

INTERNATIONAL STANDARD

REDLINE VERSION

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

Sample Document

get full document from standards.iteh.ai



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2026 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search -

webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	4
1 Scope	6
2 Normative references	6
3 Terms and definitions	8
4 Abbreviated terms	13
5 Normal and special Service conditions	13
5.1 General	13
5.2 Normal service conditions	14
5.2.1 Ambient temperature	14
5.2.2 Altitude	14
5.2.3 Mechanical stress and vibrations	14
5.2.4 Additional service conditions for indoor and completely immersed grading capacitor	14
5.3 Special service conditions	14
5.3.1 General	14
5.3.2 Altitude correction	14
5.3.3 Earthquakes	16
6 Ratings	16
6.1 Rated voltage (U_{cr})	16
6.2 Rated insulation level	16
6.3 Rated frequency (f_r)	18
7 Design and construction	18
7.1 Capacitance tolerances	18
7.2 Capacitor loss requirements	18
7.3 Partial discharge level	18
7.4 Angle of mounting	19
7.5 Minimum withstand value of mechanical bending load	19
7.5.1 Capacitors mounted on air insulated circuit-breaker	19
7.5.2 Immersed capacitors	19
7.6 Requirements for impregnation medium in capacitor Insulation fluids	19
7.6.1 General	19
7.6.2 Tightness Liquid insulation	19
7.6.3 Gas insulation	20
7.7 Protection against corrosion	21
7.8 Nameplates Marking of the equipment	21
7.9 Creepage distances for outdoor insulators capacitors	21
8 Type tests	21
8.1 Information for identification of specimens	21
8.2 Information to be included in type-test reports	22
8.3 Test conditions	22
8.4 Dielectric type tests	23
8.4.1 General	23
8.4.2 Capacitance measurement at power frequency	
8.4.3 Measurement of the tangent of the loss angle ($\tan\delta$)	
8.4.4 Partial discharge test	
8.4.2 Switching impulse voltage test	27

8.4.3	Lightning and chopped lightning impulse voltage tests.....	28
8.4.7	Power frequency voltage test.....	
8.5	Voltage test at low and high temperature	29
8.5.1	Test procedure	29
8.5.2	Capacitor reduced-scale model design	29
8.6	Radio interference voltage (RIV) test	30
8.7	Power frequency withstand voltage test	30
8.8	Short-circuit discharge test	30
8.9	Resonance frequency measurements	30
8.10	Mechanical bending test	31
8.11	Tightness test at different temperatures	31
8.12	Tightness test to check gas ingress from a pressurised environment	32
8.13	Vibration test	32
9	Routine tests	33
9.1	General.....	33
9.2	Test conditions	34
9.3	Capacitance and $\tan \delta$ (loss angle) measurement at power frequency.....	34
9.4	Power frequency withstand voltage test	35
9.5	Partial discharge test.....	35
9.6	Tightness test	36
9.6.1	General	36
9.6.2	Oil impregnated capacitor	36
9.6.3	Tightness test for gas filled grading capacitors	37
9.7	Visual inspection and dimensional check	38
10	Design test.....	38
10.1	Aging test	38
10.1.1	Test procedure	38
10.1.2	Acceptance criteria	38
11	Recommendations for transport, storage, erection installation, operation and maintenance.....	39
11.1	General.....	39
11.2	Conditions during transport, storage and installation	39
11.3	Installation	39
11.3.1	General	39
11.3.2	Unpacking and lifting	40
11.3.3	Assembly	40
11.4	Operation.....	40
11.5	Maintenance	40
11.5.1	General	40
11.5.2	Recommendation for the installation and maintenance	41
12	Safety.....	41
12.1	General.....	41
12.2	Precautions by manufacturers.....	41
12.3	Precautions by users	41
12.4	National regulations	41
13	Environmental aspects	41

Annex A (informative) Corrosion: Information regarding service conditions and recommended test requirements	43
A.1 General.....	43
A.2 Recommended test requirements	43
Annex B (informative) Resonance frequency measurements	44
B.1 General.....	44
B.2 Time domain method	45
B.2.1 General	45
B.2.2 Test procedure	45
B.2.3 Measurement results	46
B.3 Frequency domain method	46
B.3.1 General	46
B.3.2 Test setup	46
B.3.3 Measurement results	47
Bibliography.....	49
Figure 1 — Dielectric type tests.....	
Figure 1 – Factor m for the switching impulse withstand test.....	15
Figure 2 – Example of a dielectric type test sequence.....	25
Figure 2 — Dielectric routine test	
Figure 3 – Reduced scale model capacitor element geometry	30
Figure 4 – Example of an electrical routine test sequence.....	34
Figure B.1 — Example of resonance frequency measurement recording (see 8.7).....	
Figure B.1 – Example of test setup for resonance frequency measurements in time domain (see 8.9).....	45
Figure B.2 – Example of time domain voltage transient response to calculate resonance frequency (see 8.9).....	46
Figure B.3 – Wiring diagram of the measuring circuit for the high-frequency response (adapted from IEC 60358-2, Annex AA)	47
Figure B.4 – Frequency response of a high voltage capacitor: Impedance magnitude (blue, solid line) and phase (red, dashed line).....	48
Table 1 — Partial discharge test voltages and permissible levels	
Table 1 – Partial discharge test voltages and permissible levels for grading capacitors	18

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 62146-1:2016. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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 ~~is applicable to grading~~ 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.

~~Grading~~ 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.

~~The grading capacitor is a sub-component for the circuit breaker and shall be specified in accordance with the circuit-breaker specifications.~~

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 ~~SF₆~~ 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 ~~phase-to-earth capacitors installed on the circuit-breaker to modify the Transient Recovery Voltage~~ 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 60050 (all parts), International electrotechnical vocabulary (available at <http://www.electropedia.org>)~~

IEC 60060-1:2010, *High-voltage test techniques - Part 1: General terminology and test requirements*

¹ Numbers in square brackets refer to the Bibliography.

IEC 60068-2-17:19942023, ~~Official version in Russian~~ ~~Basic~~ Environmental testing procedures - Part 2-17: Tests - Test Q: Sealing

~~IEC 60071-1:2006, Insulation co-ordination - Part 1: Definitions, principles and rules~~

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

IEC 60270:20002025, High-voltage test techniques - Charge-based measurement of partial discharges ~~measurements~~

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

~~IEC 60376:2005, Specification of technical grade sulfur hexafluoride (SF₆) for use in electrical equipment~~

~~IEC 60507-1:1991, Artificial pollution tests on high-voltage insulators to be used on a.c. systems~~

IEC 60567:2011, Oil-filled electrical equipment - Sampling of gases and analysis of free and dissolved gases in mineral oils and other insulating liquids - Guidance

~~IEC 60721-1:2002, Classification of environmental conditions - Part 1: Environmental parameters and their severities~~

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 61462:2007, 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 62271-1:2007, High-voltage switchgear and controlgear - Part 1: Common specifications for alternating current switchgear and controlgear

IEC 62271-100:2008, High-voltage switchgear and controlgear - Part 100: Alternating-current circuit-breakers

IEC 62271-203:2003, 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 62271-300:2006, *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*

~~IEC Guide 109, *Environmental aspects — Inclusion in electrotechnical product standards*~~

~~CISPR 18-2:1986, *Radio interference characteristics of overhead power lines and high-voltage equipment — Part 2: Methods of measurement and procedure for determining limits*~~

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 ~~in~~ **through the** air and the surfaces in contact with ~~open the~~ **air of** ~~insulation 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~~

~~**major failure (of a grading capacitor)**~~

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

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

3.18

mechanical stress

any mechanical stress applied to the insulating envelope and to the terminals of the ~~grading~~ 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 ~~grading~~ capacitors.

3.20**~~minor failure (of a grading capacitor)~~**~~any failure of a grading capacitor which does not cause a major failure of the grading capacitor~~**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

3.21**rated chopped lightning impulse withstand voltage**

required peak value of the chopped lightning impulse withstand voltage which characterises the insulation of a ~~grading~~ 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.

3.22**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.]

3.23**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:

- 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.
- 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 ~~grading~~ 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]

3.24**rated lightning impulse withstand voltage** U_{CL}

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 μ s and a time-to-half-value of 50 μ s as specified in IEC 60060-1.

3.25

rated short duration power frequency withstand voltage

$U_{C PF}$

required RMS 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

3.26

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 μ s and a time-to-half-value of 2 500 μ s as specified in IEC 60060-1.

3.27

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

3.28

rated voltage of a capacitor

U_{cr}

RMS value of the alternating voltage assigned to the capacitor for identification and at which the capacitor is designed to operate continuously

3.29

rated voltage of circuit-breaker

U_r

indicates the upper limit of the highest voltage of systems for which the circuit-breaker is intended

Note 1 to entry: See IEC 62271-1.

Note 2 to entry: U_r used in IEC 62271-1 series corresponds to U_m presented in IEC 60071.

3.30

resonance frequency

frequency for which the reactance of the intrinsic capacitance of the capacitor is equal to the reactance of the self-inductance of the capacitor

3.31

sample

device for testing

Note 1 to entry: Examples of such devices are a complete small capacitor, or the housing of a grading capacitor with metal end flanges filled with impregnating fluid.

3.32

tangent of the loss angle of a capacitor

$\tan \delta$

ratio between the equivalent series resistance and the capacitive reactance of a capacitor at specified sinusoidal alternating voltage and frequency

[SOURCE: IEC 60050-436:1990, 436-04-11]

3.33**voltage grading factor of a circuit-breaker** **F_{VG}**

value that defines the standard values of rated voltages for the grading capacitor

Note 1 to entry: This factor is the ratio between the actual maximum power frequency voltage fraction across one interrupter unit of a multi-break circuit-breaker and the calculated linear power frequency voltage distribution per interrupting unit.

Note 2 to entry: It is dependent on the circuit-breaker design, of the capacitance value of the grading capacitor and its tolerance and of the safety margin.

4 Abbreviated terms

TRV	Transient Recovery Voltage
C_r	Rated capacitance of a capacitor
f_r	Rated frequency of a capacitor
U_{cr}	Rated voltage of a capacitor
U_r	Rated voltage of circuit-breaker
$\tan \delta$	Tangent of the loss angle of a capacitor
F_{VG}	Voltage grading factor of a circuit-breaker
$U_{C PF}$	Rated short-duration power frequency withstand voltage for the grading capacitor
U_{PF}	Rated short-duration power frequency withstand voltage across the open circuit-breaker
$U_{GLIWL} U_{C LI}$	Rated lightning impulse withstand voltage for the grading capacitor
$U_{(LIWL LI + PF)}$	Combined lightning and power frequency withstand voltage for the circuit-breaker
$U_{GSIWL} U_{C SI}$	Rated switching impulse withstand voltage for the grading capacitor
$U_{(SIWL SI + PF)}$	Combined switching and power frequency withstand voltage for the circuit-breaker
$U_{CCHOPPED} U_{C LIC}$	Chopped lightning impulse voltage for the grading capacitor
BIL	Bushings insulated level
SIL	Standard insulation level
RIV	Radio interference voltage
ESR	Equivalent series resistance

5 ~~Normal and special~~ Service conditions**5.1 General**

The ~~grading~~ capacitors **mentioned in this document** are intended to be installed on circuit-breakers, for which the normal and special service conditions are described in IEC 62271-1.

Additional service conditions specific to the capacitors are given in 5.2.3.