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Low-voltage switchgear and controlgear - Part 10: Semiconductor circuit-breakers

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Low-voltage switchgear and controlgear - Part 10: Semiconductor circuit-breakers

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IEC 60947-10 has been prepared by subcommittee 121A: Low-voltage switchgear and controlgear, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low-voltage.

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

Draft	Report on voting
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Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

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This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

This document is to be used in conjunction with IEC 60947-1:2020.

The provisions of the general rules dealt with in IEC 60947-1 are applicable to this document, where specifically called for. Clauses and subclauses, tables, figures and annexes of the general rules thus applicable are identified by reference to IEC 60947-1:2020.

A list of all parts in the IEC 60947 series, published under the general title *Low-voltage switchgear and controlgear*, 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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

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1 Scope

This part of IEC 60947 applies to semiconductor circuit-breakers with a rated voltage up to 1 000 V AC or 1 500 V DC, intended to be installed and operated by instructed or skilled persons.

This document covers the following different types:

- semiconductor circuit-breakers (SCCBs) having semiconductor switching elements and, for isolation function, mechanical isolation contacts connected in series;
- semiconductor hybrid circuit-breakers (SCHCBs) having semiconductor switching elements and mechanical switching elements in parallel and in addition, for isolation function, mechanical isolation contacts connected in series.

NOTE 1 Circuit-breakers not incorporating power semiconductors in the main circuit are covered by IEC 60947-2.

In this document, where the term "circuit-breaker" only is used, it applies to both types.

This document applies regardless of the rated currents, the method of construction or the proposed applications of the circuit-breakers.

The object of this document is to state:

a) the characteristics of circuit-breakers;
b) the conditions with which circuit-breakers shall comply with reference to:
   1) operation and behaviour in normal service;
   2) operation and behaviour under specific abnormal circuit conditions (e.g. overload or short-circuit);
   3) dielectric properties;
   4) requirements on electromagnetic compatibility;
c) tests intended for confirming that these conditions have been met and the methods to be adopted for these tests;
d) information to be marked on or given with the circuit-breakers.

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NOTE 2 For cybersecurity aspects, see IEC 63208.

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

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

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

IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests*

IEC 60695-2-11:2021, *Fire hazard testing - Part 2-11: Glowing/hot-wire based test methods - Glow-wire flammability test method for end products (GWEPT)*

IEC 60747-9, *Semiconductor devices - Part 9: Discrete devices - 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 60749-23, *Semiconductor devices - Mechanical and climatic test methods - Part 23: High temperature operating life*

IEC 60749-25, *Semiconductor devices - Mechanical and climatic test methods - Part 25: Temperature cycling*

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

IEC 60947-1:2020, *Low-voltage switchgear and controlgear - Part 1: General rules*

IEC 60947-2:2024, *Low-voltage switchgear and controlgear - Part 2: Circuit-breakers*

IEC 61000-3-2, *Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC 61000-3-3, *Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤16 A per phase and not subject to conditional connection*

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IEC 61000-4-2:2025 *Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test*

IEC 61000-4-3:2020, *Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test*

IEC 61000-4-6:2023, *Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per* phase

IEC 61000-4-29, *Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests*

IEC 61000-4-34, *Electromagnetic compatibility (EMC) - Part 4-34: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current more than 16 A per phase*

IEC 61508-1:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements*

IEC 61508-3:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 3: Software requirements*

IEC 61709, *Electric components - Reliability - Reference conditions for failure rates and stress models for conversion*

IEC 62475:2010, *High-current test techniques - Definitions and requirements for test currents and measuring systems*

CISPR 11:2024, *Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement*

AEC-Q101, *Failure mechanism based stress test qualification for discrete semiconductors in automotive applications*

JEDEC JESD47, *Stress-test-driven qualification of integrated circuit*

UL 991:2024, *Tests for Safety-Related Controls Employing Solid-State Devices*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60947-1:2020 and IEC 60947-2:2024 and the following apply.

NOTE When a term is already defined in IEC 60947-1:2020 or IEC 60947-2:2024 but a new definition is given in this document, the following terms and definitions apply.

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- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
semiconductor circuit-breaker
SCCB
<of low-voltage switchgear and controlgear> protective device capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal circuit conditions such as those of short-circuit, which integrates semiconductor switching elements and isolation contacts connected in series

Note 1 to entry: The term "solid state" is often used synonymously with "semiconductor".

3.2
semiconductor hybrid circuit-breaker
SCHCB
<of low-voltage switchgear and controlgear> protective device capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal circuit conditions such as those of short-circuit, which integrates semiconductor switching elements and isolation contacts connected in series, as well as additional mechanical switching elements in parallel to the semiconductor switching elements

3.3
plug-in circuit-breaker
device which has a set of exterior contacts which enable the circuit breaker to be connected to a dedicated receiving device

3.4
withdrawable circuit-breaker

device which has a set of exterior isolating contacts which enable the circuit-breakers to be withdrawn from the main circuit, and, when placed in the disconnected position, achieves an isolating distance in accordance with specified requirements

3.5
breaking time

interval of time between the specified instant of initiation of the breaking operation and the instant when the current is practically zero

Note 1 to entry:

- In the case of breaking due to overcurrent, the instant of initiation of the breaking operation is the instant of initiation of a current large enough to cause the circuit-breaker to operate;
- For measurements, it is accepted to consider that the instant of initiation of the breaking operation starts at the onset of the current;
- In the case of breaking due to any form of external command, the instant of initiation of the breaking operation is the instant of application of the command.

Note 2 to entry: The expression "practically zero" is used in the context of the resolution of the typical current measuring system in switching tests

Note 3 to entry: At the end of the breaking operation, the circuit-breaker is not necessarily in open state.

Note 4 to entry: See Figure 6.

3.6
tripping time

interval of time between the specified instant of initiation of the breaking operation and the instant when the breaking operation becomes irreversible

Sample Document

Note 1 to entry:

- In the case of breaking due to overcurrent, the instant of initiation of the breaking operation is the instant of initiation of a current large enough to cause the circuit-breaker to operate;
- In the case of breaking due to any form of external command, the instant of initiation of the breaking operation is the instant of application of the command.

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Note 2 to entry: See Figure 6.

3.7
interrupting time

interval of time between the specified instant of the initiation of the turn-off of the power semiconductor and the instant when the current is practically zero

Note 1 to entry: Practically zero is used in the context of the resolution of the typical current measuring system in switching tests.

Note 2 to entry: See Figure 6.

3.8
limitation time

t_L

interval of time between the onset of the short-circuit current and the time when the let-through current is reached

Note 1 to entry: See Figure 6.

3.9
isolation time

interval of time between the specified instant of the initiation of the breaking operation and the instant when the circuit-breaker is in open state

Note 1 to entry: See Figure 6.