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Interested committees:

Title: BS EN 62146-1 Capacitors for high-voltage alternating current circuit-breakers

Part 1: General and grading capacitors

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



33/712/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER: IEC 62146-1 ED2	
DATE OF CIRCULATION: 2024-07-12	CLOSING DATE FOR COMMENTS: 2024-10-04
SUPERSEDES DOCUMENTS: 33/687/RR	

IEC TC 33 : POWER CAPACITORS AND THEIR APPLICATIONS	
SECRETARIAT: Italy	SECRETARY: Mr Stefano Zunino
OF INTEREST TO THE FOLLOWING COMMITTEES: SC 17A	HORIZONTAL FUNCTION(S):
ASPECTS CONCERNED: Environment,Safety	

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Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Recipients of this document are invited to submit, with their comments, notification of any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "In Some Countries" clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

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

NOTE FROM TC/SC OFFICERS:

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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 subcommittee JMT 17A: Joint Maintenance Team 17A, of IEC technical committee TC 33: Power capacitors and their applications.

This second edition cancels and replaces the first edition published in 2016-06. 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/XX/FDIS	33/XX/RVD

162
163 Full information on the voting for its approval can be found in the report on voting indicated in
164 the above table.

165 The language used for the development of this international standard is English.

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

170 A list of all parts in the IEC 62146 series, published under the general title *Capacitors for high-*
171 *voltage alternating current circuit-breakers*, can be found on the IEC website. The title of the
172 series was changed in 2022 by decision of TC 33, and the title of this standard, IEC 62146-1,
173 is modified accordingly.

174 The committee has decided that the contents of this document will remain unchanged until the
175 stability date indicated on the IEC website under webstore.iec.ch in the data related to the
176 specific document. At this date, the document will be replaced by a revised edition.

177

178

179

CAPACITORS FOR HIGH-VOLTAGE ALTERNATING CURRENT CIRCUIT-BREAKERS

Part 1: General and grading capacitors

1 Scope

This part of the IEC 62146 series includes generalities of capacitors used on alternating current circuit-breakers and introduce 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 the IEC 62146-2:2023 standard.

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

This standard 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 standard is:

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

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

This standard 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 definitions and test requirements*

IEC 60068-2-11, *Environmental testing - Part 2-11: Tests - Test Ka: Salt mist*

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

IEC 60068-2-42, *Environmental testing - Part 2-42: Tests - Test Kc: Sulphur dioxide test for contacts and connections*

- 219 IEC 60071-1, *Insulation co-ordination – Part 1: Definitions, principles and rules*
- 220 IEC 60270:2000, *High-voltage test techniques – Partial discharge measurements*
- 221 IEC 60358-1, *Coupling capacitors and capacitor dividers - Part 1: General rules*
- 222 IEC 60567, *Oil-filled electrical equipment – Sampling of gases and analysis of free and*
223 *dissolved gases – Guidance*
- 224 IEC 60815 (all parts), *Selection and dimensioning of high-voltage insulators intended for use in*
225 *polluted conditions*
- 226 IEC 61462, *Composite hollow insulators - Pressurized and unpressurized insulators for use in*
227 *electrical equipment with AC rated voltage greater than 1 000 V AC and D.C. voltage greater*
228 *than 1500V - Definitions, test methods, acceptance criteria and design recommendations*
- 229 IEC 62146-2:2023, *Capacitors for high-voltage alternating current circuit-breakers - Part 2: TRV*
230 *capacitors*
- 231 IEC 62155:2003, *Hollow pressurized and unpressurized ceramic and glass insulators for use in*
232 *electrical equipment with rated voltages greater than 1 000 V*
- 233 IEC 62271-1, *High-voltage switchgear and controlgear – Part 1: Common specifications*
- 234 IEC 62271-100, *High-voltage switchgear and controlgear – Part 100: Alternating current circuit-*
235 *breakers*
- 236 IEC 62271-203, *High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-*
237 *enclosed switchgear for rated voltages above 52 kV*
- 238 IEC 62271-205, *High-voltage switchgear and controlgear - Part 205: Compact switchgear*
239 *assemblies for rated voltages above 52 kV*
- 240 IEC 62271-300, *High-voltage switchgear and controlgear – Part 300: Seismic qualification of*
241 *alternating current circuit-breakers*
- 242 IEC Guide 109, *Environmental aspects – Inclusion in electrotechnical product standards*
- 243 CIGRE TB-368, *Operating Environment of Voltage grading Capacitors applied to High Voltage*
244 *Circuit-Breakers*

245 **3 Terms and definitions**

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

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

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

251

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.

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

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

297 **3.9**

298 **dielectric of a capacitor**

299 insulating material between the electrodes of the capacitor element

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

302 **3.10**

303 **external insulation**

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

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

308 **3.11**

309 **failure**

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

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

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

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

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

315 **3.12**

316 **flashover**

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

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

320 **3.13**

321 **grading capacitor**

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

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

325 **3.14**

326 **indoor capacitor**

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

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

331 **3.15**

332 **insulating envelope**

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

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

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

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

339 **3.16**

340 **outdoor capacitor**

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

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

345 **3.17**

346 **internal insulation**

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

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

351 **3.18**

352 **major failure (of a capacitor)**

353 failure of a capacitor which causes the cessation of its fundamental function.

354 Note 1 to entry: A major failure will result in a mandatory removal from service within 30 min for unscheduled
355 maintenance.

356 **3.19**

357 **mechanical stress**

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

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

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

366 **3.20**

367 **minor failure (of a capacitor)**

368 any failure of a capacitor which does not cause a major failure of the capacitor

369 **3.21**

370 **puncture**

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

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

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

375 **3.22**

376 **rated capacitance of a capacitor**

377 C_r

378 capacitance value for which the capacitor has been designed

3.23

rated chopped lightning impulse withstand voltage

required peak value of the chopped lightning impulse withstand voltage which characterises the insulation of a capacitor as regards the withstand tests

Note 1 to entry: The definitions and the standard parameters applicable to chopped impulses are specified in IEC 60060-1.

3.24

rated frequency of a capacitor

f_r

frequency for which the capacitor has been designed

[SOURCE: IEC 60050-436:1990, 436-01-14, modified by addition of symbol]

3.25

rated insulation level

test voltages, under specified conditions, that the insulation is designed to withstand

Note 1 to entry: These test voltages can be for instance:

a) rated chopped and lightning impulse and short duration power frequency withstand voltages for capacitors installed on circuit-breaker with rated voltage lower than 300 kV.

b) rated switching, lightning, chopped impulse and short duration power frequency withstand voltages for capacitors installed on circuit-breaker with rated voltage equal to or greater than 300 kV.

Note 2 to entry: The rated insulation levels of the capacitor should be equal to or higher than the relevant requirements for the circuit-breaker interrupting unit.

[SOURCE: IEC 60050-421:1990, 421-09-02, modified Note to entry]

3.26

rated lightning impulse withstand voltage

$U_{C LI}$

required peak value of the lightning impulse withstand voltage which characterises the insulation of an equipment as regards the withstand tests

Note 1 to entry: The standard lightning impulse has a front time of 1,2 μs and a time-to-half-value of 50 μs as specified in IEC 60060-1.

3.27

rated short duration power frequency withstand voltage

$U_{C PF}$

required r.m.s. value of sinusoidal power frequency voltage that the equipment withstands during tests made under specified conditions and for a duration of 1 min unless otherwise specified

3.28

rated switching impulse withstand voltage

$U_{C SI}$

required peak value of the switching impulse withstand voltage which characterises the insulation of an equipment as regards the withstand tests

Note 1 to entry: The standard switching impulse has a time-to-crest of 250 μs and a time-to-half-value of 2500 μs as specified in IEC 60060-1.

3.29

rated temperature category of a capacitor

range of temperature of the ambient air or other medium in which the capacitor is immersed during the service life and for which it has been designed.