BS EN IEC 62271-100:2021+A1:2024



BSI Standards Publication

High-voltage switchgear and controlgear

Part 100: Alternating-current circuit-breakers

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National foreword

This British Standard is the UK implementation of EN IEC 62271-100:2021+A1:2024. It is identical to IEC 62271-100:2021, incorporating amendment 1:2024. It supersedes BS EN IEC 62271-100:2021, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee PEL/17, High voltage switchgear, controlgear and assemblies.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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NORME EUROPÉENNE

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High-voltage switchgear and controlgear - Part 100: Alternating current circuit-breakers (IEC 62271-100:2021)

Appareillage à haute tension - Partie 100: Disjoncteurs à courant alternatif (IEC 62271-100:2021)

Hochspannungs-Schaltgeräte und -Schaltanlagen - Teil 100: Wechselstrom-Leistungsschalter (IEC 62271-100:2021)

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European foreword

The text of document 17A/1299/FDIS, future edition 3 of IEC 62271-100, prepared by SC 17A "Switching devices" of IEC/TC 17 "High-voltage switchgear and controlgear" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62271-100:2021.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2022–05–11
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2024–08–11

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The text of the International Standard IEC 62271-100:2021 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60137:2017 NOTE Harmonized as EN 60137:2017 (not modified)

IEC 62271-110 NOTE Harmonized as EN IEC 62271-110

IEC 60296 NOTE Harmonized as EN IEC 60296

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IEC 60480 NOTE Harmonized as EN IEC 60480

European foreword to Amendment 1

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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60050-151	2001	International Electrotechnical Vocabulary (IEV) - Part 151: Electrical and magnetic devices	-	-
+A1	2013			
+A2	2014			
+A3	2019			
+A4	2020			
IEC 60050-441	1984	International Electrotechnical Vocabulary (IEV) - Part 441: Switchgear, controlgear and fuses	-	-
+A1	2000			
IEC 60050-442	1998	International Electrotechnical Vocabulary (IEV) - Part 442: Electrical accessories	-	-
+A1	2015			
+A2	2015			
+A3	2019			
IEC 60050-461	2008	International Electrotechnical Vocabulary (IEV) - Part 461: Electric cables	-	-
IEC 60050-601	1985	International Electrotechnical Vocabulary (IEV) - Part 601: Generation, transmission and distribution of electricity - General	-	-
+A1	1998			
+A2	2020			
IEC 60050-614	2016	International Electrotechnical Vocabulary (IEV) - Part 614: Generation, transmission and distribution of electricity - Operation	-	-
IEC 60059	-	IEC standard current ratings	EN 60059	-
IEC 60060-1	-	High-voltage test techniques - Part 1: General definitions and test requirements	EN 60060-1	-

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IEC 60255-151	2009	Measuring relays and protection equipment - Part 151: Functional requirements for over/under current protection	EN 60255-151	2009
IEC 60270	-	High-voltage test techniques - Partial discharge measurements	EN 60270	-
IEC 62271-1	2017	High-voltage switchgear and controlgear - Part 1: Common specifications for alternating current switchgear and controlgear	EN 62271-1	2017
IEC 62271-101	-	High-voltage switchgear and controlgear - Part 101: Synthetic testing	EN 62271-101	-
IEC 62271-102	2018	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches	EN IEC 62271-102	2018
IEC 62271-200	2021	High-voltage switchgear and controlgear - Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV	EN IEC 62271-200	2021
IEC 62271-203	-	High-voltage switchgear and controlgear - Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV	EN 62271-203	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 100: Alternating-current circuit-breakers

FOREWORD

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International Standard IEC 62271-100 has been prepared by subcommittee 17A: Switching devices, of IEC technical committee 17: High-voltage switchgear and controlgear.

This third edition cancels and replaces the second edition published in 2008, Amendment 1:2012 and Amendment 2:2017. This edition constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

– the document has been updated to IEC 62271-1:2017;
– Amendments 1 and 2 have been included;
– the definitions have been updated, terms not used have been removed;
– Subclauses 7.102 through 7.108 have been restructured.

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

FDIS	Report on voting
17A/1299/FDIS	17A/1305/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/standardsdev/publications.

This document is to be read in conjunction with IEC 62271-1, second edition, published in 2017, to which it refers and which is applicable unless otherwise specified. In order to simplify the indication of corresponding requirements, the same numbering of clauses and subclauses is used as in IEC 62271-1. Amendments to these clauses and subclauses are given under the same references whilst additional subclauses are numbered from 101.

A list of all parts of IEC 62271 series, under the general title *High-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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

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INTRODUCTION to Amendment 1

This amendment includes the following significant changes:

In IEC 62271-100:2021 there is a slight difference for the calculation of u_c for T10 in Table 20 and Table 21. The u_c value for T10 shall be the same for k_{pp} 1,3 and k_{pp} 1,5 because both conditions also cover transformer limited faults. For voltage ratings higher than 170 kV u_c also covers cases of three-phase line faults with effectively earthed neutral systems. See also the notes in Table 20 and Table 21. By increasing the k_{af} from 1,76 to 1,765 the u_c values are practically the same again for k_{pp} 1,3 and k_{pp} 1,5.

Furthermore:

– The definition of terminal fault has been updated.
– The description of the time parameters for the rated operated sequence has been updated (the parameters remained the same).
– Rated voltages 15,5; 27 and 40,5 kV added to Table 1.
– Additional criteria for dielectric test added.
– It has been made explicit that partial discharge test only is applicable to GIS and dead-tank circuit-breakers.
– Voltage test as condition check as per 7.2.12.103 added to 7.2.12.101.
– The t_2 for T60 are corrected to the t_2 values of T100.
– TRV values in Table 16, Table 17, Table 18, Table 19, Table 20, Table 22, Table 23, Table 24, Table 25, Table 30 and Table F.1 have been recalculated and updated.
– Requirement on having inrush making current in the same phase as minimum arcing times during three-phase back-to-back capacitor bank current tests.
– Requirement to perform mechanical operating tests on all releases added.
– Existing tolerance for single-phase and double-earth fault added to Table B.1.
– Tolerance for breaking current L_{75} updated in Table B.1.

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 100: Alternating-current circuit-breakers

1 Scope

This part of IEC 62271 is applicable to three-phase AC circuit-breakers designed for indoor or outdoor installation and for operation at frequencies of 50 Hz and/or 60 Hz on systems having voltages above 1 000 V. This document includes only direct testing methods for making-breaking tests. For synthetic testing methods refer to IEC 62271-101.

NOTE In a direct testing method one source is used to supply the voltage and current during the making and breaking tests.

This part of IEC 62271 is not applicable to:

– circuit-breakers with a closing mechanism for dependent manual operation;
– circuit-breakers intended for use on motive power units of electrical traction equipment; these are covered by IEC 60077 (all parts) [1][1];
– generator circuit-breakers installed between generator and step-up transformer; these are covered by the IEC 62271-37-013 [2];
– self-tripping circuit-breakers with tripping devices that cannot be made inoperative during testing. Tests on automatic circuit reclosers are covered by IEC 62271-111 [3];
– tests to prove the performance under abnormal conditions that are not described in this document are subject to agreement between manufacturer and user. Such abnormal conditions are, for example, cases where the voltage is higher than the rated voltage of the circuit-breaker, conditions which can occur due to sudden loss of load on long lines or cables.

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 60050-151:2001, *International Electrotechnical Vocabulary (IEV) – Part 151: Electrical and magnetic devices*
IEC 60050-151:2001/AMD1:2013
IEC 60050-151:2001/AMD2:2014
IEC 60050-151:2001/AMD3:2019
IEC 60050-151:2001/AMD4:2020

IEC 60050-441:1984, *International Electrotechnical Vocabulary (IEV) – Part 441: Switchgear, controlgear and fuses*
IEC 60050-441:1984/AMD1:2000

[1] Numbers in square brackets refer to the bibliography.

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IEC 60050-442:1998, *International Electrotechnical Vocabulary (IEV) – Part 442: Electrical accessories*
IEC 60050-442:1998/AMD1:2015
IEC 60050-442:1998/AMD2:2015
IEC 60050-442:1998/AMD3:2019

IEC 60050-461:2008, *International Electrotechnical Vocabulary (IEV) – Part 461: Electric cables*

IEC 60050-601:1985, *International Electrotechnical Vocabulary (IEV) – Part 601: Generation, transmission and distribution of electricity – General*
IEC 60050-601:1985/AMD1:1998
IEC 60050-601:1985/AMD2:2020

IEC 60050-614:2016, *International Electrotechnical Vocabulary (IEV) – Part 614: Generation, transmission and distribution of electricity – Operation*

IEC 60059, *IEC standard current ratings*

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60255-151:2009, *Measuring relays and protection equipment – Part 151: Functional requirements for over/under current protection*

IEC 60270, *High-voltage test techniques – Partial discharge measurements*

IEC 62271-1:2017, *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*

IEC 62271-101, *High-voltage switchgear and controlgear – Part 101: Synthetic testing*

IEC 62271-102:2018, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

IEC 62271-200:20—[2], *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-151, IEC 60050-441, IEC 60050-442, IEC 60050-461, IEC 60050-601 and IEC 60050-614, some of which are recalled hereunder, and the following apply.

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

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

[2] Under preparation. Stage at the time of publication: IEC RFDIS 62271-200:2021.

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NOTE Terms and definitions are classified in accordance with IEC 60050-441. Reference from other parts than IEC 60050-441 are classified so as to be aligned with the classification used in IEC 60050-441.

3.1 General terms and definitions

3.1.101
switchgear and controlgear
general term covering switching devices intended to be installed indoor or outdoor and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures

[SOURCE: IEC 60050-441:1984, 441-11-01, modified – The definition has been rephrased.]

3.1.102
short-circuit current
overcurrent resulting from a short-circuit due to a fault or an incorrect connection in an electric circuit

[SOURCE: IEC 60050-441:1984, 441-11-07]

3.1.103
isolated neutral system
system where the neutral point is not intentionally connected to earth, except for high impedance connections for protection or measurement purposes

[SOURCE: IEC 60050-601:1985, 601-02-24]

3.1.104
solidly earthed (neutral) system
system whose neutral point(s) is (are) earthed directly

[SOURCE: IEC 60050-601:1985, 601-02-25]

3.1.105
impedance earthed (neutral) system
system whose neutral point(s) is (are) earthed through impedances to limit earth fault currents

[SOURCE: IEC 60050-601:1985, 601-02-26]

3.1.106
resonant earthed (neutral) system,
arc-suppression-coil-earth (neutral) system
system in which one or more neutral points are connected to earth through reactances which approximately compensate the capacitive component of a single-phase-to-earth fault current

[SOURCE: IEC 60050-601:1985, 601-02-27]

3.1.107
effectively earthed (neutral) system
system earthed through a sufficiently low impedance such that for all system conditions the ratio of the zero-sequence reactance to the positive-sequence reactance (X_0/X_1) is positive and less than 3, and the ratio of the zero-sequence resistance to the positive-sequence reactance (R_0/X_1) is positive and less than 1

Note 1 to entry: Normally such systems are solidly earthed (neutral) systems or low impedance earthed (neutral) systems.

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Note 2 to entry: The earthing conditions depend not only on the physical earthing conditions around the relevant location but also on the total system.

3.1.108
non-effectively earthed (neutral) system
system other than effectively earthed neutral system, not meeting the conditions given in 3.1.107

Note 1 to entry: Normally such systems are isolated neutral systems, high impedance earthed (neutral) systems or resonant earthed (neutral) systems.

Note 2 to entry: The earthing conditions depend not only on the physical earthing conditions around the relevant location but also on the total system.

3.1.109
ambient air temperature
temperature, determined under prescribed conditions, of the air surrounding the complete switching device or fuse

Note 1 to entry: For switching devices or fuses installed inside an enclosure, it is the temperature of the air outside the enclosure.

[SOURCE: IEC 60050-441:1984, 441-11-13]

3.1.110
temperature rise <of a part of a circuit-breaker>
difference between the temperature of the part under consideration and the ambient air temperature

3.1.111
single capacitor bank
bank of shunt capacitors in which the inrush current is limited by the inductance of the supply system and the capacitance of the bank of capacitors being energised, there being no other capacitors connected in parallel to the system sufficiently close to increase the inrush current appreciably

3.1.112
back-to-back capacitor bank
bank of shunt capacitors or capacitor assemblies each of them switched independently to the supply system, the inrush current of one capacitor or capacitor assembly being appreciably increased by the capacitors already connected to the supply

3.1.113
overvoltage <in an electric power system>
voltage:

– between one line conductor and earth or across a longitudinal insulation having a peak value exceeding the corresponding peak of the highest voltage of the system divided by $\sqrt{3}$
– between phase conductors having a peak value exceeding the amplitude of the highest voltage of the system

[SOURCE: IEC 60050-614:2016, 614-03-10]

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3.1.114
out-of-phase conditions
abnormal circuit conditions of loss or lack of synchronism between the parts of an electrical system on either side of a circuit-breaker in which, at the instant of operation of the circuit-breaker, the phase angle between rotating vectors, representing the generated voltages on either side, exceeds the normal value

Note 1 to entry: The requirements of this document cater for the great majority of applications of circuit-breakers intended for making and breaking during out-of-phase conditions. Out-of-phase angles corresponding to the specified power frequency recovery voltages are given in 7.110.3. For extreme service conditions see 9.103.3.

3.1.115
out-of-phase <as prefix to a characteristic quantity>
qualifying term indicating that the characteristic quantity is applicable to operation of the circuit-breaker in out-of-phase conditions

3.1.116
unit test
test made on a making and breaking unit or group of making and breaking units at the making current or the breaking current, specified for the test on the complete pole of a circuit-breaker and at the appropriate fraction of the applied voltage, or the recovery voltage, specified for the test on the complete pole of the circuit-breaker

3.1.117
loop
part of the wave of the current embraced by two successive current zero crossings

Note 1 to entry: A distinction is made between a major loop and a minor loop depending on the time interval between two successive current zero crossings being longer or shorter than the half-period of the alternating component of the current.

3.1.118
short-line fault
SLF
short-circuit on an overhead line at a short, but significant, distance from the terminals of the circuit-breaker

Note 1 to entry: As a rule this distance is not more than a few kilometres.

3.1.119
power factor <of a circuit>
ratio of the resistance to the impedance at power frequency of an equivalent circuit supposed to be formed by a reactance and a resistance in series

3.1.120
external insulation
distances in atmospheric air, and along the surfaces in contact with atmospheric air of solid insulation of the equipment which are subject to dielectric stresses and to the effects of atmospheric and other environmental conditions from the site

Note 1 to entry: Examples of environmental conditions are pollution, humidity, vermin, etc.

[SOURCE: IEC 60050-614:2016, 614-03-02]

3.1.121
internal insulation
internal distances of the solid, liquid or gaseous insulation of equipment which are protected from the effects of atmospheric and other external conditions

[SOURCE: IEC 60050-614:2016, 614-03-03]

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3.1.122
disruptive discharge
phenomenon associated with the failure of insulation under electrical stress which includes a collapse of voltage and the passage of current

Note 1 to entry: The term applies to electric breakdown in solid, liquid and gaseous dielectrics and combination of these.

Note 2 to entry: A disruptive discharge in a solid dielectric produces permanent loss of dielectric strength; in a liquid or gaseous dielectric the loss can be temporary only.

[SOURCE: IEC 60050-614:2016, 614-03-16]

3.1.123
non-sustained disruptive discharge
NSDD
disruptive discharge associated with current breaking, that does not result in the resumption of power frequency current or, in the case of capacitive current breaking does not result in current in the load circuit

Note 1 to entry: Oscillations following NSDDs are associated with the parasitic capacitance and inductance local to or of the circuit-breaker itself. NSDDs can also involve the stray capacitance to ground of nearby equipment.

3.1.124
restrike performance
expected probability of restrike during capacitive current breaking as demonstrated by specified type tests

Note 1 to entry: Specific numeric probabilities cannot be applied throughout a circuit-breaker service life.

3.1.125
re-ignition <of an AC mechanical switching device>
resumption of current between the contacts of a mechanical switching device during a breaking operation with an interval of zero current of less than a quarter cycle of power frequency

[SOURCE: IEC 60050-441:1984, 441-17-45]

3.1.126
restrike <of an AC mechanical switching device>
resumption of current between the contacts of a mechanical switching device during a breaking operation with an interval of zero current of a quarter cycle of power frequency or longer

[SOURCE: IEC 60050-441:1984, 441-17-46]

3.1.127
current chopping
current breaking prior to the natural power frequency current zero of the circuit connected

3.1.128
belted cable
multiconductor cable in which part of the insulation is applied to each conductor individually, and the remainder is applied over the assembled cores

[SOURCE: IEC 60050-461:2008, 461-06-11]

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3.1.129
individually screened cable
radial field cable
cable in which each core is covered with an individual screen

[SOURCE: IEC 60050-461:2008, 461-06-12]

3.2 Assemblies

No definitions.

3.3 Parts of assemblies

No definitions.

3.4 Switching devices

3.4.101
switching device
device designed to make or break the current in one or more electric circuits

[SOURCE: IEC 60050-441:1984, 441-14-01]

3.4.102
mechanical switching device
switching device designed to close and open one or more electric circuits by means of separable contacts

Note 1 to entry: Any mechanical switching device can be designated according to the medium in which its contacts open and close, for example, air, SF_6, oil.

[SOURCE: IEC 60050-441:1984, 441-14-02]

3.4.103
circuit-breaker
mechanical switching 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

[SOURCE: IEC 60050-441:1984, 441-14-20]

3.4.104
dead tank circuit-breaker
circuit-breaker in which the making and breaking units are housed in an earthed metal tank

[SOURCE: IEC 60050-441:1984, 441-14-25, modified – "interrupters" replaced with "making and breaking units".]

3.4.105
live tank circuit-breaker
circuit-breaker in which the making and breaking units are housed in a tank insulated from earth

[SOURCE: IEC 60050-441:1984, 441-14-26, modified – "interrupters" replaced with "making and breaking units".]

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3.4.106
air circuit-breaker
circuit-breaker in which the contacts open and close in air at atmospheric pressure

[SOURCE: IEC 60050-441:1984, 441-14-27]

3.4.107
oil circuit-breaker
circuit-breaker in which the contacts open and close in oil

Note 1 to entry: Typical examples of oil circuit-breakers are live tank minimum oil circuit-breakers and dead tank bulk oil circuit-breakers

[SOURCE: IEC 60050-441:1984, 441-14-28]

3.4.108
vacuum circuit-breaker
circuit-breaker in which the contacts open and close within a highly evacuated envelope

[SOURCE: IEC 60050-441:1984, 441-14-29]

3.4.109
sealed-for-life circuit-breaker
circuit-breaker having its making and breaking unit(s) in a sealed pressure system

3.4.110
gas-blast circuit-breaker
circuit-breaker in which the arc develops in a blast of gas

Note 1 to entry: Where the gas is moved by a difference in pressure established by mechanical means during the opening operation of the circuit-breaker, it is termed a single pressure gas-blast circuit-breaker. Where the gas is moved by a difference in pressure established before the opening operation of the circuit-breaker, it is termed a double pressure gas-blast circuit-breaker.

[SOURCE: IEC 60050-441:1984, 441-14-30]

3.4.111
sulphur hexafluoride circuit-breaker
SF_6 circuit-breaker
circuit-breaker in which the contacts open and close in sulphur hexafluoride

[SOURCE: IEC 60050-441:1984, 441-14-31]

3.4.112
air-blast circuit-breaker
gas-blast circuit-breaker in which the gas used is air

[SOURCE: IEC 60050-441:1984, 441-14-32]

3.4.113
self-tripping circuit-breaker
circuit-breaker which is tripped by a current in the main circuit without the aid of any form of auxiliary power

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3.5 Parts of circuit-breakers

3.5.101
pole
portion of a switching device associated exclusively with one electrically separated conducting path of its main circuit and excluding those portions which provide a means for mounting and operating all poles together

Note 1 to entry: A switching device is called single-pole if it has only one pole. If it has more than one pole, it can be called multipole (two-pole, three-pole, etc.) provided the poles are or can be coupled in such a manner as to operate together.

[SOURCE: IEC 60050-441:1984, 441-15-01]

3.5.102
main circuit <of a switching device>
all the conductive parts of a switching device included in the circuit which it is designed to close or open

[SOURCE: IEC 60050-441:1984, 441-15-02]

3.5.103
control circuit <of a switching device>
all the conductive parts (other than the main circuit) of a switching device which are included in a circuit used for the closing operation or opening operation, or both, of the device

[SOURCE: IEC 60050-441:1984, 441-15-03]

3.5.104
auxiliary circuit <of a switching device>
all the conductive parts of a switching device which are intended to be included in a circuit other than the main circuit and the control circuits of the device

Note 1 to entry: Some auxiliary circuits fulfil supplementary functions such as signalling, interlocking etc., and, as such, they can be part of the control circuit of another switching device

[SOURCE: IEC 60050-441:1984, 441-15-04]

3.5.105
contact <of a mechanical switching device>
conductive parts designed to establish circuit continuity when they touch and which, due to their relative motion during an operation, open or close a circuit, or in the case of hinged or sliding contacts, maintain circuit continuity

[SOURCE: IEC 60050-441:1984, 441-15-05]

3.5.106
main contact
contact included in the main circuit of a mechanical switching device, intended to carry, in the closed position, the current of the main circuit

[SOURCE: IEC 60050-441:1984, 441-15-07]

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3.5.107
arcing contact
contact on which the arc is intended to be established

Note 1 to entry: An arcing contact can serve as a main contact; it can be a separate contact so designed that it opens after and closes before another contact which it is intended to protect from injury.

[SOURCE: IEC 60050-441:1984, 441-15-08]

3.5.108
control contact
contact included in a control circuit of a mechanical switching device and mechanically operated by this device

[SOURCE: IEC 60050-441:1984, 441-15-09]

3.5.109
auxiliary contact
contact included in an auxiliary circuit and mechanically operated by the switching device

[SOURCE: IEC 60050-441:1984, 441-15-10]

3.5.110
auxiliary switch <of a mechanical switching device>
switch containing one or more control and/or auxiliary contacts mechanically operated by a switching device

[SOURCE: IEC 60050-441:1984, 441-15-11]

3.5.111
“a” contact
make contact
control or auxiliary contact which is closed when the main contacts of the mechanical switching device are closed and open when they are open

[SOURCE: IEC 60050-441:1984, 441-15-12]

3.5.112
“b” contact
break contact
control or auxiliary contact which is open when the main contacts of a mechanical switching device are closed and closed when they are open

[SOURCE: IEC 60050-441:1984, 441-15-13]

3.5.113
butt contact
contact in which relative movement of the contact pieces is substantially in a direction perpendicular to the contact surface

[SOURCE: IEC 60050-441:1984, 441-15-14]

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3.5.114
release <of a mechanical switching device>
device, mechanically connected to a mechanical switching device, which releases the holding means and permits the opening or the closing of the switching device

[SOURCE: IEC 60050-441:1984, 441-15-17]

3.5.115
overcurrent release
release which permits a mechanical switching device to open with or without time-delay when the current in the release exceeds a predetermined value

Note 1 to entry: This value can in some cases depend upon the rate-of-rise of current.

[SOURCE: IEC 60050-441:1984, 441-16-33, modified – Replacement of "may" with "can".]

3.5.116
inverse time-delay overcurrent release
overcurrent release which operates after a time-delay inversely dependent upon the value of the overcurrent

Note 1 to entry: Such a release may be designed so that the time-delay approaches a definite minimum value for high values of overcurrent.

[SOURCE: IEC 60050-441:1984, 441-16-35]

3.5.117
direct overcurrent release
overcurrent release directly energised by the current in the main circuit of a mechanical switching device

[SOURCE: IEC 60050-441:1984, 441-16-36]

3.5.118
shunt release
release energised by a source of voltage

Note 1 to entry: The source of voltage can be independent of the voltage of the main circuit.

[SOURCE: IEC 60050-441:1984, 441-16-41]

3.5.119
under-voltage release
shunt release which permits a mechanical switching device to open or close, with or without time-delay, when the voltage across the terminals of the release falls below a predetermined value

[SOURCE: IEC 60050-441:1984, 441-16-42]

3.5.120
anti-pumping device
device which prevents reclosing after a close-open operation as long as the device initiating closing is maintained in the position for closing

[SOURCE: IEC 60050-441:1984, 441-16-48]

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3.5.121
interlocking device
device which makes the operation of a switching device dependent upon the position or operation of one or more other pieces of equipment

[SOURCE: IEC 60050-441:1984, 441-16-49]

3.5.122
circuit-breaker with lock-out preventing closing
circuit-breaker in which none of the moving contacts can make current if the closing command is initiated while the conditions which should cause the opening operation remain established

[SOURCE: IEC 60050-441:1984, 441-14-23]

3.5.123
arc control device
device, surrounding the arcing contacts of a mechanical switching device, designed to confine the arc and to assist in its extinction

[SOURCE: IEC 60050-441:1984, 441-15-18]

3.5.124
connection <bolted or equivalent>
two or more conductors designed to ensure permanent circuit continuity when forced together by means of screws, bolts or the equivalent

3.5.125
terminal
conductive part of a device, electric circuit or electric network, provided for connecting that device, electric circuit or electric network to one or more external conductors

Note 1 to entry: The term "terminal" is also used for a connection point in circuit theory.

[SOURCE: IEC 60050-151:2001, 151-12-12]

3.5.126
making and breaking unit
part of a circuit-breaker within which the flow of current is initiated and interrupted

3.5.127
enclosure <of an assembly>
part of an assembly providing a specified degree of protection of equipment against external influences and a specified degree of protection against approach to or contact with live parts and against contact with moving parts

[SOURCE: IEC 60050-441:1984, 441-13-01]

3.5.128
operating mechanism
part of the circuit-breaker that actuates the main contacts

3.5.129
power kinematic chain
mechanical connecting system from and including the operating mechanism up to and including the moving contacts

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3.5.130
alternative operating mechanism
〖A1〗change in the power kinematic chain of the original operating mechanism or use of a different operating mechanism which retains the same mechanical characteristics〖/A1〗

Note 1 to entry: An alternative operating mechanism can utilise an operating principle different from the original one (for example the alternative mechanism can be spring-operated and the original hydraulic).

3.5.131
resistor switch
contacts intended for switching of a resistive element

3.5.132
vacuum interrupter
contacts in a highly evacuated, hermetically sealed envelope

3.6 Operational characteristics

3.6.101
operation <of a mechanical switching device>
transfer of the moving contact(s) from one position to an adjacent position

Note 1 to entry: For a circuit-breaker, this can be a closing operation or an opening operation.

Note 2 to entry: If distinction is necessary, an operation in the electrical sense, for example make or break, is referred to as a switching operation, and an operation in the mechanical sense, for example close or open, is referred to as a mechanical operation.

[SOURCE: IEC 60050-441:1984, 441-16-01]

3.6.102
operating cycle <of a mechanical switching device>
succession of operations from one position to another and back to the first position through all other positions, if any

[SOURCE: IEC 60050-441:1984, 441-16-02]

3.6.103
operating sequence <of a mechanical switching device>
succession of specified operations with specified time intervals

[SOURCE: IEC 60050-441:1984, 441-16-03]

3.6.104
switching
closing and/or opening of one or more electrical circuits

3.6.105
closing operation <of a mechanical switching device>
operation by which the device is brought from the open position to the closed position

[SOURCE: IEC 60050-441:1984, 441-16-08]

3.6.106
opening operation <of a mechanical switching device>
operation by which the device is brought from the closed position to the open position

[SOURCE: IEC 60050-441:1984, 441-16-09]

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3.6.107
auto-reclosing <of a mechanical switching device>
operating sequence of a mechanical switching device whereby, following its opening, it closes automatically after a predetermined time

[SOURCE: IEC 60050-441:1984, 441-16-10]

3.6.108
dependent manual operation <of a mechanical switching device>
operation solely by means of directly applied manual energy, such that the speed and force of the operation are dependent upon the action of the operator

[SOURCE: IEC 60050-441:1984 441-16-13]

3.6.109
dependent power operation <of a mechanical switching device>
operation by means of energy other than manual, where the completion of the operation is dependent upon the continuity of the power supply (to solenoids, electric or pneumatic motors, etc.)

[SOURCE: IEC 60050-441:1984, 441-16-14]

3.6.110
stored energy operation
operation by means of energy stored in the mechanism itself prior to the completion of the operation and sufficient to complete it under predetermined conditions

Note 1 to entry: This kind of operation can be subdivided according to:

a) The manner of storing the energy (spring, weight, etc.);

b) The origin of the energy (manual, electric, etc.);

c) The manner of releasing the energy (manual, electric, etc.).

SOURCE: IEC 60050-441:1984, 441-16-15]

3.6.111
closed position <of a mechanical switching device>
position in which the predetermined continuity of the main circuit of the device is secured

[SOURCE: IEC 60050-441:1984, 441-16-22]

3.6.112
open position <of a mechanical switching device>
position in which the predetermined clearance between open contacts in the main circuit of the device is secured

[SOURCE: IEC 60050-441:1984, 441-16-23]

3.6.113
operating current <of an overcurrent release>
current value at and above which the release can operate

[SOURCE: IEC 60050-441:1984, 441-16-45]

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3.6.114
current setting <of an overcurrent release>
value of the operating current for which the release is adjusted and in accordance with which its operating conditions are defined

[SOURCE: IEC 60050-441:1984, 441-16-46]

3.6.115
current setting range <of an overcurrent release>
range between the minimum and maximum values over which the current setting of the release can be adjusted

[SOURCE: IEC 60050-441:1984, 441-16-47]

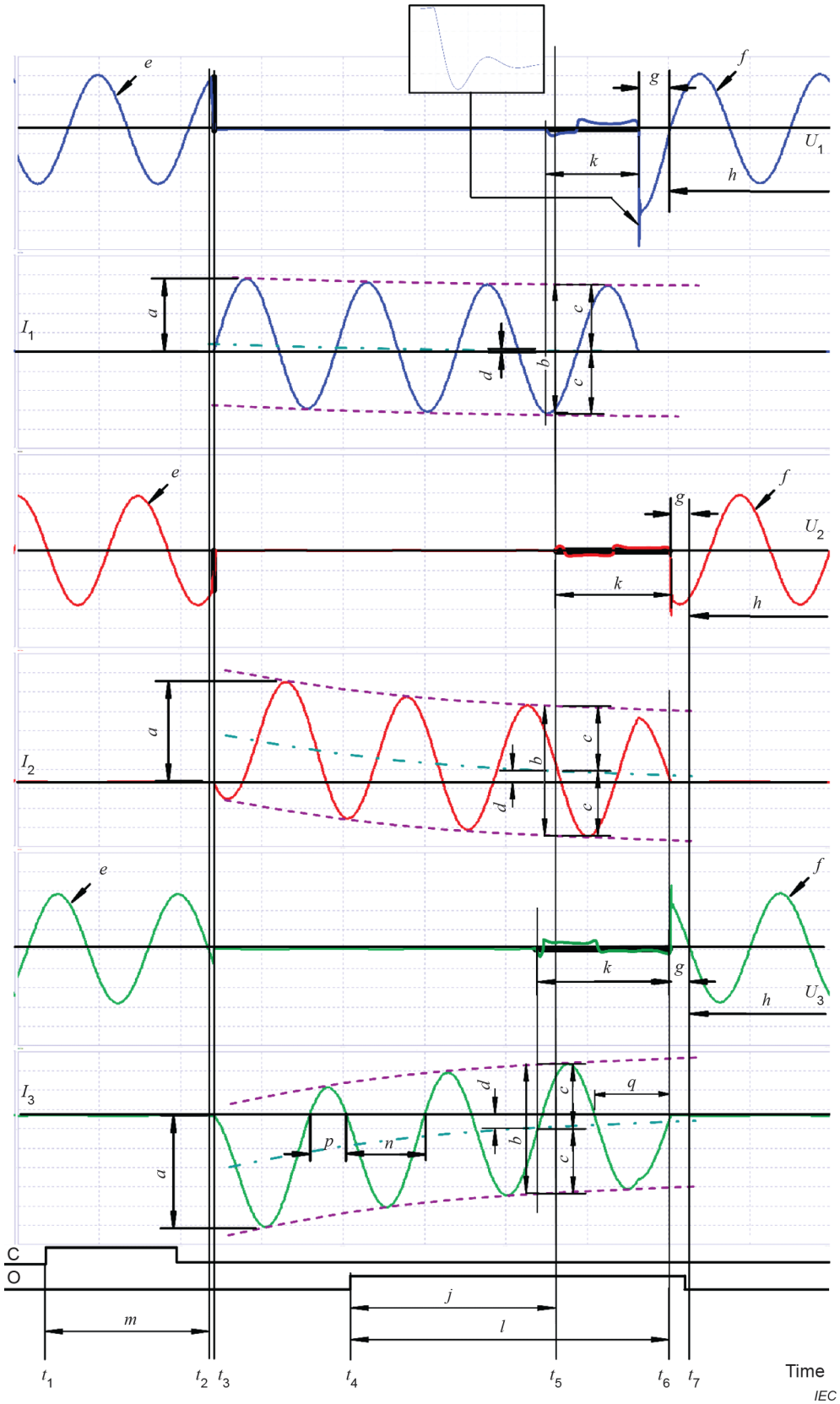
3.7 Characteristic quantities

Figure 1 through Figure 7 illustrate some definitions of this subclause.

Time quantities, see definitions 3.7.131 to 3.7.143, are expressed in milliseconds or in cycles. When expressed in cycles, the power frequency should be stated in brackets. In the case of circuit-breakers incorporating switching resistors, a distinction is made, where applicable, between time quantities associated with the contacts switching the full current and the contacts switching the current limited by switching resistors.

Unless otherwise stated, the time quantities referred to are associated with the contacts switching the full current.

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Key to Figure 1**:**

U_1	voltage across the terminals of the first-pole-to-clear	*a*	(peak) making current
I_1	current in the first-pole-to-clear	*b*	peak-to-peak value of the breaking current
U_2, U_3	voltage across the terminals of the two other poles	*c*	peak value of the alternating component
I_2, I_3	current in the two other poles	*d*	direct current (DC) component
C	closing command, for example voltage across the terminals of the closing circuit	*e*	applied voltage
O	opening command, for example voltage across the terminals of the opening release	*f*	recovery voltage
t_1	initiation of the closing operation	*g*	TRV
t_2	instant of the voltage breakdown	*h*	power frequency recovery voltage
t_3	instant when the current is established in all poles	*j*	opening time
t_4	initiation of the opening operation	*k*	arcing time
t_5	instant when the arcing contacts have separated (or instant of initiation of the arc) in all poles	*l*	break-time
t_6	instant of final arc extinction in all poles	*m*	make time
t_7	instant when the transient voltage phenomena have subsided in the last pole to clear	*n*	major loop
		p	minor loop
		q	major extended loop

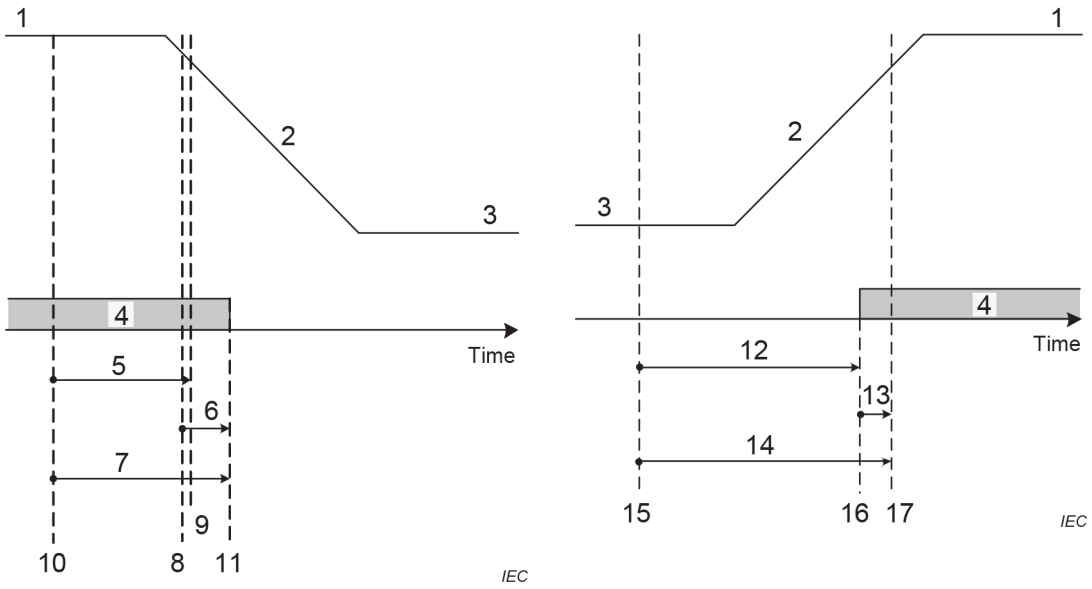
Figure 1 – Typical oscillogram of a three-phase short-circuit make-break cycle

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Notes to the following Figure 2 to Figure 7:

NOTE 1 In practice, there will be a time spread between the travel of the contacts of the three poles. For clarity the travel of the contacts in the figures is indicated with a single line for all three poles.

NOTE 2 In practice, there will be a time spread between both the start and end of current flow in the three poles. For clarity, both the start and end of current flow in the figures is indicated with a single line for all three poles.



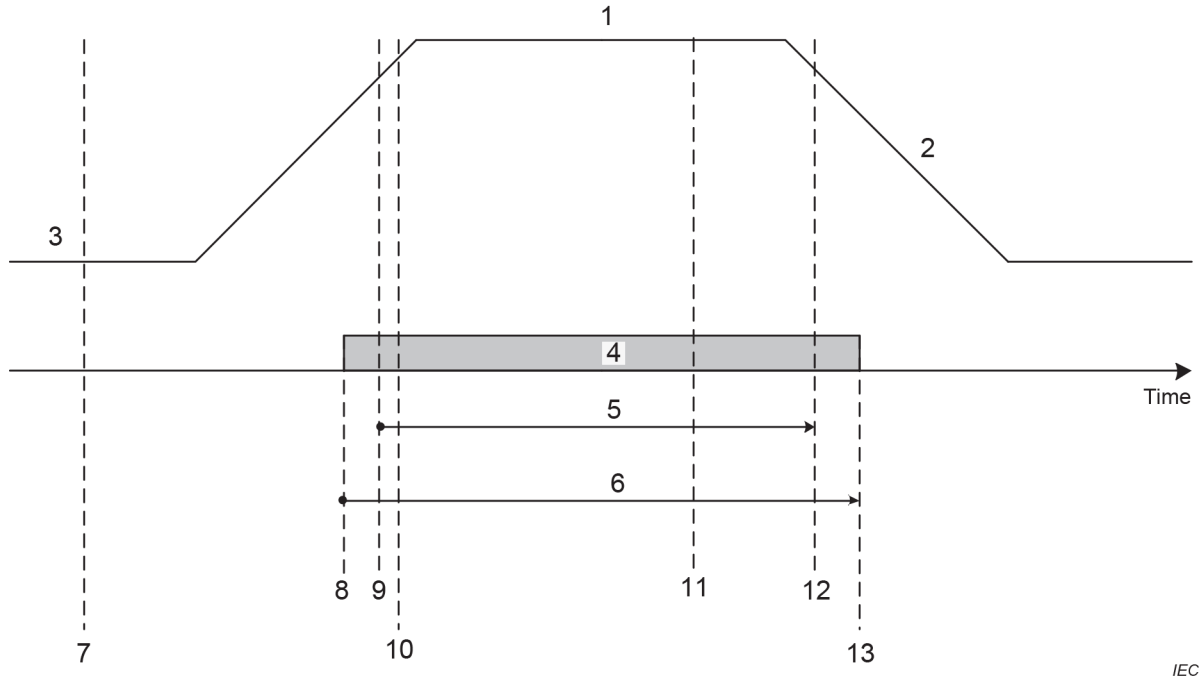
Opening operation **Closing operation**

Key

1	Closed position	10	Initiation of opening operation, 3.7.153
2	Contact travel	11	Instant of final arc extinction in all poles
3	Open position	12	Make time, 3.7.135
4	Current flow	13	Pre-arcing time, 3.7.136
5	Opening time, 3.7.131	14	Closing time, 3.7.134
6	Total arcing time, 3.7.154	15	Initiation of closing operation, 3.7.153
7	Break-time, 3.7.133	16	Instant of start of current flow in the first pole
8	Instant of separation of arcing contacts in first opening pole	17	Instant of contact touch in all poles
9	Instant of separation of arcing contacts in all poles		

Figure 2 – Circuit-breaker without switching resistors – Opening and closing operations

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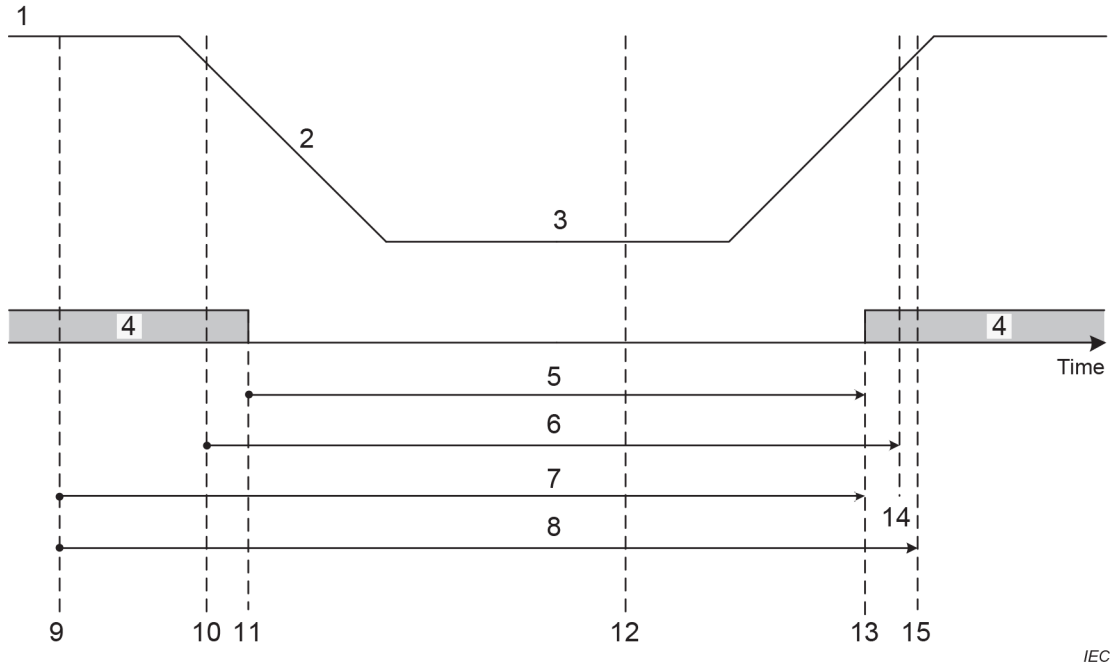


Key

1	Closed position	8	Instant of start of current flow in the first pole
2	Contact travel	9	Instant of contact touch in the first closing pole
3	Open position	10	Instant of contact touch in all poles
4	Current flow	11	Initiation of opening operation, 3.7.153
5	Close-open time, 3.7.141	12	Instant of separation of arcing contacts in all poles
6	Make-break time, 3.7.142	13	Instant of arc extinction in all poles
7	Initiation of closing operation, 3.7.153		

Figure 3 – Circuit breaker without switching resistors – Close-open cycle

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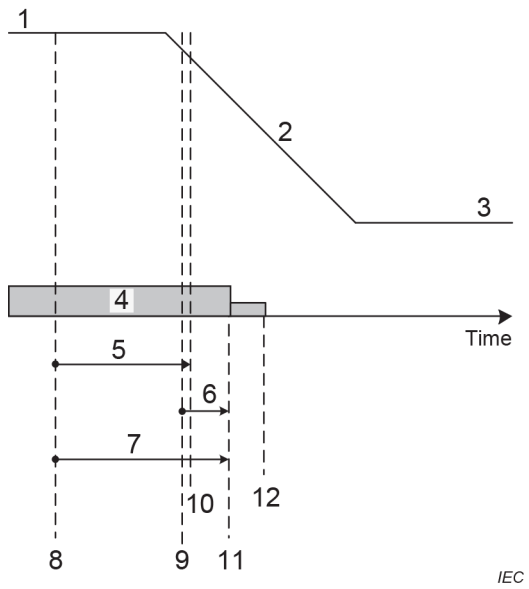


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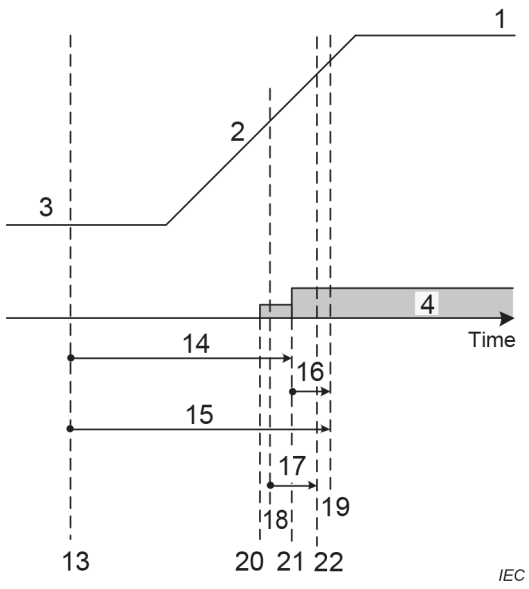
1	Closed position	9	Initiation of opening operation, 3.7.153
2	Contact travel	10	Instant of separation of arcing contacts in all poles
3	Open position	11	Instant of final arc extinction in all poles
4	Current flow	12	Initiation of closing operation, 3.7.153
5	Dead time, 3.7.138	13	Instant of start of current flow in the first closing pole
6	Open-close time, 3.7.137	14	Instant of contact touch in first pole
7	Re-make time, 3.7.140	15	Instant of contact touch in all poles
8	Reclosing time, 3.7.139		

Figure 4 – Circuit-breaker without switching resistors – Reclosing (auto-reclosing)

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Opening operation



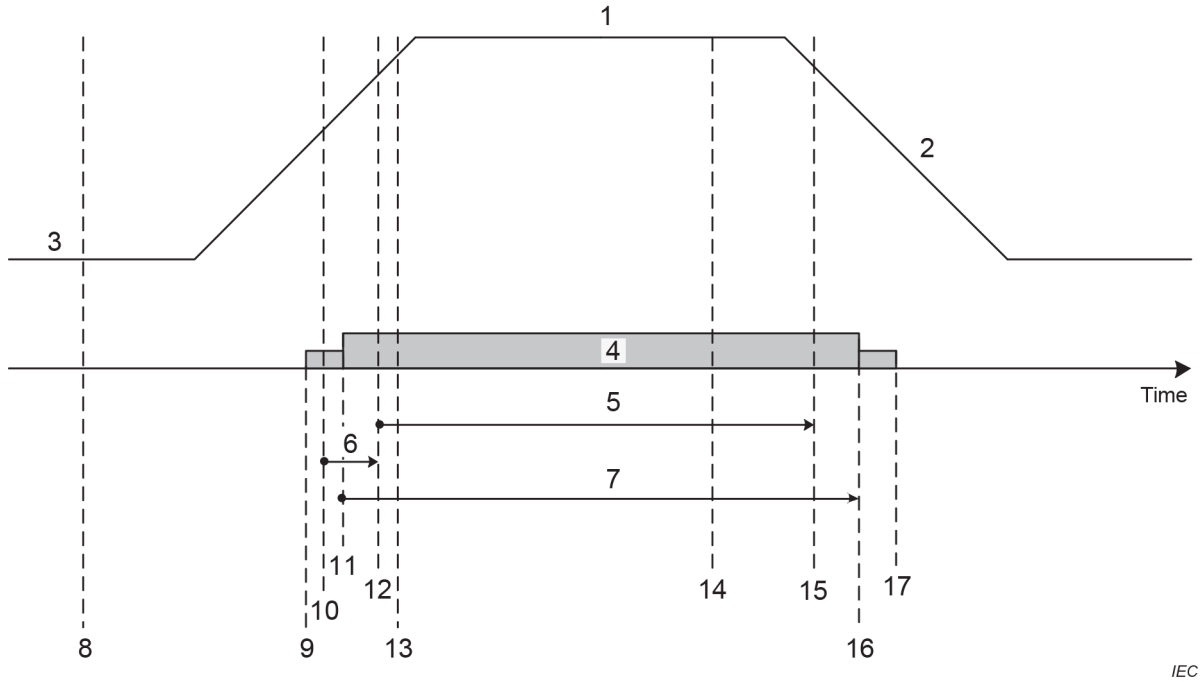
Closing operation

Key

1	Closed position	12	Instant of arc extinction in all poles – Resistor current
2	Contact travel	13	Initiation of the closing operation, 3.7.153
3	Open position	14	Make time, 3.7.135
4	Current flow	15	Closing time, 3.7.134
5	Opening time, 3.7.131	16	Pre-arcing time, 3.7.136
6	Total arcing time, 3.7.154	17	Pre-insertion time, 3.7.143
7	Break-time, 3.7.133	18	Instant of contact touch in the closing resistor of any one pole
8	Initiation of opening operation, 3.7.153	19	Instant of contact touch in all poles
9	Instant of separation of arcing contacts in first opening pole	20	Instant of start of current flow in the first pole – Resistor current
10	Instant of separation of arcing contacts in all poles	21	Instant of the start of current flow in the first pole – Full current
11	Instant of arc extinction in all poles – Full current	22	Instant of contact touch in the making and breaking unit of the same pole as regarded for the resistor

Figure 5 – Circuit-breaker with switching resistors – Opening and closing operations

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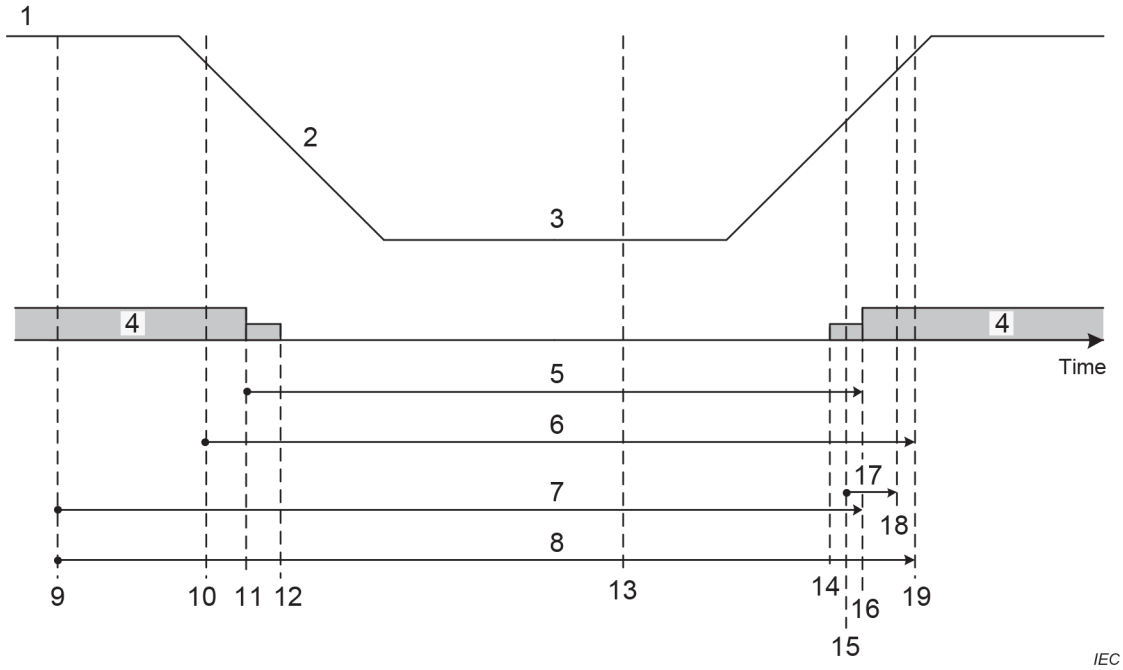


Key

1	Closed position	10	Instant of contact touch in the closing resistor of any one pole
2	Contact travel	11	Instant of start of current flow in the first pole – Full current
3	Open position	12	Instant of contact touch in the making and breaking unit of the same pole as regarded for the resistor
4	Current flow	13	Instant of contact touch in all poles
5	Close-open time, 3.7.141	14	Initiation of opening operation, 3.7.153
6	Pre-insertion time, 3.7.143	15	Instant of separation of arcing contacts in all poles
7	Make-break time, 3.7.142	16	Instant of arc extinction in all poles – Full current
8	Initiation of closing operation, 3.7.153	17	Instant of arc extinction in all poles – Resistor current
9	Instant of start of current flow in the first pole – Resistor current		

Figure 6 – Circuit-breaker with switching resistors – Close-open cycle

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Key

1	Closed position	11	Instant of arc extinction in all poles – Full current
2	Contact travel	12	Instant of arc extinction in all poles – Resistor current
3	Open position	13	Initiation of closing operation, 3.7.153
4	Current flow	14	Resistor current
5	Dead time, 3.7.138	15	Instant of contact touch in the closing resistor of any one pole
6	Open-close time, 3.7.137	16	Instant of start of current flow in the first pole – Full current
7	Re-make time, 3.7.140	17	Pre-insertion time, 3.7.143
8	Reclosing time, 3.7.139	18	Instant of contact touch in the breaking unit of the same pole as regarded for the resistor
9	Initiation of opening operation, 3.7.153	19	Instant of contact touch in all poles
10	Instant of separation of arcing contacts in all poles		

Figure 7 – Circuit-breaker with switching resistors – Reclosing (auto-reclosing)

3.7.101
rated value
quantity value assigned, generally by the manufacturer, for a specified operating condition of a component, device or equipment

Note 1 to entry: Examples of rated value usually stated for fuses: voltage, current, breaking capacity.

[SOURCE: IEC 60050-441:2000, 441-18-35]

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3.7.102
prospective current <of a circuit and with respect to a switching device or a fuse>
current that would flow in the circuit if each pole of the switching device or the fuse were replaced by a conductor of negligible impedance

Note 1 to entry: The method to be used to evaluate and to express the prospective current is specified in the relevant publications.

[SOURCE: IEC 60050-441:1984, 441-17-01]

3.7.103
prospective peak current
peak value of the first major loop of the prospective current during the transient period following initiation

Note 1 to entry: The definition assumes that the current is made by an ideal circuit-breaker, i.e. with instantaneous and simultaneous transition of its impedance across the terminals of each pole from infinity to zero. The peak value can differ from one pole to another; it depends on the instant of current initiation relative to the voltage wave across the terminals of each pole.

3.7.104
peak current
peak value of the first major loop of current during the transient period following initiation

3.7.105
prospective symmetrical current <of an AC circuit>
prospective current when it is initiated at such an instant that no transient phenomenon follows the initiation

Note 1 to entry: For polyphase circuits, the condition of non-transient period can only be satisfied for the current in one pole at a time.

Note 2 to entry: The prospective symmetrical current is expressed by its RMS value.

[SOURCE: IEC 60050-441:1984, 441-17-03]

3.7.106
maximum prospective peak current <of an AC circuit>
prospective peak current when initiation of the current takes place at the instant which leads to the highest possible value

Note 1 to entry: For a multiple device in a polyphase circuit, the maximum prospective peak current refers to a single pole only.

[SOURCE: IEC 60050-441:1984, 441-17-04]

3.7.107
prospective making current <for a pole of a switching device>
prospective current when initiated under specified conditions

Note 1 to entry: The specified conditions can relate to the method of initiation, for example by an ideal switching device, or to the instant of initiation, for example leading to the maximum prospective peak current in an AC circuit, or to the highest rate of rise. The specification of these conditions is found in the relevant publications.

[SOURCE: IEC 60050-441:1984, 441-17-05]

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3.7.108
making current
peak value of the first major loop of the current in a pole of a circuit-breaker during the transient period following the initiation of current during a making operation

Note 1 to entry: The peak value can differ from one pole to another and from one operation to another as it depends on the instant of current initiation relative to the wave of the applied voltage.

Note 2 to entry: Where, for a polyphase circuit, a single value of (peak) making current is referred to, this is, unless otherwise stated, the highest value in any phase.

3.7.109
prospective breaking current <for a pole of a switching device>
prospective current evaluated at a time corresponding to the instant of the initiation of the breaking process

Note 1 to entry: Specifications concerning the instant of the initiation of the breaking process can be found in the relevant publications. For mechanical switching devices or fuses, it is usually defined as the moment of initiation of the arc during the breaking process.

[SOURCE: IEC 60050-441:1984, 441-17-06]

3.7.110
breaking current <of a switching device or a fuse>
current in a pole of a switching device or in a fuse at the instant of initiation of the arc during a breaking process

[SOURCE: IEC 60050-441:1984, 441-17-07]

3.7.111
making and breaking test
test during which the circuit-breaker is closed (to make) and opened (to break)

3.7.112
terminal fault
〚A1〛 short-circuit on at least one of the terminals of the circuit-breaker 〚A1〛

Note 1 to entry: The terminal fault current has contributions from the source side only.

3.7.113
critical (breaking) current
value of breaking current, less than rated short-circuit breaking current, at which the arcing time is a maximum and is significantly longer than that of the rated short-circuit breaking current

3.7.114
breaking capacity <of a switching device or a fuse>
value of prospective current that a switching device or a fuse is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

Note 1 to entry: The voltage to be stated and the conditions to be prescribed are dealt with in the relevant publications.

Note 2 to entry: For switching devices, the breaking capacity can be termed according to the kind of current included in the prescribed conditions, for example line-charging breaking capacity, cable charging breaking capacity, single capacitor bank breaking capacity, etc.

[SOURCE: IEC 60050-441:1984, 441-17-08]

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3.7.115
no-load line-charging breaking capacity
breaking capacity for which the specified conditions of use and behaviour include the opening of an overhead line operating at no-load

3.7.116
no-load cable-charging breaking capacity
breaking capacity for which the specified conditions of use and behaviour include the opening of an insulated cable operating at no-load

3.7.117
capacitor bank breaking capacity
breaking capacity for which the specified conditions of use and behaviour include the opening of a capacitor bank

3.7.118
making capacity <of a switching device or a fuse>
value of prospective making current that a switching device is capable of making at a stated voltage under prescribed conditions of use and behaviour

Note 1 to entry: The voltage to be stated and the conditions to be prescribed are dealt with in the relevant specifications.

[SOURCE: IEC 60050-441:1984, 441-17-09]

3.7.119
capacitor bank inrush making capacity
making capacity for which the specified conditions of use and behaviour include the closing onto a capacitor bank

3.7.120
out-of-phase (making or breaking) capacity
making or breaking capacity for which the specified conditions of use and behaviour include the loss or the lack of synchronism between the parts of an electrical system on either side of the circuit-breaker

3.7.121
short-circuit making capacity
making capacity for which the prescribed conditions include a short-circuit at the terminals of the switching device

[SOURCE: IEC 60050-441:1984, 441-17-10]

3.7.122
short-circuit breaking capacity
breaking capacity for which the prescribed conditions include a short-circuit at the terminals of the switching device

[SOURCE: IEC 60050-441:1984, 441-17-11]

3.7.123
short-time withstand current
current that a circuit or a switching device in the closed position can carry during a specified short time under prescribed conditions of use and behaviour

[SOURCE: IEC 60050-441:1984, 441-17-17]

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3.7.124
peak withstand current
value of peak current that a circuit or a switching device in the closed position can withstand under prescribed conditions of use and behaviour

[SOURCE: IEC 60050-441:1984, 441-17-18]

3.7.125
applied voltage <for a switching device>
voltage which exists across the terminals of a pole of a switching device just before the making of the current

[SOURCE: IEC 60050-441:1984, 441-17-24]

3.7.126
recovery voltage
voltage which appears across the terminals of a pole of a switching device or a fuse after the breaking of the current

Note 1 to entry: This voltage can be considered in two successive intervals of time, one during which a transient voltage exists, followed by a second one during which the power frequency or the steady-state recovery voltage alone exists.

[SOURCE: IEC 60050-441:1984, 441-17-25]

3.7.127
transient recovery voltage
TRV
recovery voltage during the time in which it has a significant transient character

Note 1 to entry: The transient recovery voltage can be oscillatory or non-oscillatory or a combination of these depending on the characteristics of the circuit and the switching device. It includes the voltage shift of the neutral of a polyphase circuit.

Note 2 to entry: The transient recovery voltages in three-phase circuits is, unless otherwise stated, that across the first pole to clear, because this voltage is generally higher than that which appears across each of the other two poles.

[SOURCE: IEC 60050-441:1984, 441-17-26]

3.7.128
prospective transient recovery voltage <of a circuit>
transient recovery voltage following the breaking of the prospective symmetrical current by an ideal switching device

Note 1 to entry: The definition assumes that the switching device or the fuse, for which the prospective transient recovery voltage is sought, is replaced by an ideal switching device, i.e. having instantaneous transition from zero to infinite impedance at the very instant of zero current, i.e. at the "natural" zero. For circuits where the current can follow several different paths, for example a polyphase circuit, the definition further assumes that the breaking of the current by the ideal switching device takes place only in the pole considered.

[SOURCE: IEC 60050-441:1984, 441-17-29]

3.7.129
power frequency recovery voltage
recovery voltage after the transient voltage phenomena have subsided

[SOURCE: IEC 60050-441:1984, 441-17-27]

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3.7.130
clearance
distance between two conductive parts along a string stretched the shortest way between these conductive parts

[SOURCE: IEC 60050-441:1984, 441-17-31]

3.7.131
opening time <of a mechanical switching device>
interval of time between the specified instant of initiation of the opening operation and the instant when the arcing contacts have separated in all poles

Note 1 to entry: The instant of initiation of the opening operation, i.e. the application of the opening command (for example energizing the release, etc.) is given in the relevant specifications.

[SOURCE: IEC 60050-441:1984, 441-17-36]

3.7.132
arcing time <of a pole or a fuse>
interval of time between the instant of the initiation of the arc in a pole or a fuse and the instant of final arc extinction in that pole or that fuse

[SOURCE: IEC 60050-441:1984, 441-17-37]

3.7.133
break-time
interval of time between the beginning of the opening time of a mechanical switching device (or the pre-arcing time of a fuse) and the end of the arcing time

[SOURCE: IEC 60050-441:1984, 441-17-39]

3.7.134
closing time
interval of time between the initiation of the closing operation and the instant when the contacts touch in all poles

[SOURCE: IEC 60050-441:1984, 441-17-41]

3.7.135
make-time
interval of time between the initiation of the closing operation and the instant when the current begins to flow in the main circuit

[SOURCE: IEC 60050-441:1984, 441-17-40]

3.7.136
pre-arcing time <of a circuit-breaker>
interval of time between the initiation of current flow in the first pole during a closing operation and the instant when the contacts touch in all poles for three-phase conditions and the instant when the contacts touch in the arcing pole for single-phase conditions

Note 1 to entry: The pre-arcing time depends on the instantaneous value of the applied voltage during a specific closing operation and therefore can vary considerably.

Note 2 to entry: The definition of pre-arcing time of a circuit-breaker is different from that of a fuse.

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3.7.137
open-close time <during auto-reclosing>
interval of time between the instant when the arcing contacts have separated in all poles and the instant when the contacts touch in the first pole during a reclosing cycle

3.7.138
dead time <during auto-reclosing>
interval of time between final arc extinction in all poles on the opening operation and the first reestablishment of current in any pole on the subsequent closing operation

[SOURCE: IEC 60050-441:1984, 441-17-44]

3.7.139
reclosing time
interval of time between the beginning of the opening time and the instant when the contacts touch in all poles during a reclosing cycle

3.7.140
re-make time <during reclosing>
interval of time between the beginning of the opening time and the first re-establishment of current in any pole in the subsequent closing operation

Note 1 to entry: The re-make time can vary, for example due to the variation of the pre-arcing time.

3.7.141
close-open time
interval of time between the instant when the contacts touch in the first pole during a closing operation and the instant when the arcing contacts have separated in all poles during the subsequent opening operation

[SOURCE: IEC 60050-441:1984, 441-17-42]

3.7.142
make-break time
interval of time between the instant when the current begins to flow in a pole and the instant of final arc extinction in all poles, with the opening release energised at the instant when current begins to flow in the main circuit

[SOURCE: IEC 60050-441:1984, 441-17-43]

3.7.143
pre-insertion time <of a closing resistor>
interval of time during which the resistor remains in the main circuit during a no-load operation

3.7.144
continuous current
current that the main circuit of a circuit-breaker is capable of carrying continuously under specified conditions of use and behaviour

3.7.145
peak factor
ratio of the maximum absolute value of an alternating quantity to its RMS value

Note 1 to entry: For an alternating quantity x, the peak factor is equal to x_{max} / X_{eff}.

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3.7.146
first-pole-to-clear factor <in a three-phase system>
k_{pp}
when breaking any symmetrical three-phase current, the first-pole-to-clear factor is the ratio of the power frequency voltage across the first interrupting pole before current breaking in the other poles, to the power frequency voltage occurring across the pole or the poles after breaking in all three poles

3.7.147
amplitude factor
k_{af}
ratio between the maximum excursion of the TRV to the crest value of the power frequency recovery voltage

3.7.148
insulation level
set of withstand voltages specified which characterise the dielectric strength of the insulation

[SOURCE: IEC 60050-614:2016, 614-03-23]

3.7.149
power frequency withstand voltage
RMS value of sinusoidal power frequency voltage that the insulation of the given equipment can withstand during tests made under specified conditions and for a specified duration

[SOURCE: IEC 60050-614:2016, 614-03-22]

3.7.150
impulse withstand voltage
highest peak value of impulse voltage of prescribed form and polarity which does not cause breakdown of insulation under specified conditions

[SOURCE: IEC 60050-442:2014, 442-09-18]

3.7.151
minimum clearing time
sum of the minimum opening time, minimum relay time (0,5 cycle), and the shortest arcing time of a minor loop breaking in the phase with intermediate asymmetry that starts with a minor loop at short-circuit current initiation

3.7.152
insertion time <of an opening resistor>
interval of time during an opening operation between the instant of separation of the arcing contacts in the making and breaking units of any one pole and the instant of contact separation in the resistor switch in that pole

3.7.153
initiation of (opening or closing) operation
instant of receipt of command for operation at the control circuit

3.7.154
total arcing time
interval of time between the instant of the first initiation of an arc in a pole and the instant of arc extinction in all poles

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3.7.155
direct connection to an overhead line
connection between a circuit-breaker and an overhead line having a capacitance less than 5 nF

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