IEC 62271-109

Edition 3.0 2019-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

High-voltage switchgear and controlgear – Part 109: Alternating-current series capacitor by-pass switches

Appareillage à haute tension – Partie 109: Interrupteurs de contournement pour condensateurs série à courant alternatif

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 109: Alternating-current series capacitor by-pass switches

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International Standard IEC 62271-109 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 and Amendment 1:2013. This edition constitutes a technical revision.

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

a) the document has been restructured according to edition 2.0 of IEC 62271-1;
b) the rated voltage assignation across the by-pass switch has been aligned to the rule defined in IEC 60143-1;
c) clarification has been given regarding rated continuous current of compensated and uncompensated line;
d) some clarifications have been given following a loss of "suitable precautions";

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e) as per Amendment 2 of IEC 62271-100, the section "Rated time quantities" has been moved to Clause 6 under "Time quantities";

f) as per Amendment 2 of IEC 62271-100, the section "Test for static mechanical loads" have been moved to Clause 6 under "Static mechanical loads";

g) additional rules have been introduced for vacuum interrupters during impulse tests;

h) additional clarifications have been given regarding the number of reduced impulses during impulse tests;

i) a wider tolerance on the current damping during by-pass making current test-duty has been introduced.

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

FDIS	Report on voting
17A/1208/FDIS	17A/1215/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 62271 series can be found, under the general title *High-voltage switchgear and controlgear*, on the IEC website.

This standard is to be read in conjunction with IEC 62271-100:2008 with its Amendment 1:2012 and Amendment 2:2017, and IEC 62271-1:2017, to which it refers and which is applicable, unless otherwise specified in this standard. In order to simplify the indication of corresponding requirements, the same numbering of clauses and subclauses is used as in IEC 62271-1:2017. Amendments to these clauses and subclauses are given under the same references whilst additional subclauses are numbered from 101.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://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.

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 109: Alternating-current series capacitor by-pass switches

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1 Scope

This part of IEC 62271 is applicable to AC series capacitor by-pass switches designed for outdoor installation and for operation at frequencies of 50 Hz and 60 Hz on systems having voltages above 52 kV.

It is only applicable to by-pass switches for use in three-phase systems.

This document is also applicable to the operating devices of by-pass switches and to their auxiliary equipment.

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 – Part 151: Electrical and magnetic devices*

IEC 60050-436:1990, *International Electrotechnical Vocabulary – Chapter 436: Power capacitors*

IEC 60050-441:1984, *International Electrotechnical Vocabulary – Chapter 441: Switchgear, controlgear and fuses*

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

IEC 60060 (all parts), *High-voltage test techniques*

IEC 60137:2017, *Insulated bushings for alternating voltages above 1000 V*

IEC 60143-1:2015, *Series capacitors for power systems – Part 1: General*

IEC 60143-2:2012, *Series capacitors for power systems – Part 2: Protective equipment for series capacitor banks*

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

IEC 60376, *Specification of technical grade sulphur hexafluoride (SF_6) and complementary gases to be used in its mixtures for use in electrical equipment*

IEC 60480, *Guidelines for the checking and treatment of sulphur hexafluoride (SF_6) taken from electrical equipment and specification for its re-use*

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

IEC 62271-4, *High-voltage switchgear and controlgear – Part 4: Handling procedures for sulphur hexafluoride (SF_6) and its mixtures*

IEC 62271-100:2008, *High-voltage switchgear and controlgear – Part 100: Alternating current circuit-breakers*
IEC 62271-100:2008/AMD1:2012
IEC 62271-100:2008/AMD2:2017

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*

3 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 60050-151, IEC 60050-436, IEC 60050-441, IEC 60050-614, IEC 60143-1, IEC 60143-2 and IEC 62271-1 apply. Some of them are recalled here for ease of reference.

Additional terms and definitions are classified so as to be aligned with the classification used in IEC 60050-441.

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

3.1 General terms and definitions

3.1.101
switchgear and controlgear
a general term covering switching devices 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 60050-441:2000, 441-11-01]

3.1.102
outdoor switchgear and controlgear
switchgear and controlgear suitable for installation in the open air, i.e. capable of withstanding wind, rain, snow, dirt deposits, condensation, ice and hoar frost

[SOURCE: IEC 60050-441:2000, 441-11-05]

3.1.103
short-circuit current
overcurrent resulting from a short circuit due to a fault or an incorrect connection in an electric circuit

[SOURCE: IEC 60050-441:2000, 441-11-07]

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3.1.104
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 60050-441:2000, 441-11-13]

3.1.105
temperature rise
<of a part of a by-pass switch>
difference between the temperature of the part under consideration and the ambient air temperature

[SOURCE: IEC 60050-151:2001, 151-16-26, modified – "A reference" has been replaced by "the ambient air".]

3.1.106
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 $\sqrt{3}$

or;

- 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]

3.1.107
unit test
test carried out on a by-passing or insertion unit or group of units at the by-pass making current or the insertion current, specified for the test on the complete pole of a by-pass switch and at the appropriate fraction of the applied voltage, or the recovery voltage, specified for the test on the complete pole of the by-pass switch

3.1.108
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.

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

3.1.109
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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3.1.110
self-restoring insulation
insulation which completely recovers its insulating properties within a short time interval after a disruptive discharge

[SOURCE: IEC 60050-614:2016, 614-03-04]

3.1.111
non-self-restoring insulation
insulation which loses its insulating properties, or does not recover them completely, after a disruptive discharge

[SOURCE: IEC 60050-614:2016, 614-03-05]

3.1.112
disruptive discharge
phenomenon associated with the failure of insulation under electric stress, which includes a collapse of voltage and the passage of current

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

Note 2 to entry: A disruptive discharge in a solid dielectric produces permanent loss of dielectric strength (non-self-restoring insulation); in a liquid or gaseous dielectric, the loss may be temporary only.

Note 3 to entry: The term "sparkover" is used when a disruptive discharge occurs in a gaseous or liquid dielectric. The term "flashover" is used when a disruptive discharge occurs over the surface of a solid dielectric in a gaseous or liquid medium. The term "puncture" is used when a disruptive discharge occurs through a solid dielectric.

[SOURCE: IEC 60050-614:2016, 614-03-16, modified – Note 3 to entry added.]

3.1.113
restrike performance
expected probability of restrike during insertion current test-duty as demonstrated by specified type test

Note 1 to entry: Specific numeric probabilities cannot be applied throughout a by-pass switch service life.

3.1.114
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 60050-441:2000, 441-17-45]

3.1.115
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 60050-441:2000, 441-17-46]

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3.1.116
non-sustained disruptive discharge
NSDD
disruptive discharge associated with current interruption which does not result in the resumption of power frequency current or, in the case of insertion does not result in a current in the series capacitor bank

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

Note 2 to entry: This note applies to the French language only.

3.2 Assemblies

No particular definitions.

3.3 Parts of assemblies

No particular 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 60050-441:2000, 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 may be designated according to the medium in which its contacts open and close, e.g. air, SF_6, oil.

[SOURCE: IEC 60050-441:2000, 441-14-02]

3.4.103
by-pass switch
three-phase switching device used in parallel with a series capacitor and its overvoltage protector to shunt line current of a specified level for a specified time, or continuously

Note 1 to entry: By-pass switches can be three-pole or single-pole operated

Note 2 to entry: Besides by-passing the capacitor, this device normally has the capability to insert the capacitor into a circuit that carries a specified level of current.

Note 3 to entry: By-pass switches are normally used in conjunction with a fast by-passing device, for example, spark-gap (for special applications without the use of a fast by-passing device, see Annex E).

Note 4 to entry: Examples of series capacitor layouts using a fast by-passing device in parallel with the by-pass switch (see IEC 60143-1) are given in Figure 1.

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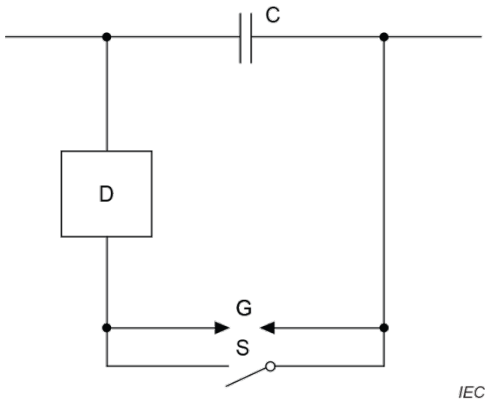
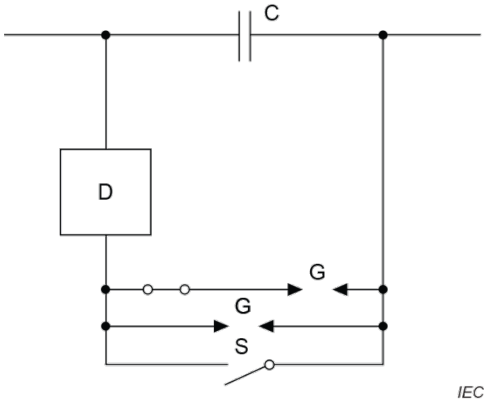
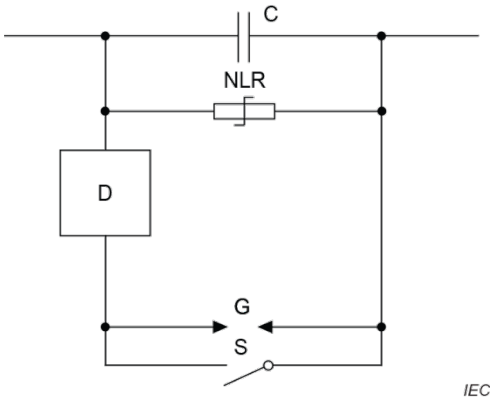


Single gap



Dual gap



Non-linear resistor with by-pass gap

Key

C	series capacitor
D	damping circuit
G	spark-gap
S	by-pass switch
NLR	non-linear resistor

Figure 1 – Different layouts for series capacitor banks

3.4.104
by-pass switch class M1
by-pass switch with normal mechanical endurance as demonstrated by specific type tests

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3.4.105
by-pass switch class M2
frequently operated by-pass switch for special service requirements and designed so as to require only limited maintenance as demonstrated by specific type tests.

Note 1 to entry: This type of by-pass switch is normally used on multi-segmented capacitors where the control of the capacitor impedance is a frequent duty.

3.5 Parts of by-pass switches

3.5.101
pole of a switching device
the 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 may 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 60050-441:2000, 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 60050-441:2000, 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 60050-441:2000, 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 may be part of the control circuit of another switching device.

[SOURCE: IEC 60050-441:2000, 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 60050-441:2000, 441-15-05]

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3.5.106
contact
contact piece
one of the conductive parts forming a contact

[SOURCE: IEC 60050-441:2000, 441-15-06]

3.5.107
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 60050-441:2000, 441-15-07]

3.5.108
arcing contact
contact on which the arc is intended to be established

Note 1 to entry: An arcing contact may serve as a main contact; it may 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 60050-441:2000, 441-15-08]

3.5.109
control contact
contact included in a control circuit of a mechanical switching device and mechanically operated by this device

[SOURCE: IEC 60050-441:2000, 441-15-09]

3.5.110
auxiliary contact
contact included in an auxiliary circuit and mechanically operated by the switching device

[SOURCE: IEC 60050-441:2000, 441-15-10]

3.5.111
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 60050-441:2000, 441-15-11]

3.5.112
“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 60050-441:2000, 441-15-12]

3.5.113
“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

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[SOURCE: IEC 60050-441:2000, 441-15-13]

3.5.114
sliding contact
contact in which relative movement of the contact pieces is substantially in a direction parallel to the contact surface

[SOURCE: IEC 60050-441:2000, 441-15-15]

3.5.115
rolling contact
contact in which one contact piece rolls on the other

[SOURCE: IEC 60050-441:2000, 441-15-16]

3.5.116
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 60050-441:2000, 441-15-17]

3.5.117
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 60050-441:2000, 441-15-18]

3.5.118
position indicating device
part of a mechanical switching device which indicates whether it is in the open, closed, or where appropriate, earthed position

[SOURCE: IEC 60050-441:2000, 441-15-25]

3.5.119
connection
two or more conductors designed to ensure permanent circuit continuity when forced together by means of screws, bolts or the equivalent

3.5.120
terminal
component provided for the connection of a device to external conductors

3.5.121
by-pass unit
insertion unit
part of a by-pass switch which in itself acts as a by-pass switch and which, in series with one or more identical and simultaneously operated by-pass or insertion units, forms the complete by-pass switch

Note 1 to entry: By-pass units and insertion units are normally combined but may be separated. Each unit may have several contacts.

Note 2 to entry: The means controlling the voltage distribution between units may differ from unit to unit.

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3.5.122
module
<of a by-pass switch> assembly which generally comprises by-pass or insertion units, post-insulators (for live tank by-pass switches), bushings (for dead tank by-pass switches) and mechanical parts and which is mechanically and electrically connected to other identical assemblies to form a pole of a by-pass switch

3.5.123
enclosure
part of switchgear and controlgear providing a specified degree of protection of equipment against external influences and a specified degree of protection against an approach to or contact with live parts and against contact with moving parts

[SOURCE: IEC 60050-441:2000, 441-13-01, modified – "a part of an assembly" has been changed for "part of switchgear and controlgear"]

3.5.124
operating mechanism
part of the by-pass switch that actuates, through the power kinematic chain, the main circuit contacts of the by-pass switch

3.5.125
power kinematic chain
mechanical connecting system from and including the operating mechanism up to and including the moving contacts

Note 1 to entry: See also Figure 1 of IEC 62271-102:2018.

3.5.126
alternative operating mechanism
mechanism obtained when a change in the power kinematic chain of the original operating mechanism or the use of an entirely different operating mechanism leads to the same mechanical characteristics

Note 1 to entry: Mechanical characteristics are defined in 7.101.1.1. The use of mechanical characteristics and related requirements are described in Annex G.

Note 2 to entry: An alternative operating mechanism can implement an operating principle different from the original one (for example the alternative mechanism can be spring-operated and the original hydraulic).

Note 3 to entry: A change in the secondary equipment does not lead to an alternative operating mechanism.

3.6 Operational characteristics of by-pass switches

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 may be a closing operation or an opening operation.

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

[SOURCE: IEC 60050-441:2000, 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

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[SOURCE: IEC 60050-441:2000, 441-16-02]

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

[SOURCE: IEC 60050-441:2000, 441-16-03]

3.6.104
closing operation
<of a mechanical switching device>
operation by which the device is brought from the open position to the closed position

[SOURCE: IEC 60050-441:2000, 441-16-08]

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

[SOURCE: IEC 60050-441:2000, 441-16-09]

3.6.106
auto-reopening
operating sequence of a by-pass switch whereby, following its closing, it opens automatically after a predetermined time

3.6.107
positive opening operation
<of a mechanical switching device>
opening operation which, in accordance with specified requirements, ensures that all the main contacts are in the open position when the actuator is in the position corresponding to the open position of the device

[SOURCE: IEC 60050-441:2000, 441-16-11]

3.6.108
positively driven operation
operation which, in accordance with specified requirements, is designed to ensure that auxiliary contacts of a mechanical switching device are in the respective positions corresponding to the open or closed position of the main contacts

[SOURCE: IEC 60050-441:2000, 441-16-12]

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 60050-441:2000, 441-16-14]

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3.6.110
stored energy operation
operation by means of energy stored in the mechanism itself prior to the switching operation and sufficient to complete the specified operating sequence under predetermined conditions

3.6.111
independent manual operation
<of a mechanical switching device>
stored energy operation where the energy originates from manual power, stored and released in one continuous operation, such that the speed and force of the operation are independent of the action of the operator

[SOURCE: IEC 60050-441:2000, 441-16-16]

3.6.112
closed position
<of a mechanical switching device>
position in which the predetermined continuity of the main circuit of the device is secured

[SOURCE: IEC 60050-441:2000, 441-16-22]

3.6.113
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 60050-441:2000, 441-16-23]

3.6.114
shunt release
release energized by a source of voltage

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

[SOURCE: IEC 60050-441:2000, 441-16-41]

3.6.115
anti-pumping device
device that prevents the reopening after an open-close operation as long as the device initiating opening is maintained in the position for opening

3.6.116
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 60050-441:2000, 441-16-49]

3.6.117
by-pass switch with lock-out preventing opening
by-pass switch in which none of the moving contacts can insert the capacitor if the opening command is initiated while the conditions that cause the closing operation remain established

3.7 Characteristic quantities

Figures 2 to 4 illustrate some definitions of this subclause.

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Time quantities (see definitions 3.7.120 to 3.7.130) are expressed in milliseconds or in cycles. When expressed in cycles, the power frequency shall be stated in brackets.

Concerning Figures 2 to 4:

- 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 by a single line for all three poles.
- 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 are indicated by a single line for all three poles.

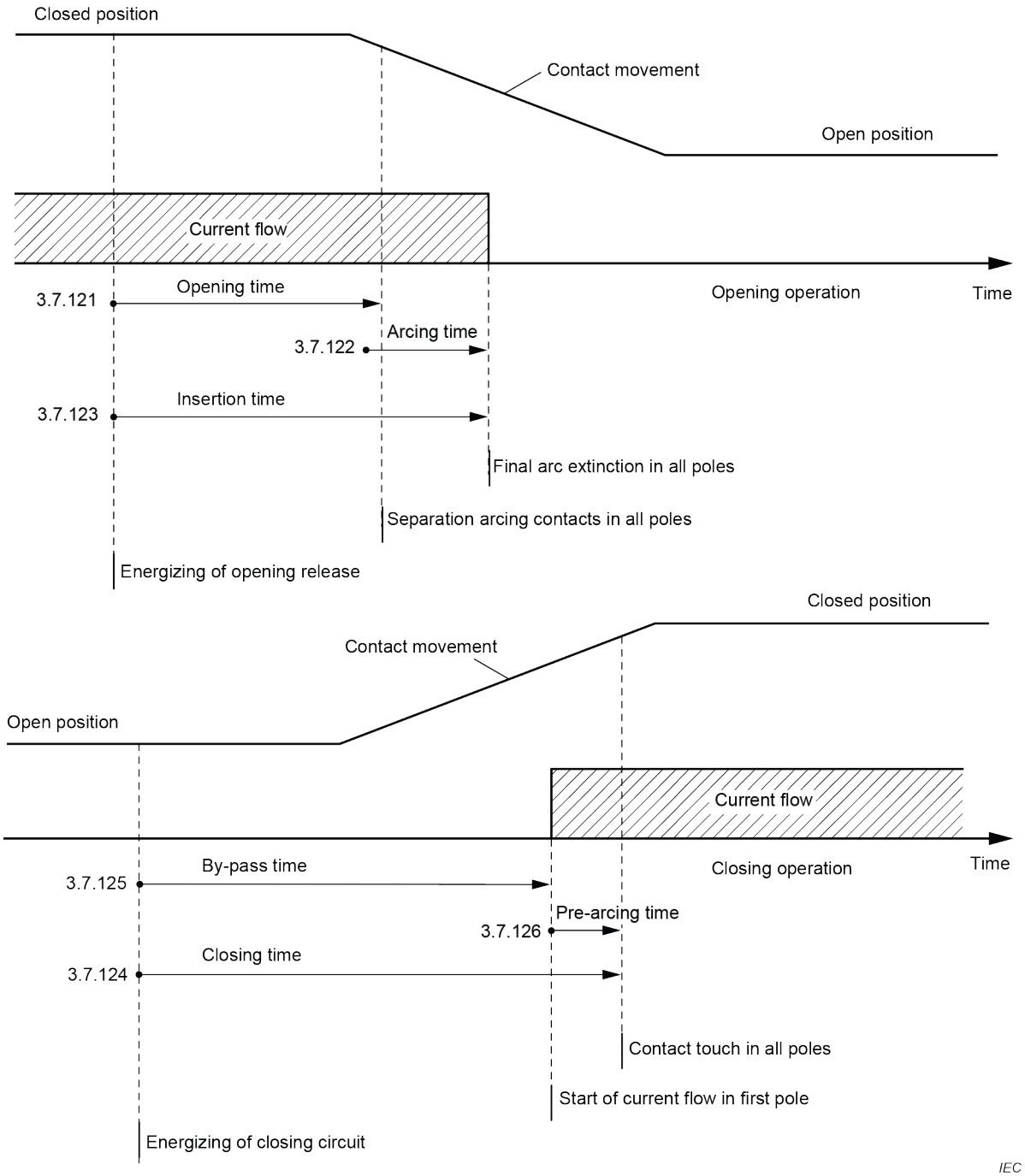

Figure 2 – By-pass switch – Opening and closing operations

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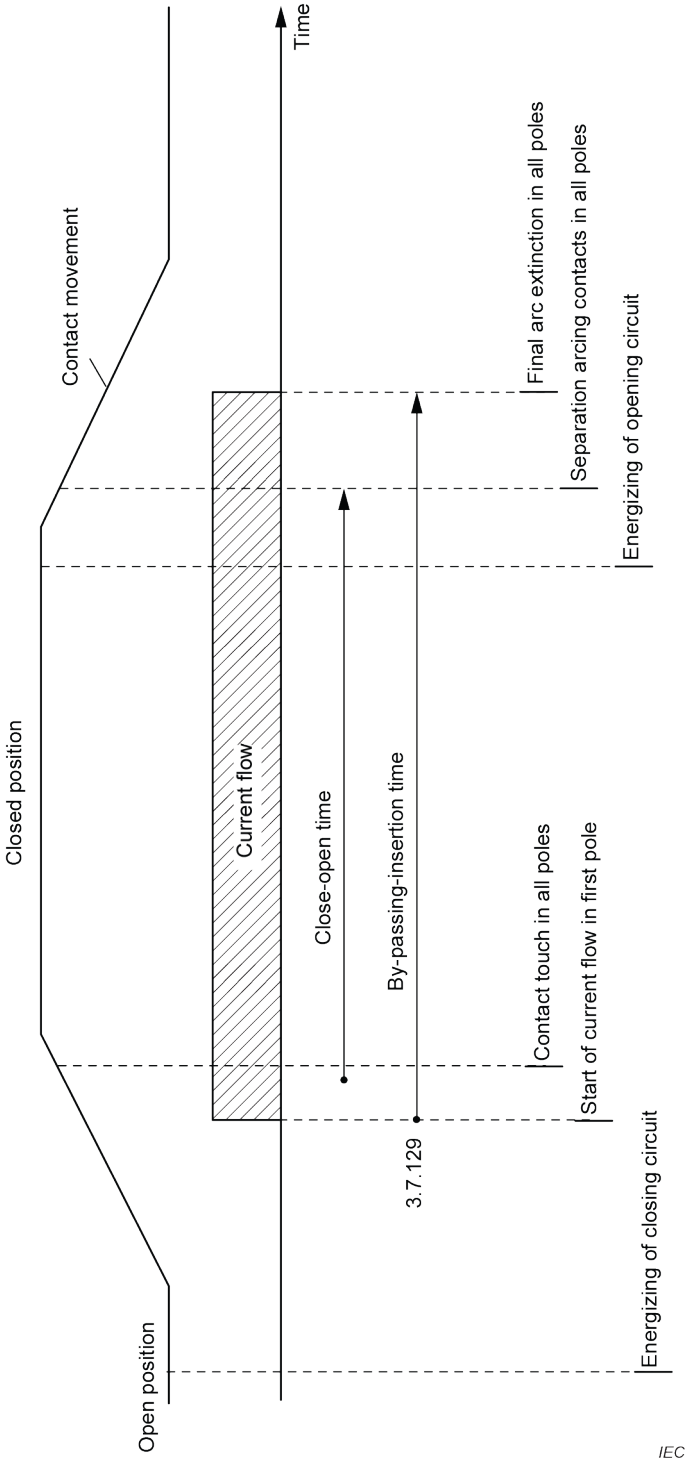

Figure 3 – By-pass switch – Close-open cycle

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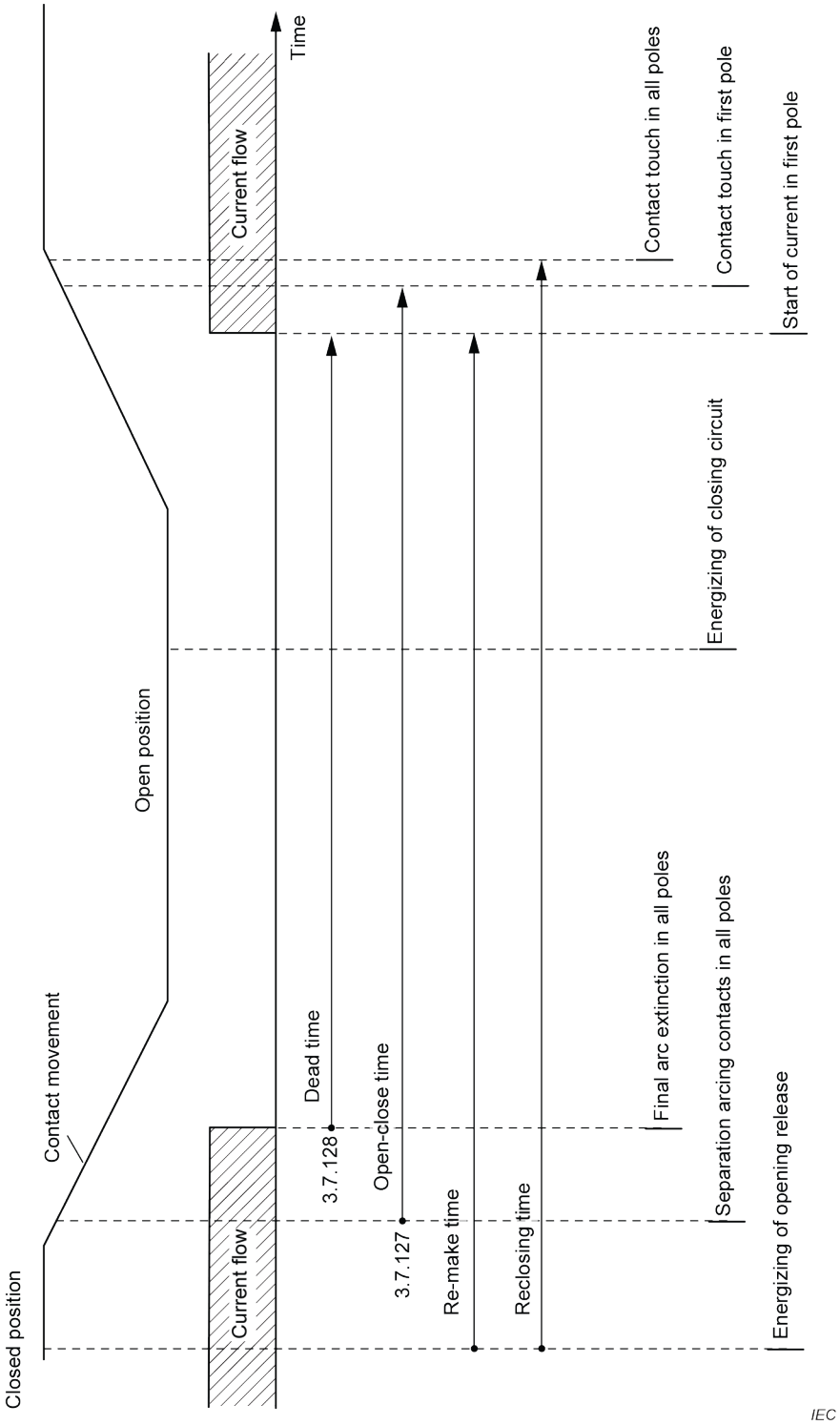

Figure 4 – By-pass switch – Open-close cycle

3.7.101
rated value
quantity value assigned, generally by a 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.

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 to be specified in the relevant publications.

[SOURCE: IEC 60050-441:2000, 441-17-01]

3.7.103
prospective peak current
peak value of the first current 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 by-pass switch, i.e. with the instantaneous and simultaneous transition of its impedance across the terminals of each pole from infinity to zero. The peak value may differ from one pole to another; it depends on the instantaneous voltage across the capacitor prior to by-passing.

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

3.7.105
transient by-pass current
superposition of capacitor bank discharge current and power-frequency current

3.7.106
by-pass making current
peak value of the by-pass current in a pole of a by-pass switch during the transient period following the initiation of current during a by-passing operation

Note 1 to entry: The value is the maximum instantaneous value of the sum of the capacitor bank discharge current component and the power-frequency current component. In case of system faults, the power-frequency fault current is equal to the maximum varistor coordinating current or for schemes without varistor, the actual maximum power-frequency fault current at the particular location.

Note 2 to entry: The peak value may differ from one pole to another and from one operation to another as it depends on the instantaneous capacitor voltage prior to by-passing.

Note 3 to entry: Where, for a three-phase circuit, a single value of peak value of by-pass making current is referred to, this is, unless otherwise stated, the highest value in any phase.

Note 4 to entry: The maximum power-frequency fault current at a particular location or the maximum varistor coordinating current is generally much lower than the rated peak withstand current of the by-pass switch.

3.7.107
insertion current
by-pass insertion current
steady state root-mean-square current that flows through the by-pass switch immediately prior to opening

3.7.108
insertion capacity
value of prospective current that a by-pass switch is capable of inserting at the stated voltage under prescribed conditions of use and behaviour

3.7.109
by-passing capacity
value of prospective current that a by-pass switch is capable of by-passing at a stated voltage under prescribed conditions of use and behaviour

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3.7.110
short-circuit making capacity
making capacity for which the prescribed conditions include a short circuit at the terminals of the switching device

[SOURCE: IEC 60050-441:2000, 441-17-10]

3.7.111
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 60050-441:2000, 441-17-17]

3.7.112
peak withstand current
value of peak current that a circuit or a switching device in the closed position can withstand under prescribed codnditions of use and behaviour

[SOURCE: IEC 60050-441:2000, 441-17-18]

3.7.113
applied voltage
<of 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 60050-441:2000, 441-17-24]

3.7.114
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 may 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 60050-441:2000, 441-17-25]

3.7.115
power-frequency recovery voltage
recovery voltage after the transient voltage phenomena have subsided

[SOURCE: IEC 60050-441:2000, 441-17-27]

3.7.116
peak arc voltage
<of a mechanical switching device>
maximum instantaneous value of voltage which under prescribed conditions appears across the terminals of a pole of a switching device during the arcing time

[SOURCE: IEC 60050-441:2000, 441-17-30]

3.7.117
clearance
distance between two conductive parts along a string stretched the shortest way between these conductive parts

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[SOURCE: IEC 60050-441:2000, 441-17-31]

3.7.118
clearance between poles
clearance between any conductive parts of adjacent poles

[SOURCE: IEC 60050-441:2000, 441-17-32]

3.7.119
clearance to earth
clearance between any conductive parts and any parts which are earthed or intended to be earthed

[SOURCE: IEC 60050-441:2000, 441-17-33]

3.7.120
clearance between open contacts
total clearance between the contacts, or any conductive parts connected thereto, of a pole of a mechanical switching device in the open position

[SOURCE: IEC 60050-441:2000, 441-17-34]

3.7.121
opening time
opening time of a by-pass switch defined according to the tripping method as stated below and with any time delay device forming an integral part of the by-pass switch adjusted to its minimum setting

Note 1 to entry: For a by-pass switch tripped by any form of auxiliary power, the opening time is the interval of time between the instant of energising the opening release, the by-pass switch being in the closed position, and the instant when the arcing contacts have separated in all poles.

Note 2 to entry: For by-pass switches with more than one insertion unit per pole, the instant when the arcing contacts have separated in all poles is determined as the instant of contact separation in the first unit of the last pole.

Note 3 to entry: The opening time includes the operating time of any auxiliary equipment necessary to open the by-pass switch and forming an integral part of the by-pass switch.

3.7.122
arcing time
<of a pole>
interval of time between the instant of the first initiation of an arc in a pole and the instant of final arc extinction in that pole

[SOURCE: IEC 60050-441:2000, 441-17-37]

3.7.123
insertion time
interval of time between the beginning of the opening time of a by-pass switch and the end of the arcing time

3.7.124
closing time
interval of time between energizing the closing circuit, the by-pass switch being in the open position, and the instant when the contacts touch in all poles

Note 1 to entry: The closing time includes the operating time of any auxiliary equipment necessary to close the by-pass switch and forming an integral part of the by-pass switch.

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3.7.125
by-pass time
interval of time between energising the closing circuit, the by-pass switch being in the open position, and the instant when the current begins to flow in the first pole

Note 1 to entry: The by-pass time includes the operating time of any auxiliary equipment necessary to close the by-pass switch and forming an integral part of the by-pass switch.

Note 2 to entry: The by-pass time may vary, e.g. due to the variation of the pre-arcing time.

3.7.126
pre-arcing time
interval of time between the initiation of current flow in the first pole during a by-passing operation and the instant when the contacts touch in all poles for three-phase conditions or 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 by-passing operation and therefore may vary considerably.

3.7.127
open-close time
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 by-passing operation

Note 1 to entry: Unless otherwise stated, it is assumed that the closing release incorporated in the by-pass switch is energized at the instant when the contacts have separated in all poles during opening. This represents the minimum open-close time.

3.7.128
dead time
<during auto-reclosing>
interval of time between final arc extinction in all poles in the insertion operation and the first re-establishment of current in any pole in the subsequent by-passing operation

Note 1 to entry: The dead time can vary, for example owing to the variation of the pre-arcing time.

3.7.129
by-passing-insertion time
interval of time between the initiation of current flow in the first pole during a by-passing operation and the end of the arcing time during the subsequent insertion operation

Note 1 to entry: The by-pass insertion time may vary due to the variation of the pre-arcing and arcing times.

Note 2 to entry: The by-pass insertion time should be compatible with system requirements.

3.7.130
minimum trip duration
minimum time the auxiliary power is applied to the opening release to ensure complete opening of the by-pass switch

3.7.131
minimum close duration
minimum time the auxiliary power is applied to the closing device to ensure complete closing of the by-pass switch

3.7.132
insulation level
for a by-pass switch, a characteristic defined by values indicating the insulation withstand voltages to earth and/or across the by-pass units

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3.7.133
power-frequency withstand voltage
RMS value of sinusoidal power-frequency voltage that the by-pass switch can withstand during tests made under specified conditions and for a specified duration

[SOURCE: IEC 60050-614:2016, 614-03-22, modified, words "insulation of the given equipment" has been replaced by "by-pass switch"]

3.7.134
impulse withstand voltage
peak value of the standard impulse voltage wave which the insulation of the by-pass switch withstands under specified test conditions

Note 1 to entry: Depending on the shape of the wave, the term may be qualified as "switching impulse withstand voltage" or "lightning impulse withstand voltage".

3.7.135
minimum functional pressure ρ_{mm} for operation
pressure (in Pa), for operation, referred to the standard atmospheric air conditions of +20 °C and 101,3 kPa (or density), which may be expressed in relative or absolute terms, at which and above which rated characteristics of a by-pass switch are maintained and at which a replenishment of the energy storage device becomes necessary

Note 1 to entry: This pressure is often designated as interlocking pressure (refer to 3.6.5.6 of IEC 62271-1:2017).

3.7.136
minimum functional pressure ρ_{me} for by-passing, insertion and insulation
pressure (in Pa), for by-passing, insertion and for insulation, referred to the standard atmospheric air conditions of +20 °C and 101,3 kPa (or density), which may be expressed in relative or absolute terms, at which and above which rated characteristics of a by-pass switch are maintained and at which a replenishment of the by-passing, insertion and/or insulating fluid becomes necessary

Note 1 to entry: See also 3.6.5.5 of IEC 62271-1:2017.

Note 2 to entry: For by-pass switches with a sealed pressure system (also termed sealed-for-life), the minimum functional pressure for by-passing and insertion is the one at which the rated characteristics of the by-pass switch are maintained taking into account the pressure drop at the end of the expected operating life.

3.7.137
initiation of closing operation
instant of receipt of a command for a closing operation at the control circuit

3.7.138
initiation of opening operation
instant of receipt of a command for an opening operation at the control circuit

3.8 Terms and definitions related to series capacitor banks

3.8.1
capacitor
term used when it is not necessary to distinguish between the different meanings of the words "capacitor unit" and the assembly of capacitors associated with a segment

3.8.2
overvoltage protector
<of a series capacitor>
fast-acting device intended to limit the voltage across the capacitor to a permissible value when that value would otherwise be exceeded as a result of a circuit fault or other abnormal power system conditions

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[SOURCE: IEC 60050-436:1990, 436-03-14, modified – words added: "when that value would otherwise be exceeded as a result of a circuit fault or other abnormal power system conditions"]

3.8.3
rated capacitance
C_N
<of a capacitor>
capacitance value for which the capacitor has been designed

3.8.4
rated current of a capacitor
I_N
RMS value of the alternating current for which the capacitor has been designed

[SOURCE: IEC 60050-436:1990, 436-01-13]

3.8.5
rated reactance
X_N
<of a capacitor>
reactance of each phase of the series capacitor at rated frequency and 20 °C dielectric temperature

3.8.6
rated voltage
U_N
<of a capacitor>
RMS value of the voltage between the terminals, derived from rated reactance and rated current $U_N = X_N \times I_N$

[SOURCE: IEC 60050-436:1990, 436-01-15, modified – words "of the alternating voltage for which the capacitor has been designed." Have been replaced by " of the voltage between the terminals, derived from rated reactance and rated current $U_N = X_N \times I_N$"]

3.8.7
limiting voltage
U_{LIM}
maximum peak of the power-frequency voltage occurring between capacitor unit terminals immediately before or during operation of the overvoltage protector, divided by $\sqrt{2}$

3.8.8
series capacitor bank
three-phase assembly of capacitors with associated protection and insulated support structure

Note 1 to entry: The bank may include one or more modules.

3.8.9
segment
<of a series capacitor>
where each phase of a bank is divided into one or more series connected parts, of which each part contains its own assembly of capacitor units, overvoltage protector, protective functions and bypass switch, each such complete part is called segment

Note 1 to entry: Segments are not normally separated by isolating disconnectors. More than one segment can be on the same insulated platform.

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3.8.10
bank protection
general term for all protective equipment for a capacitor bank, or part thereof

3.8.11
by-pass current
steady-state RMS current flowing through the by-pass switch in parallel with the capacitor

3.8.12
by-pass fault current
current flowing through the by-passed series capacitor bank caused by a fault on the line

3.8.13
by-pass gap (protective gap)
gap, or system of gaps, to protect either the capacitor (type K) against overvoltage or the non-linear resistor (type M) against overload by carrying the load or fault current around the protected parts for a specified time (see Figure 2 of IEC 60143-2:2012)

3.8.14
by-pass interlocking device
device that requires all three poles of the by-pass switch to be in the same open or closed position

3.8.15
current-limiting damping equipment
reactor or a reactor with a parallel connected resistor to limit the current magnitude and frequency and to provide a sufficient damping of the discharge of the capacitors upon operation of the by-pass gap or the by-pass switch

3.8.16
insertion
opening of the series capacitor by-pass switch to insert the series capacitor in series with the transmission line

3.8.17
insertion current
RMS current that flows through the series capacitor after the by-pass switch has opened. This current may be at the specified continuous or overload current magnitudes

3.8.18
insertion voltage
peak voltage appearing across the series capacitor upon transfer of the by-pass current with the opening of the by-pass switch

3.8.19
main gap
that part of the protective spark-gap intended to carry the fault current during a specified time, comprising two or more heavy-duty electrodes

3.8.20
module
<capacitor switching step>
three-phase function unit consisting of one capacitor segment (possibly several) per phase with provision for interlocked operation of the single-phase by-pass switches

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3.8.21
non-linear resistor
varistor
device to act as overvoltage protection of the capacitor consisting of resistors with a non-linear voltage-dependent resistance (normally metal-oxide varistors)

3.8.22
protective level
U_{PL}
magnitude of the maximum peak of the power-frequency voltage appearing across the overvoltage protector during a power system fault ($U_{PL} = U_{LIM} \times \sqrt{2}$)

Note 1 to entry: The protective level may be expressed in terms of the actual peak voltage across a segment or in terms of per unit of the peak of the rated voltage across the capacitor.

3.8.23
reinsertion
restoration of load current to the series capacitor from the by-pass path

3.8.24
reinsertion current
transient current, power-frequency current, or both, flowing through the series capacitor during the opening of the by-pass path

3.8.25
reinsertion voltage
recovery voltage appearing across the series capacitor during the opening of the by-pass path

3.8.26
temporary overvoltage
temporary power-frequency voltage higher than the continuous rated voltage of the series capacitor

3.8.27
varistor coordinating current
magnitude of the maximum varistor current associated with the protective level

3.8.28
capacitor bank discharge current
$I_{DISCHARGE}$
current which flows during the discharging of the capacitor bank

Note 1 to entry: The maximum peak value of the capacitor discharge current occurs when the capacitor bank is charged to the protective level U_{PL}.

3.9 Index of definitions

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4 Normal and special service conditions

Clause 4 of IEC 62271-1:2017 is applicable.

5 Ratings

5.1 General

The characteristics of a by-pass switch, including its operating devices and auxiliary equipment, that shall be used to determine the ratings are the following.

Rated characteristics to be given for all by-pass switches

a) rated voltage to earth (U_{re}) and across the by-pass switch (U_{rp});
b) rated insulation level to earth (U_{pe}, U_{de}, U_{se}) and across the by-pass switch (U_{pp}, U_{dp}, U_{sp});
c) rated frequency (f_r);
d) rated continuous current (I_r);
e) rated short-time withstand current (I_k);
f) rated peak withstand current (I_p);
g) rated duration of short-circuit (t_k);

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