

High-voltage switchgear and controlgear –

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

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PUBLICLY AVAILABLE SPECIFICATION



INTERNATIONAL
ELECTROTECHNICAL
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Reference number
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

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

FOREWORD

A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public.

IEC-PAS 62271-109 has been processed by subcommittee 17A: High-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

The text of this PAS is based on the following document:

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document.

Draft PAS	Report on voting
17A/631/PAS	17A/637/RVD

Following publication of this PAS, the technical committee or subcommittee concerned will investigate the possibility of transforming the PAS into an International Standard.

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
- 4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
- 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

New numbering

In accordance with the decision taken at the joint SC 17A/SC 17C meeting in Frankfurt (item 20.7 of 17A/535/RM) a common numbering system will be established of the standards falling under the responsibility of SC 17A and SC 17C. IEC 62271 (with the main title of *High-voltage switchgear and controlgear*) is the basis of the common standard.

Numbering of the standards will apply the following principle:

- a) Common standards prepared by SC 17A and SC 17C will start with IEC 62271-001;
- b) Standards of SC 17A will start with IEC 62271-100;
- c) Standards of SC 17C will start with number IEC 62271-200;
- d) Guides prepared by SC 17A and SC 17C will start with number IEC 62271-300.

The following Table provides an overview of the relationship between the old and new numbering:

Common numbering of standards falling under the responsibility of subcommittees 17A and 17C

IEC 62271	HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR	Old IEC number, if any
Part	Original title	
1	Common specifications	IEC 60694 IEC 60516
100	High-voltage alternating current circuit-breakers	IEC 60056
101	Synthetic testing of high-voltage alternating current circuit-breakers	IEC 60427
102	High-voltage alternating current disconnectors and earthing switches	IEC 60129
103	High-voltage switches for rated voltages above 1 kV and less than 52 kV	IEC 60265-1
104	High-voltage switches for rated voltages of 52 kV and above	IEC 60265-2
105	High voltage alternating current switch-fuse combinations	IEC 60420
106	High-voltage alternating current contactors and contactor based motor-starters	IEC 60470
107	Alternating current switchgear-fuse combinations	New
108	Switchgear having combined functions	New
200	Metal enclosed switchgear and controlgear for rated voltages up to and including 38 kV	IEC 60298
201	Insulation-enclosed switchgear and controlgear for rated voltages up to and including 52 kV	IEC 60466
202	High-voltage/low voltage prefabricated substations	IEC 61330
203	Gas-insulated metal enclosed switchgear for rated voltages above 52 kV	IEC 60517 IEC 61259
204	High-voltage gas-insulated transmission lines for rated voltages of 72,5 kV and above	IEC 61640
300	Guide for seismic qualification	IEC 61166
301	Guide for inductive load switching	IEC 61233
302	Guide for short-circuit and switching test procedures for metal-enclosed and dead tank circuit-breakers switches	IEC 61633
303	Use and handling of sulphur hexafluoride (SF ₆) in high-voltage switchgear and controlgear	IEC 61634
304	Additional requirements for enclosed switchgear and controlgear from 1 kV to 72,5 kV to be used in severe climatic conditions	IEC 60932
305	Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV	IEC 60859
306	Direct connection between power transformers and gas-insulated metal-enclosed switchgear for rated voltages above 52 kV	IEC 61639
307	The use of electronic and associated technologies in auxiliary equipment of switchgear and controlgear	IEC 62063
308	Guide for asymmetrical short-circuit breaking test duty T100a	New
309	Electrical endurance testing for circuit-breakers rated 72,5 kV and above	New

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

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

1 General

1.1 Scope

This Publicly Available Specification is applicable to a.c. 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 1 000 V.

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

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

This specification does not cover vacuum by-pass switches.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this Publicly Available Specification. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this Publicly Available Specification are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(151):1978, *International Electrotechnical Vocabulary – Chapter 151: Electrical and magnetic devices*

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

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

IEC 60050(601):1985, *International Electrotechnical Vocabulary – Chapter 601: Generation, transmission and distribution of electricity – General*

IEC 60050(604):1987, *International Electrotechnical Vocabulary – Chapter 604: Generation, transmission and distribution of electricity – Operation*

IEC 60059:1999, *IEC standard current ratings*

IEC 60060: all parts, *High-voltage test techniques*

IEC 60099-4:2002, *Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems*

IEC 60129:1984, *Alternating current disconnectors and earthing switches*

IEC 60137:1995, *Bushings for alternating voltages above 1 000 V*

IEC 60143-1:1992, *Series capacitors for power systems – Part 1: General – Performance, testing and rating – Safety requirements – Guide for installation*

IEC 60143-2:1994, *Series capacitors for power systems – Part 2: Protective equipment for series capacitor banks*

IEC 60255-3:1989, *Electrical relays – Part 3: Single output energizing quantity measuring relays with dependent or independent time*

IEC 60296:1982, *Specification for unused mineral insulating oils for transformers and switchgear*

IEC 60376:1971, *Specification and acceptance of new sulphur hexafluoride*

IEC 60427:1989, *Synthetic testing of high-voltage alternating current circuit-breakers*

IEC 60480:1974, *Guide to the checking of sulphur hexafluoride (SF₆) taken from electrical equipment*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP code)*

IEC 60694:1996, *Common specifications for high-voltage switchgear and controlgear standards*

IEC 61633:1995, *High-voltage alternating current circuit-breakers – Guide for short-circuit and switching test procedures for metal-enclosed and dead tank circuit-breakers*

IEC 61634:1995, *High-voltage switchgear and controlgear – Use and handling of sulphur hexafluoride (SF₆) in high-voltage switchgear and controlgear*

IEC 62271-100:2001, *High-voltage switchgear and controlgear – Part 100: High-voltage alternating current circuit-breakers*

2 Normal and special service conditions

Clause 2 of IEC 60694 is applicable.

3 Definitions

For the purpose of this Publicly Available Specification, the definitions of IEC 60050(151), IEC 60050(436), IEC 60050(441), IEC 60050(604), IEC 60143-1, IEC 60143-2 and IEC 60694 apply. Some of them are recalled here for ease of reference.

Additional definitions are classified so as to be aligned with the classification used in IEC 60050(441).

3.1 General terms

3.1.101

switchgear and controlgear

[IEV 441-11-01]

3.1.102

outdoor switchgear and controlgear

[IEV 441-11-05]

3.1.103
short-circuit current
[IEV 441-11-07]

3.1.104
ambient air temperature
[IEV 441-11-13]

3.1.105
temperature rise (of a part of a by-pass switch)
difference between the temperature of the part and the ambient air temperature

3.1.106
overvoltage (in a system)
any voltage between one phase and earth or between phases having a peak value or values exceeding the corresponding peak of the highest voltage for equipment
[IEV 604-03-09, modified]

3.1.107
unit test
test made 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 transient recovery voltage, specified for the test on the complete pole of the by-pass switch

3.1.108
external insulation
distances in air and the surfaces in contact with open air of solid insulation of the equipment, which are subject to dielectric stresses and to the effects of atmospheric and other external conditions such as pollution, humidity, vermin, etc.
[IEV 604-03-02, modified]

3.1.109
internal insulation
internal solid, liquid or gaseous parts of the insulation of equipment, which are protected from the effects of atmospheric and other external conditions
[IEV 604-03-03]

3.1.110
self-restoring insulation
insulation which completely recovers its insulating properties after a disruptive discharge
[IEV 604-03-04]

3.1.111
non-self restoring insulation
insulation which loses its insulating properties, or does not recover them completely, after a disruptive discharge
[IEV 604-03-05]

3.1.112
disruptive discharge
phenomenon associated with the failure of insulation under electric stress, in which the discharge completely bridges the insulation under test, reducing the voltage between the electrodes to zero or nearly to zero

NOTE 1 This term applies to discharges in solid, liquid and gaseous dielectrics and to combinations of these.

NOTE 2 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 only temporary (self-restoring insulation).

NOTE 3 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.

3.1.112

restrike performance

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

NOTE Specific numeric probabilities cannot be applied throughout a by-pass switch service life.

3.2 Assemblies

No particular definitions.

3.3 Parts of assemblies

No particular definitions.

3.4 Switching devices

3.4.101

switching device

[IEV 441-14-01]

3.4.102

mechanical switching device

[IEV 441-14-02]

3.4.103

by-pass switch

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. 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

3.4.104

by-pass switch class BP1

by-pass switch used as the non-primary device for by-passing the capacitor. This class of by-pass switch is used in conjunction with a fast by-passing device such as a spark gap (see Figure 2 of IEC 60143-2)

3.4.105

by-pass switch class BP2

by-pass switch used as the primary by-passing device

3.4.106

by-pass switch class M1

by-pass switch with normal mechanical endurance (mechanically type tested for 2 000 operating sequences) not falling into the category of class M2 as defined in 3.4.107

3.4.107

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 (by-pass switch with extended mechanical endurance, mechanically type tested for 10 000 operating sequences). This type of by-pass switch is normally used on multi-segmented capacitors where the control of the capacitor impedance is a frequent duty

NOTE A combination of the different classes of by-pass switches with regard to application and mechanical endurance is possible. For the designation of these by-pass switches the notation of the different classes are combined following an alphabetical order, for example BP1-M2.

3.5 Parts of by-pass switches

3.5.101

pole

[IEV 441-15-01]

3.5.102

main circuit

[IEV 441-15-02]

3.5.103

control circuit

[IEV 441-15-03]

3.5.104

auxiliary circuit

[IEV 441-15-04]

3.5.105

contact

[IEV 441-15-05]

3.5.106

contact piece

[IEV 441-15-06]

3.5.107

main contact

[IEV 441-15-07]

3.5.108

arcing contact

[IEV 441-15-08]

3.5.109

control contact

[IEV 441-15-09]

3.5.110

auxiliary contact

[IEV 441-15-10]

3.5.111

auxiliary switch

[IEV 441-15-11]

3.5.112

“a” contact;

make contact

[IEV 441-15-12]

3.5.113

“b” contact;

break contact

[IEV 441-15-13]

3.5.114
sliding contact
[IEV 441-15-15]

3.5.115
rolling contact
[IEV 441-15-16]

3.5.116
release
[IEV 441-15-17]

3.5.117
arc control device
[IEV 441-15-18]

3.5.118
position indicating device
[IEV 441-15-25]

3.5.119
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

3.5.120
terminal
component provided for the connection of a device to external conductors
[IEV 151-01-03]

3.5.121
by-pass (or 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 By-pass units and insertion units are normally combined but may be separated. Each unit may have several contacts.

NOTE 2 The means controlling the voltage distribution between units may differ from unit to unit.

3.5.122
module
assembly which generally comprises by-pass or insertion units, post-insulators 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 (see IEC 60529) 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
[IEV 441-13-01, modified]

3.6 Operation

3.6.101
operation
[IEV 441-16-01]