exceed the specified ratings (limiting values) for normal operation, and to which the specified safety requirements refer.

5.2 Electrical safety requirements of a photocoupler for reinforced isolation

Electrical requirements that have to be met and maintained after the photocoupler has been subjected to specified safety ratings, to ensure protection against electrical shock.

NOTE The photocoupler may become permanently inoperative when safety ratings are applied.

5.2.1 Partial discharge p_d

Localized electrical discharge which occurs in the insulation between input and output terminals of the photocoupler

5.2.2 Apparent charge q_{pd} , q

Electrical charge caused by a partial discharge in the photocoupler

5.2.3 Threshold apparent charge $q_{pd(TH)}$, q_{TH}

A specified value of apparent charge that is as small as technically feasible and to which measured values of the partial-discharge inception voltage or extinction voltage, respectively, refer.

NOTE 1 A threshold apparent charge of 5 pC was found to be a practicable criterion for photocouplers. Otherwise it should be defined on each individual device design. Smaller values are desirable but are not viable at this time.

NOTE 2 In actual tests, this criterion applies to the apparent charge pulse with the maximum value.

NOTE 3 The term "specified discharge magnitude" (see 3.18.2 of IEC 60664-1) is synonymous with threshold apparent charge.

5.2.4 Test voltages for the partial-discharge test of a photocoupler

See Figure 1a and Figure 1b. All voltages used are a.c. peak voltages.

5.2.5 Test voltage $V_{pd(t)}$, V_t

The voltage applied during the test period between the input terminals (connected together) and the output terminals (connected together) of the photocoupler under test

5.2.6 Partial discharge test voltage $V_{pd(t)}$

The isolation voltage applied during the partial discharge test period.

NOTE 1 Specified values of this voltage may be expressed as multiple of the specified value of the maximum working isolation voltage or maximum repetitive peak isolation voltage: $V_{pd(t)} = F \times V_{IOWM}$ if $V_{IOWM} \geq V_{IORM}$.

($V_{pd(m)} = F \times V_{IOWM}$ or $V_{pd(m)} = F \times V_{IORM}$, whichever is higher. Refer to 5.2.8 for $V_{pd(m)}$.)

Refer 5.2.7 item c) multiplying factor.

NOTE 2 Test voltage, where the apparent charge has to be equal or less than the specified value.

5.2.7 Initial test voltage $V_{pd(ini)}$, V_{ini}

The test voltage applied during the initial test time t_{ini} .

- a) Initial voltage: $V_{pd(ini),a}$; $V_{ini,a}$ (see Table F.1 of IEC 60664-1 for minimum voltages, interpolation is also possible.)

The 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.

- b) Initial test voltage: $V_{pd(ini),b}$; $V_{ini,b}$

The isolation test voltage applied between the short-circuited input and the short-circuited output terminals at routine test (method b). A withstand voltage equal to the manufacturer's rating with a maximum of V_{IOTM}

NOTE 1 The initial test voltage is higher than or equal to the test voltage in the second part of the test period in which partial discharge characteristics are measured, see Subclause 5.2.10.

NOTE 2 For method a), the specified value for the initial test voltage is equal to the specified value of the maximum transient isolation voltage V_{IOTM} .

NOTE 3 For method b), the specified value for the initial test voltage (isolation voltage) is equal to or lower than the specified value of the maximum transient isolation voltage V_{IOTM} .

NOTE 4 The equivalent r.m.s. value of an a.c. test voltage may also be used.

- c) Multiplying factor: F

[IEC 60747-5-5:2007](https://standards.iteh.ai/catalog/standards/sist/4e693f8e-c7d6-41f6-b754-7e068ca61d1e/iec-60747-5-5-2007)

At routine test stage: $F = 1,875$

At sample test stage and after life tests, subgroup 1: $F = 1,6$

After endurance tests, subgroups 2 and 3: $F = 1,2$

NOTE When the test result using the above F factors is certainly affected by testability on, for example, the device package size, package leads or the test system, the following F factors can be chosen instead by manufacturer's decision; $F = 1,6$, $F = 1,2$ and $F = 1,0$ respectively.

5.2.8 Apparent charge measuring voltage $V_{pd(m)}$, V_m

The test voltage at which apparent charge is measured

5.2.9 Partial-discharge inception voltage $V_{pd(i)}$, V_i

The lowest peak value of an a.c. 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.

NOTE The equivalent r.m.s. value of an a.c. test voltage may also be used.

5.2.10 Partial-discharge extinction voltage $V_{pd(e)}$, V_e

The lowest peak value of an a.c. 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 The equivalent r.m.s. value of an a.c. test voltage may also be used.

5.2.11 Time intervals of the test voltage

See the terms and letter symbols indicated in Figure 1a and 1b.