



IEC 62271-103

Edition 1.0 2011-06

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

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**High-voltage switchgear and controlgear –  
Part 103: Switches for rated voltages above 1 kV up to and including 52 kV**

**Appareillage à haute tension –  
Partie 103: Interrupteurs pour tensions assignées supérieures à 1 kV et  
inférieures ou égales à 52 kV**



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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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### HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

#### **Part 103: Switches for rated voltages above 1 kV up to and including 52 kV**

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International Standard IEC 62271-103 has been prepared by subcommittee 17A: High-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

This standard cancels and replaces the third edition of IEC 60265-1, published in 1998. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC 60265-1:1998:

- the rated voltage of 52 kV is now included;
- the document is aligned with IEC 62271-1 and IEC 62271-100;
- addition of a test procedure for short-circuit making tests;
- introduction of notion of NSDD (non-sustained disruptive discharge) as defined in IEC 62271-1 and restrikes;
- new classes C1 and C2 for capacitive switching;



- new Annex A defining tolerances.

The text of this standard is based on the following documents:

FDIS	Report on voting
17A/961/FDIS	17A/966/RVD

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

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

This standard is to be read in conjunction with IEC 62271-1:2007, 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. Amendments to these clauses and subclauses are given under the same references whilst additional subclauses are numbered from 101.

The list of all parts of the 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 publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

## HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

### Part 103: Switches for rated voltages above 1 kV up to and including 52 kV

#### 1 General

##### 1.1 Scope

This part of IEC 62271 is applicable to three-phase, alternating current switches and switch-disconnectors for their switching function, having making and breaking current ratings, for indoor and outdoor installations, for rated voltages above 1 kV up to and including 52 kV and for rated frequencies from  $16^{2/3}$  Hz up to and including 60 Hz. This standard is also applicable to single-pole switches used on three phase systems.

This standard is also applicable to the operating devices of these switches and to their auxiliary equipment.

Switch-disconnectors are also covered by IEC 62271-102 for their disconnecting function.

Devices that require a dependent manual operation are not covered by this standard.

General principles and provisions of this standard may also be applicable to single pole switches intended for application in single-phase systems. The requirements for dielectric tests and making and breaking tests should be in accordance with the requirements of the specific application.

This standard establishes requirements for general, limited and special purpose switches used in distribution systems.

It is assumed that opening and closing operations are performed according to the manufacturer's instructions. A making operation may immediately follow a breaking operation but a breaking operation should not immediately follow a making operation since the current to be broken may then exceed the rated breaking current of the switch.

NOTE 1 Except where special clarification is required, the term "switch" is used to refer to all kinds of switches and switch-disconnectors within the scope of this standard.

NOTE 2 Earthing switches are not covered by this standard. Earthing switches forming an integral part of a switch are covered by IEC 62271-102.

NOTE 3 This standard is not applicable to switching devices attached as an accessory to a high-voltage fuse assembly or its mounting and operated by opening and closing the fuse assembly.

##### 1.2 Normative references

The following referenced documents are indispensable for the application 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 60050-441:1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*

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

IEC 62271-1:2007, *High-voltage switchgear and controlgear – Part 1: Common specifications*

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

IEC 62271-102:2001, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

IEC 62271-110:2009, *High-voltage switchgear and controlgear – Part 110: Inductive load switching*

## 2 Normal and special service conditions

Clause 2 of IEC 62271-1 is applicable.

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-441 and IEC 62271-1, as well as the following apply.

NOTE 1 Some terms and definitions are recalled hereunder for easier use or for the necessity of some precision or adaptation for the interpretation of this standard.

NOTE 2 The terms and definitions given below are classified in accordance with IEC 60050-441. The additional terms and definitions are classified so as to be aligned with the classification used in IEC 60050-441.

### 3.1 General terms

Subclause 3.1 of IEC 62271-1 is applicable with the following additions.

#### 3.1.101

##### **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. Normally such systems are solidly earthed (neutral) systems or low impedance earthed (neutral) systems

NOTE For the correct assessment of the earthing conditions not only the physical earthing conditions around the relevant location but the total system is to be considered.

#### 3.1.102

##### **non-effectively earthed neutral system**

system other than effectively earthed neutral system, not meeting the conditions given in 3.1.101. Normally such systems are isolated neutral systems, high impedance earthed (neutral) systems or resonant earthed (neutral) systems

NOTE For the correct assessment of the earthing conditions not only the physical earthing conditions around the relevant location but the total system is to be considered.

### 3.2 Assemblies of switchgear and controlgear

Subclause 3.2 of IEC 62271-1 applies.

### 3.3 Parts of assemblies

Subclause 3.3 of IEC 62271-1 applies.

### 3.4 Switching devices

Subclause 3.4 of IEC 62271-1 applies with the following addition.

**3.4.101****switch**

switching device capable of making, carrying and breaking currents under normal circuit conditions, which may include specified operating overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions, such as those of a short-circuit

[IEC 60050-441:1984, 441-14-10, modified]

**3.4.102****switch-disconnector**

switch which, in the open position, satisfies the isolating requirements specified for a disconnector

[IEC 60050-441:1984, 441-14-12]

**3.4.103****general purpose switch**

switch capable of performing, with currents up to its rated breaking currents, all making and breaking operations which may normally occur in distribution systems. The switch is also capable of carrying and making short-circuit currents

**3.4.103.1****class E1 general purpose switch**

general purpose switch capable of performing a basic electrical endurance of load breaking currents and short-circuit makings

NOTE This class is typically adequate for applications where infrequent switching operations are performed or where appropriate inspection and replacement of switching parts is permissible.

**3.4.103.2****class E2 general purpose switch**

general purpose switch capable of performing a medium electrical endurance of load breaking currents and short-circuit makings

NOTE This class is typically adequate for applications where infrequent switching operations are performed but where inspection and replacement of switching parts is not permissible or possible.

**3.4.103.3****class E3 general purpose switch**

general purpose switch capable of performing a high electrical endurance of load breaking currents and short-circuit makings

NOTE This class is typically adequate for applications where frequent switching operations are performed and inspection and replacement of switching parts is not permissible or possible.

**3.4.103.4****class M1 switch**

switch suitable for applications requiring a mechanical endurance of 1 000 operations

**3.4.103.5****class M2 switch**

switch suitable for special service applications and for frequent operation having an extended mechanical endurance of 5 000 operations

**3.4.103.6****class C1 switch**

switch with capability of capacitive current breaking as demonstrated by specific type tests (test duties  $I_{CC}$ ,  $I_{IC}$ ,  $I_{sb}$  and  $I_{bb}$ )

**3.4.103.7****class C2 switch**

switch with very low probability of restrike during capacitive current breaking as demonstrated by specific type tests (test duties  $I_{CC}$ ,  $I_{IC}$ ,  $I_{sb}$  and  $I_{bb}$ )

#### **3.4.104**

##### **limited purpose switch**

switch which has a rated normal current, a rated short-time withstand current, and one or more but not all switching capabilities of a general purpose switch

#### **3.4.105**

##### **special purpose switch**

general purpose switch or limited purpose switch suitable for one or more of the following applications:

- switching single capacitor banks;
- switching back-to-back capacitor banks;
- switching of closed-loop circuits consisting of large power transformers in parallel;
- switching of motors under steady-state and stalled conditions

#### **3.4.105.1**

##### **single capacitor bank switch**

special purpose switch intended for switching of a single capacitor bank with charging currents up to its rated single capacitor bank breaking current

#### **3.4.105.2**

##### **back-to-back capacitor bank switch**

special purpose switch intended for breaking capacitor bank charging currents with one or more capacitor banks connected to the supply side of the switch up to its rated back-to-back capacitor bank breaking current. The switch is capable of making the associated inrush current up to its rated capacitor bank inrush making current

#### **3.4.105.3**

##### **motor switch**

special purpose switch intended for switching of motors under steady-state and stalled conditions

#### **3.4.105.4**

##### **parallel power transformer closed-loop switch**

special purpose switch intended for switching a closed-loop circuit consisting of large power transformers in parallel

NOTE The switch is typically applied as a medium voltage tie switch on the transformer secondary circuit such that the breaking current is high and the transient recovery voltage (TRV) conditions are severe

### **3.5 Parts of switchgear and controlgear**

Subclause 3.5 of IEC 62271-1 applies.

### **3.6 Operation**

Subclause 3.6 of IEC 62271-1 applies.

### **3.7 Characteristic quantities**

Subclause 3.7 of IEC 62271-1 applies with the following addition.

#### **3.7.101**

##### **breaking capacity**

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

NOTE 2 For switching devices, the breaking capacity may be termed according to the kind of current included in the prescribed conditions, e.g. line-charging breaking capacity, cable charging breaking capacity, single capacitor bank breaking capacity, etc.

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

### **3.7.102**

#### **mainly active load-breaking capacity**

breaking capacity when opening a mainly active load circuit, the power factor of which is at least 0,75, in which the load can be represented by resistors and reactors in parallel

### **3.7.103**

#### **no-load transformer breaking capacity**

breaking capacity when opening a transformer circuit under no-load conditions

### **3.7.104**

#### **closed-loop breaking capacity**

breaking capacity when opening a closed-loop distribution line circuit, or a power transformer in parallel with one or more power transformers, i.e., a circuit in which both sides of the switch remain energized after breaking

### **3.7.105**

#### **cable-charging breaking capacity**

breaking capacity when opening a cable circuit under no-load conditions

### **3.7.106**

#### **line-charging breaking capacity**

breaking capacity when opening an overhead line circuit under no-load conditions

### **3.7.107**

#### **single capacitor bank breaking capacity**

breaking capacity when opening a single capacitor bank circuit connected to a supply that does not include another capacitor bank adjacent to the bank being switched

### **3.7.108**

#### **back-to-back capacitor bank breaking capacity**

breaking capacity when opening a capacitor bank circuit connected to a supply that includes one or more capacitor banks adjacent to the bank being switched

### **3.7.109**

#### **back-to-back capacitor bank inrush making current**

high-frequency and high-magnitude current occurring when closing a capacitor bank circuit onto a supply including one or more capacitor banks adjacent to the bank being switched

### **3.7.110**

#### **motor breaking capacity**

breaking capacity when opening a motor under steady-state and stalled conditions

### **3.7.111**

#### **earth fault breaking capacity**

breaking capacity in the faulty phase of a non-effectively earthed neutral system when clearing an earth fault on an unloaded cable or overhead line on the load side of the switch

### **3.7.112**

#### **cable- and line-charging breaking capacity under earth fault conditions**

breaking capacity in the sound phases of a non-effectively earthed neutral system when switching off an unloaded cable or overhead line, with an earth fault on the supply side of the switch

### 3.7.113

#### **breaking current**

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

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

### 3.7.114

#### **(peak) making current**

peak value of the first major loop of the current in a pole of a switch during the transient period following the initiation of current during a making operation

NOTE 1 Peak value may 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 Where, for a three-phase circuit, a single value of (peak) making current is referred to, it is, unless otherwise stated, the highest value in any phase.

### 3.7.115

#### **short-circuit making capacity**

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

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

### 3.7.116

#### **restrike performance**

expected probability of restrike during capacitive current interruption as demonstrated by specified type tests

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

### 3.7.117

#### **re-ignition** (of an a.c. 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

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

### 3.7.118

#### **restrike** (of an a.c. mechanical switching device)

resumption of power frequency current, or in the case of capacitive current interruption a resumption of current in the main load circuit, 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

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

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## 4 Ratings

Clause 4 of IEC 62271-1 is applicable with the additions and exceptions indicated below.

### 4.1 Rated voltage ( $U_r$ )

Subclause 4.1 of IEC 62271-1 is applicable.



#### **4.2 Rated insulation level**

Subclause 4.2 of IEC 62271-1 is applicable.

#### **4.3 Rated frequency ( $f_r$ )**

Subclause 4.3 of IEC 62271-1 is applicable.

#### **4.4 Rated normal current and temperature rise**

Subclause 4.4 of IEC 62271-1 is applicable.

#### **4.5 Rated short-time withstand current ( $I_k$ )**

Subclause 4.5 of IEC 62271-1 is applicable.

#### **4.6 Rated peak withstand current ( $I_p$ )**

Subclause 4.6 of IEC 62271-1 is applicable.

#### **4.7 Rated duration of short-circuit ( $t_k$ )**

Subclause 4.7 of IEC 62271-1 is applicable.

#### **4.8 Rated supply voltage of closing and opening devices and of auxiliary and control circuits ( $U_a$ )**

Subclause 4.8 of IEC 62271-1 is applicable.

#### **4.9 Rated supply frequency of closing and opening devices and of auxiliary circuits**

Subclause 4.9 of IEC 62271-1 is applicable.

#### **4.10 Rated pressure of compressed gas supply for controlled pressure systems**

Subclause 4.10 of IEC 62271-1 is applicable with the following addition.

This rating applies only to power sources of operating devices.

NOTE Controlled pressure systems for insulation or switching are no longer manufactured up to 52 kV level. Therefore only gas supply for operating devices is considered.

#### **4.11 Rated filling levels for insulation and/or operation**

Subclause 4.11 of IEC 62271-1 is applicable with the following additions.

##### **4.11.101 Rated filling levels for insulation and/or switching**

This rating applies for any kind of liquid or gas used for insulation or switching.

##### **4.11.102 Rated filling levels for operation**

This rating applies for any kind of liquid or gas used as power source for the operating device.

#### **4.101 Rated mainly active load-breaking current ( $I_{load}$ )**

The rated mainly active load-breaking current is the maximum mainly active load current that the switch shall be capable of breaking at its rated voltage. Its value shall be equal to the rated normal current if no other value is indicated on the nameplate.

**4.102 Rated closed-loop breaking current ( $I_{loop}$  and  $I_{pptr}$ )**

The rated closed-loop breaking current is the maximum closed-loop current the switch shall be capable of breaking. Separate ratings for distribution line loop breaking current and parallel power transformer breaking current may be assigned.

**4.103 Rated cable-charging breaking current ( $I_{cc}$ )**

The rated cable-charging breaking current is the maximum cable-charging current that the switch shall be capable of breaking at its rated voltage.

**4.104 Rated line-charging breaking current ( $I_{lc}$ )**

The rated line-charging breaking current is the maximum line-charging current that the switch shall be capable of breaking at its rated voltage.

**4.105 Rated single capacitor bank breaking current for special purpose switches ( $I_{sb}$ )**

The rated single capacitor bank breaking current is the maximum capacitor bank current that a special purpose switch shall be capable of breaking at its rated voltage with no capacitor bank connected to the supply side of the switch adjacent to the bank being switched.

**4.106 Rated back-to-back capacitor bank breaking current for special purpose switches ( $I_{bb}$ )**

The rated back-to-back capacitor bank breaking current is the maximum capacitor bank current that a special purpose switch shall be capable of breaking at its rated voltage with one or more capacitor banks connected on the supply side of the switch adjacent to the bank being switched.

**4.107 Rated back-to-back capacitor bank inrush making current for special purpose switches ( $I_{in}$ )**

The rated back-to-back capacitor bank inrush making current is the peak value of the current that a special purpose switch shall be capable of making at its rated voltage and with a frequency of the inrush current appropriate to the service conditions.

The assignment of a rated back-to-back capacitor bank inrush making current is mandatory for switches that have a rated back-to-back capacitor bank breaking current.

NOTE The frequency of the inrush current for back-to-back capacitor banks may be in the range of 2 kHz to 30 kHz. The frequency and magnitude of the inrush current are dependent upon the size and configuration of the capacitor bank being switched, the capacitor bank already connected to the supply side of the switch and the inclusion of limiting impedances, if any.

The switch is not necessarily rated to break the inrush making current produced by the back-to-back capacitor bank installation.

**4.108 Rated earth fault breaking current ( $I_{eff}$ )**

The rated earth fault breaking current is the maximum earth fault current in the faulted phase that the switch shall be capable of breaking at its rated voltage, when used on a non-effectively earthed neutral system.

NOTE The maximum earth fault breaking current is 3 times the cable- and line-charging current occurring in normal conditions. This covers the most severe case, which occurs with individually screened cables.

#### 4.109 Rated cable- and line-charging breaking current under earth fault conditions ( $I_{ef2}$ )

The rated cable- and line-charging breaking current under earth fault conditions is the maximum current in the non-faulty phases that the switch shall be capable of breaking at its rated voltage, when used on a non-effectively earthed neutral system.

NOTE The maximum cable- and line-charging current under fault conditions is  $\sqrt{3}$  times the cable- and line-charging current occurring in normal conditions. This covers the most severe case, which occurs with individually screened cables.

#### 4.110 Rated motor breaking current for special purpose switches ( $I_{mot}$ )

The rated motor breaking current is the maximum steady-state current of a motor the switch shall be capable of opening at its rated voltage. Refer to IEC 62271-110.

NOTE Unless otherwise specified, the breaking current for the condition of a stalled motor is eight times the rated normal current of the motor.

#### 4.111 Rated short-circuit making current ( $I_{ma}$ )

The rated short-circuit making current is the maximum peak current that the switch shall be capable of making at its rated voltage.

#### 4.112 Rated breaking and making currents for a general purpose switch

A general purpose switch shall have specific ratings for each switching duty as follows:

- rated mainly active load-breaking current equal to the rated normal current;
- rated distribution line loop-breaking current equal to the rated normal current;
- rated cable-charging breaking current as shown in Table 1;
- rated line-charging breaking current as shown in Table 1;
- rated short-circuit making current equal to the rated peak withstand current;

and additionally for switches intended to be used in non-effectively earthed neutral systems:

- rated earth fault breaking current;
- rated cable- and line-charging breaking current under earth fault conditions.

The standard values of ratings should be selected from the R10 series specified in IEC 60059.

NOTE The R10 series comprises the number 1 - 1,25 - 1,6 - 2 - 2,5 - 3,15 - 4 - 5 - 6,3 - 8 and their products of  $10^n$ .

**Table 1 – Preferred values of rated line- and cable-charging breaking currents for general purpose switch**

Rated voltage $U_r$ kV	Rated cable charging $I_{cc}$ A	Rated line charging $I_{lc}$ A
3,6	4	0,3
4,76 <sup>a</sup>	4	0,3
7,2	6	0,5
8,25 <sup>a</sup>	6	0,5
12	10	1
15 <sup>a</sup>	10	1