

INTERNATIONAL STANDARD

**Capacitors for high-voltage alternating current circuit-breakers -
Part 1: General and grading capacitors**

Sample Document

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Capacitors for high-voltage alternating current circuit-breakers -
Part 1: General and grading capacitors**

FOREWORD

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IEC 62146-1 has been prepared by IEC technical committee 33: Power capacitors and their applications. It is an International Standard.

This second edition cancels and replaces the first edition published in 2016. This edition constitutes a technical revision.

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

- a) Clause re-ordering and reworked sentences;
- b) New type and special tests.

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

Draft	Report on voting
33/746/FDIS	33/750/RVD

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.

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.

A list of all parts in the IEC 62146 series, published under the general title *Capacitors for high-voltage alternating current circuit-breakers*, can be found on the IEC website.

Future documents in this series will carry the new general title as cited above. Titles of existing documents in this series will be updated at the time of the next edition.

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

- reconfirmed,
- withdrawn, or
- revised.

1 Scope

This part of IEC 62146 includes generalities of capacitors used on alternating current circuit-breakers and introduces specifications for grading capacitors. Regarding grading capacitors, their function is to control the voltage distribution across the individual interrupter units of a multi-break circuit-breaker.

Capacitors can also be used in parallel to the interrupter unit on single break circuit-breakers to modify the Transient Recovery Voltage (TRV). This TRV capacitor application is covered by IEC 62146-2:2023.

Capacitors for high-voltage alternating circuit breakers are sub-components for the circuit-breaker and are specified in accordance with the circuit-breaker specifications according to IEC 62271-1, IEC 62271-100, and if applicable to IEC 62271-203.

This document applies to grading capacitors falling into one or both of the following categories for:

- mounting on air-insulated circuit-breakers.
- mounting on enclosed circuit-breakers (for example immersed in insulating gas, in oil, etc.).

The testing for each of the above applications is in some cases different.

The object of this document is:

- to define uniform rules regarding performances, testing and rating;
- to define specific safety rules;
- to provide a guidance for installation and operation.

NOTE CIGRÉ TB-368 presents a study about the operating environment of voltage grading capacitors applied to high-voltage circuit-breakers (see [2]¹).

This document does not apply to capacitors not directly associated with high-voltage alternating current circuit-breakers.

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 60060-1, *High-voltage test techniques - Part 1: General terminology and test requirements*

IEC 60068-2-17:2023, *Environmental testing - Part 2-17: Tests - Test Q: Sealing*

IEC 60071-2:2023, *Insulation co-ordination - Part 2: Application guidelines*

IEC 60270:2025, *High-voltage test techniques - Charge-based measurement of partial discharges*

IEC 60296, *Fluids for electrotechnical applications - Mineral insulating oils for electrical equipment*

¹ Numbers in square brackets refer to the Bibliography.

IEC 60567, *Oil-filled electrical equipment - Sampling of gases and analysis of free and dissolved gases in mineral oils and other insulating liquids - Guidance*

IEC 60815 (all parts), *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions*

IEC 60867, *Insulating liquids - Specifications for unused liquids based on synthetic aromatic hydrocarbons*

IEC 61099, *Insulating liquids - Specifications for unused synthetic organic esters for electrical purposes*

IEC 61462, *Composite hollow insulators - Pressurized and unpressurized insulators for use in electrical equipment with AC rated voltage greater than 1 000 V AC and DC voltage greater than 1 500 V - Definitions, test methods, acceptance criteria and design recommendations*

IEC 62146-2:2023, *Capacitors for high-voltage alternating current circuit-breakers - Part 2: TRV capacitors*

IEC 62155:2003, *Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V*

IEC 62271-1, *High-voltage switchgear and controlgear - Part 1: Common specifications for alternating current switchgear and controlgear*

IEC 62271-100, *High-voltage switchgear and controlgear - Part 100: Alternating-current circuit-breakers*

IEC 62271-203, *High-voltage switchgear and controlgear - Part 203: AC gas-insulated metal-enclosed switchgear for rated voltages above 52 kV*

IEC 62271-205, *High-voltage switchgear and controlgear - Part 205: Compact switchgear assemblies for rated voltages above 52 kV*

IEC 62271-300, *High-voltage switchgear and controlgear - Part 300: Seismic qualification of alternating current circuit-breakers*

IEC 62770, *Fluids for electrotechnical applications - Unused natural esters for transformers and similar electrical equipment*

IEC 63012, *Insulating liquids - Unused modified or blended esters for electrotechnical applications*

3 Terms and definitions

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

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

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

3.1

arcing distance

shortest distance in the air external to the insulator between the metallic parts which normally have the operating voltage between them

[SOURCE: IEC 60050-471:2007, 471-01-01]

3.2

capacitor element

device consisting essentially of two electrodes separated by a dielectric

[SOURCE: IEC 60050-436:1990, 436-01-03]

3.3

capacitor losses

active power dissipated in the capacitor

[SOURCE: IEC 60050-436:1990, 436-04-10]

3.4

capacitor terminals

terminals intended for electrical and mechanical connection to the terminals of the interrupter units of circuit-breakers

3.5

capacitance tolerance

permissible difference between the actual capacitance and the rated capacitance under specified conditions

Note 1 to entry: The actual capacitance should be measured at, or referred to, the temperature at which the rated capacitance is defined.

[SOURCE: IEC 60050-436:1990, 436-04-01, modified by addition of Note to entry.]

3.6

capacitor unit

assembly of one or more capacitor elements connected together and in the same container with terminals brought out

Note 1 to entry: A common type of unit for grading capacitors has a cylindrical housing of insulating material and metal end flanges which serve as terminals.

[SOURCE: IEC 60050-436:1990, 436-01-04, modified by addition of Note to entry]

3.7

completely immersed capacitor

capacitor, both ends of which are intended to be immersed in insulating media other than ambient air (e.g. oil or gas)

[SOURCE: IEC 60050-471:2007, 471-02-04, modified - definition originally referred to "bushing" instead of "capacitor".]

3.8

creepage distance

shortest distance along the surface of a solid insulating material between two conductive parts

Note 1 to entry: The surface of cement or any other non-insulating jointing material is not considered as forming part of the creepage distance.

Note 2 to entry: If high-resistance coating is applied to parts of the insulating part of an insulator, such parts are considered to be effective insulating surface and the distance over them is included in the creepage distance.

[SOURCE: IEC 60050-604:1987, 604-03-61, modified by addition of Notes to entry.]

3.9

dielectric (of a capacitor)

insulating material between the electrodes of the capacitor element

Note 1 to entry: The major insulation generally consists of paper, plastic film, or a mixed of paper and plastic film subsequently treated and impregnated with oil or gas at atmospheric pressure or higher.

3.10

external insulation

distance through the air and the surfaces in contact with the air of the grading capacitor that are subjected to dielectric stresses

Note 1 to entry: They are also subject to the effects of the atmospheric and other external conditions such as pollution, humidity, ice, vermin, etc.

3.11

failure

termination of the ability of an item to perform a required function

Note 1 to entry: After failure the item has a fault.

Note 2 to entry: "Failure" is an event, as distinguished from "fault", which is a state.

Note 3 to entry: This concept as defined does not apply to items consisting of software only.

[SOURCE: IEC 60050-191:1990, 191-04-01]

3.12

flashover

electric breakdown between conductors in a gas or in a liquid or in a vacuum, at least partly along the surface of solid insulation

[SOURCE: IEC 60050-212:2012, 212-11-47]

3.13

grading capacitor

capacitor for installation on high-voltage circuit-breakers to control the voltage distribution across the individual interrupter unit

Note 1 to entry: The grading capacitors alone are accessories of the circuit-breaker.

3.14

indoor capacitor

capacitor, both ends of which are intended to be in ambient air at atmospheric pressure but not exposed to outdoor atmospheric conditions

[SOURCE: IEC 60050-471:2007, 471-02-05, modified - definition originally referred to "bushing" instead of "capacitor".]

3.15**insulating envelope**

insulator which is open from end to end, with or without sheds, including end fittings

Note 1 to entry: An insulating envelope can be made from one or more permanently assembled insulating elements.

Note 2 to entry: The insulating envelope may be in ceramic, glass or analogous inorganic material, cast or moulded resin, composite insulating material, in one piece or more pieces permanently assembled.

[SOURCE: IEC 60050-471:2007, 471-01-08, modified - definition originally referred to a hollow insulator and Note 2 to entry has been added.]

3.16**outdoor capacitor**

capacitor, both ends of which are intended to be in ambient air at atmospheric pressure, and exposed to outdoor atmospheric conditions

[SOURCE: IEC 60050-471:2007, 471-02-07, modified - definition originally referred to "bushing" instead of "capacitor".]

3.17**internal insulation**

internal solid, liquid or gaseous parts of the insulation of the grading capacitor which are protected from the effects of atmospheric conditions

Note 1 to entry: The parts are also protected from other external conditions such as pollution, humidity, ice, vermin, etc.

3.18**mechanical stress**

any mechanical stress applied to the insulating envelope and to the terminals of the capacitor

Note 1 to entry: It is a function of the following main forces:

- forces on the terminals due to the circuit-breaker connection;
- forces due to the wind and ice;
- seismic forces;
- forces due to the operating conditions, opening and closing, of the circuit- breaker;
- thermal forces due to the ambient medium conditions;
- forces due to the transportation of the circuit-breaker or capacitors.

3.19**puncture**

disruptive discharge occurring through a solid insulation material, producing a path of permanent damage

Note 1 to entry: The term puncture is also used as a synonym for electrical breakdown in solids.

[SOURCE: IEC 60050-212:2010, 212-11-49]

3.20**rated capacitance of a capacitor**

C_r

capacitance value for which the capacitor has been designed