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INTERNATIONAL STANDARD

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colour inside

**High-voltage switchgear and controlgear –
Part 112: Alternating current high-speed earthing switches for secondary arc extinction on transmission lines**

**Appareillage à haute tension –
Partie 112: Sectionneurs de terre rapides à courant alternatif pour l'extinction de l'arc secondaire sur les lignes de transport**

IEC 62271-112:2013

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 112: Alternating current high-speed earthing switches for secondary arc extinction on transmission lines

FOREWORD

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International Standard IEC 62271-112 has been prepared by subcommittee 17A: High-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

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

FDIS	Report on voting
17A/1042/FDIS	17A/1050/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 International Standard should be read in conjunction with IEC 62271-1:2007, 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 numbering, whilst additional subclauses, are numbered from 101.

A list of all parts in the IEC 62271, published 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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- amended.

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 112: Alternating current high-speed earthing switches for secondary arc extinction on transmission lines

1 General

1.1 Scope

This part of IEC 62271 applies to a.c. high-speed earthing switches designed for indoor and outdoor installation and for operation at service frequencies of 50 Hz and 60 Hz on systems having voltages of 550 kV and above.

High-speed earthing switches described in this standard are intended to extinguish the secondary arc remaining after clearing faults on transmission lines by the circuit-breakers.

1.2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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 62271-203:2011, *High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV*

2 Normal and special service conditions

Clause 2 of IEC 62271-1:2007 is applicable.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in Clause 3 of IEC 62271-1:2011, as well as the following apply.

3.1 General terms

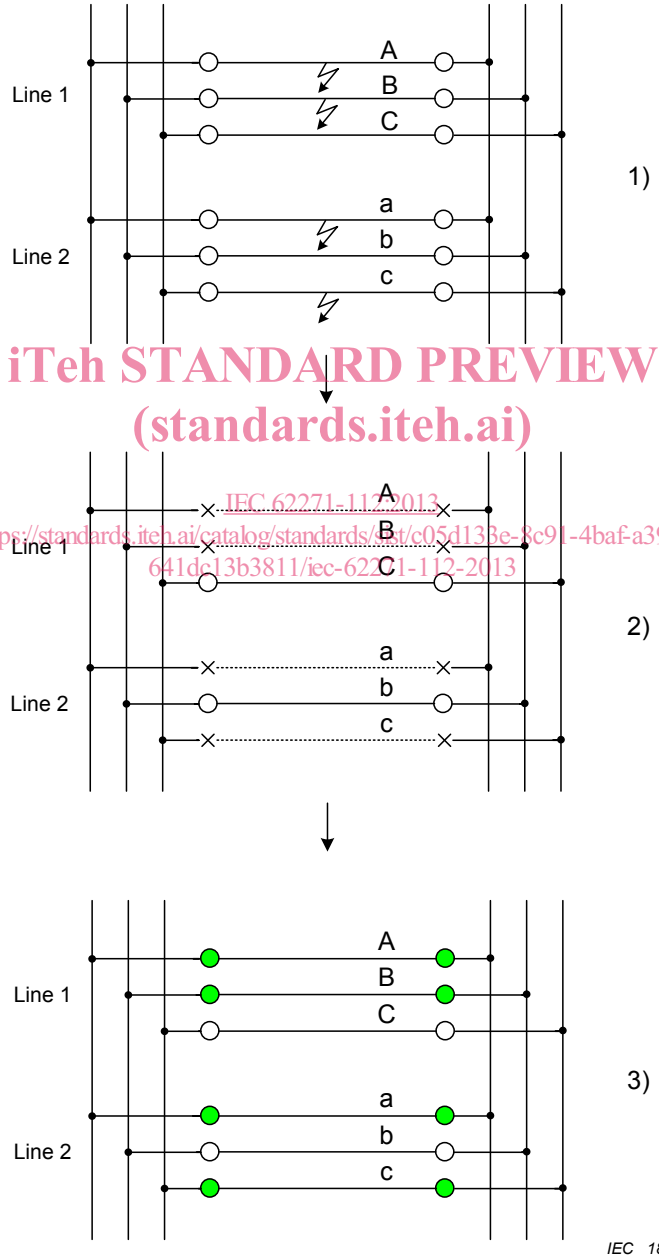
3.1.101
secondary arc
arc that remains at the faulted point after interruption of the short-circuit current fed by the network

Note 1 to entry: This secondary arc is supplied by electrostatic or electromagnetic induction from the adjacent healthy phases.

3.1.102
single-phase auto-reclosing scheme
auto-reclosing scheme in which a faulted phase circuit is opened and automatically re-closed independently from the other phases

3.1.103
multi-phase auto-reclosing scheme
auto-reclosing scheme applied to double circuit overhead lines in which all faulted phase circuits are opened and re-closed independently provided that at least two different phases remain un-faulted

Note 1 to entry: An example of multi-phase auto-reclosing scheme is indicated in Figure 1.



Key

1)	Up to 4 phases have a fault	○	Closed circuit-breaker
2)	Only the faulted phases have been tripped	×	Open circuit-breaker
3)	All circuit-breakers at both ends re-closed	●	Re-closed circuit-breaker

Figure 1 – Explanation of a multi-phase auto-reclosing scheme

Note 2 to entry: Other than the scheme described in 3.1.102 and 3.1.103, a three-phase auto-reclosing scheme is commonly applied. In this scheme, all three phases are tripped and re-closed at both ends even if a fault occurred in one phase. So far high-speed earthing switches are rarely applied with this scheme.

3.1.104
successive fault
additional earth fault that occurs in the adjacent phase circuit(s) during the time interval between a single-phase earth fault and the opening of the high-speed earthing switch(es)

3.2 Assemblies of switchgear and controlgear

No particular definitions.

3.3 Parts of assemblies

No particular definitions.

3.4 Switching devices

3.4.101
high-speed earthing switch
HSES
earthing switch that has the capability to:

– make, carry and interrupt the induced current;
– withstand the recovery voltage caused by electromagnetic and/or by electrostatic couplings prior to circuit re-closure;
– make and carry the rated short-circuit current

Note 1 to entry: The high-speed operation applies normally to both closing and opening.

Note 2 to entry: A high-speed earthing switch is not intended to be used as a maintenance earthing switch.

3.4.103.1
high-speed earthing switch class M0
high-speed earthing switch having a normal mechanical endurance of 1 000 operation cycles

3.4.103.2
high-speed earthing switch class M1
high-speed earthing switch having an extended mechanical endurance of 2 000 operation cycles for special requirements

3.5 Parts of switchgear and controlgear

No particular definitions.

3.6 Operation

No particular definitions.

3.7 Characteristics quantities

No particular definitions.

4 Ratings

Clause 4 of IEC 62271-1:2007 is applicable with the following additions.

4.4 Rated normal current and temperature rise

Subclause 4.4 of IEC 62271-1:2007 is not applicable.

4.101 Rated short-circuit making current

Subclause 4.101 of IEC 62271-102:2001 is applicable.

4.102 Rated operating sequence

The rated characteristics of the HSES are referred to the rated operating sequence.

a) C – t_{i1} – O

or

b) C – t_{i1} – O – t_{i2} – C – t_{i1} – O

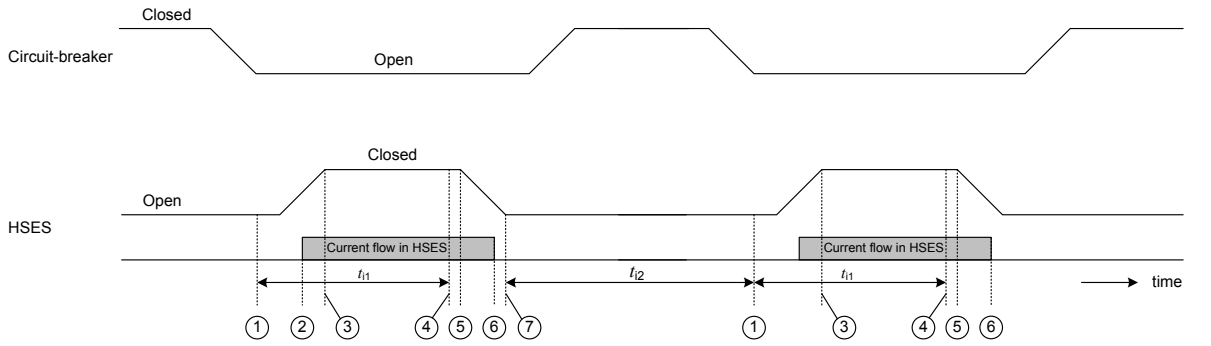
where

– t_{i1} is a time that is longer than the time required for secondary arc extinction and for dielectric recovery of air insulation at the faulted point. t_{i1} is determined by users considering system stability. The preferred value of t_{i1} is 0,15 s;

– t_{i2} is the intermediate time that is given by the system protection. t_{i2} includes the closing time of the circuit-breakers after the HSESs open, the duration of a new line fault and the breaking time of the circuit-breakers. Following this t_{i2} time, the HSES can be reclosed. The preferred value of t_{i2} is 0,5 s;

In this case the HSES shall be able to operate without intentional time delay.

Figure 2 shows the time chart for the rated operating sequence of C – t_{i1} – O – t_{i2} – C – t_{i1} – O.



IEC 1896/13

Key

Circuit-breaker	Transmission line circuit-breakers that interrupt the fault	3	Contact touch of HSESs
HSES	High-speed earthing switches	4	Energizing of the opening release of the HSESs
1	Energizing of the closing circuit of the HSESs	5	Contact separation of HSESs
2	Current start in HSESs	6	Arc extinction in HSESs
t_{i1}, t_{i2}	Times defined in 4.102	7	Fully open position of HSESs

NOTE 1 A common value for the re-closing time of the circuit-breaker is 1 s to guarantee system stability.

NOTE 2 t_{i1} is normally within the range of 0,15 s to 0,5 s.

NOTE 3 t_{i2} is normally within the range of 0,5 s to 1 s.

NOTE 4 The operating sequence b) is for system stability requirements to cover cases where another fault occurs on the same phase.

NOTE 5 The HSES closing time is normally less than 0,2 s

Figure 2 – Timing chart of HSES and circuit-breakers

4.103 Standard values for interruption

Standard values for HSES are given in Table 1.

Table 1 – Standardized values of rated induced currents and voltages

Rated voltage U_r	Electromagnetic coupling				Electrostatic coupling	
	Rated induced current ($^{+10}_{-0}$ %)	Rated power frequency recovery voltage ($^{+10}_{-0}$ %)	First TRV peak ($^{+10}_{-0}$ %)	Time to first peak ($^{+10}_{-0}$ %)	Rated induced current ($^{+10}_{-0}$ %)	Rated induced voltage ($^{+10}_{-0}$ %)
kV	A (rms)	kV (rms)	kV	ms	A (rms)	kV (rms)
550	6 800	240	580	0,6	120	115
800	6 800	240	580	0,6	170	170
1 100 to 1 200	6 800	240	580	0,6	230	235

NOTE 1 For Table 1 the rated induced voltages by electrostatic recovery voltage have a 1-cos wave shape.

NOTE 2 For networks with up to two faults (category 0 and 1 as described in B.2) the corresponding values are presented in Table B.3.

For networks with delayed current zero crossing occurrence (category 3 as described in B.2), the corresponding values are presented in Table B.1.

For networks with multi-phase faults (category 4 as described in B.2) the corresponding values are presented in Table B.2.

5 Design and construction

Clause 5 of IEC 62271-1:2007 is applicable with the following modifications.

5.5 Dependent power operation

Subclause 5.5 of IEC 62271-1:2007 is not applicable.

5.7 Independent manual operation power operation (independent unlatched operation)

Subclause 5.7 of IEC 62271-1:2007 is not applicable.

5.10 Nameplates

The designation of the equipment is specified as HSES.

Items to be indicated on the nameplate are listed in Table 2.

Table 2 – Items to be listed on nameplate of a HSES

Item
Manufacturer
Designation of type
Serial number Year of manufacture
Rated voltage
Rated lightning impulse withstand voltage
Rated switching impulse withstand voltage
Rated power-frequency withstand voltage
Rated short-time withstand and peak withstand current
Rated duration of short-circuit
Rated filling pressure for insulation and /or operation
Rated supply voltage of auxiliary circuit
Rated frequency
Mechanical endurance class
Mass (including fluid)
Operating sequence

5.11 Interlocking devices

Subclause 5.11 of IEC 62271-1:2007 is not applicable.

5.101 Anti-pumping device

Anti-pumping device shall be provided for pneumatic and hydraulic operating mechanism.

5.102 Special requirements for HSES

A HSES shall be able to earth transmission lines and re-open to achieve their full voltage withstand within the dead time of the auto-reclosing duty cycle of the transmission line circuit-breakers. The dead time is defined by system stability and is normally set around 1 s enabling dielectric recovery of insulation capability at the fault location. Fast operating capability for both making and breaking is required.

The HSES shall have a capability to by-pass secondary arc current on the transmission lines.

The HSES shall have a capability to break induced current by electromagnetic and/or electrostatic coupling on transmission lines with a recovery voltage specified in Table 1.

The HSES shall have a capability to withstand transient recovery voltage after interruption and rated power frequency voltage to earth ($U_r/\sqrt{3}$) in open position.

The HSES shall be single-pole operated unless otherwise specified.

6 Type tests

Clause 6 of IEC 62271-1:2007 is applicable with the following additions.

The dielectric performance shall be verified for phase-to-earth in the open position only in accordance with IEC 62271-1:2007.

6.1.1 Grouping of tests

Subclause 6.1.1 of IEC 62271-1:2007 is not applicable.

6.3 Radio interference voltage (r.i.v.) test

Subclause 6.3 of 62271-1:2007 is applicable.

In case of metal enclosed type, 6.3 of CEI 62271-203:2011 is applicable.

6.5 Temperature-rise tests

Subclause 6.5 of IEC62271-1:2007 is not applicable.

6.101 Tests to prove the short-circuit making performance

Subclause 6.101 of IEC 62271-102:2001 is applicable.

6.102 Operating and mechanical endurance tests

Subclause 6.102 of IEC 62271-102:2001 is applicable.

The rated operating sequence shall be verified during mechanical operation.

The mechanical operating sequence for class M0 shall be one of the following:

a) A HSES with a specified duty cycle required C – t_{i1} – O:
   – 1 000 C – t_{i1} – O operations
b) A HSES with a specified duty cycle C – t_{i1} – O – t_{i2} – C – t_{i1} – O
   – 500 C – t_{i1} – O operations, plus
   – 250 C – t_{i1} – O – t_{i2} – C – t_{i1} – O operations.

For class M1 the number of operations shall be twice the sequence specified.

Mechanical travel characteristics shall be recorded and acceptance criteria are referred to 6.101.1.1 of IEC 62271-100:2008 with the modification of the total tolerance to 20 % (for example $^{+20}_{-0}$ %, $^{+10}_{-10}$ % or $^{+0}_{-20}$ %).

6.103 Operation under severe ice condition

Subclause 6.103 of 62271-102:2001 is applicable.

6.104 Operation at the temperature limits

Subclause 6.104 of 62271-102:2001 is applicable.

6.105 Tests to prove the making and breaking performance of HSES

6.105.1 General test conditions

Tests shall be performed in accordance with the condition specified in Table 1.

Subclause C.6.105 of IEC 62271-102:2001 is applicable with the following additions and modifications.

Number of tests:

– 10 times C and O

Measurement of travel characteristics shall be in accordance with subclause 6.101.1.1 of IEC 62271-100:2008.

Test circuits are those shown in Figures C.1 and C.2 of IEC 62271-102:2001.

For electrostatic induced current test independent of the rated voltage of the HSES, the test circuit parameters shall be:

– capacitance value C_1 = 1,56 μF;
– surge impedance: 245 Ω;
– line length 200 km.

The HSES shall preferably be tested at rated frequency; however, for convenience of testing, tests at 50 Hz covers the requirement for 60 Hz and vice versa.

These tests cover the classes of A and B described in Annex C of IEC 62271-102:2001.

6.105.2 Induced current switching details

Type tests for HSES having a rated induced current making and breaking capability shall include tests to prove the electromagnetically and/or electrostatically induced current making and breaking capability.

The test currents shall be within a tolerance of ($^{+10}_{0}$ %) of the rated induced currents as shown in Table 1.

For convenience of testing, the control voltage of the HSES can be either the rated or maximum of the auxiliary supply voltage if the control voltage does not affect the making and breaking capability of HSES. This condition is considered to be satisfied if the travel characteristics of that condition are within a range of ($^{+5}_{-5}$ %) of those obtained with a minimum control voltage.

Induced current making and breaking tests shall be conducted without maintenance.

6.105.3 Arrangement of HSES before the test

The HSES under test shall be completely mounted on its own support or on a mechanically equivalent test support. Its operating device shall be operated in the manner prescribed and, in particular, if it is electrically, hydraulically or pneumatically operated, it shall be operated either at the minimum supply voltage or at the minimum functional pressure for operation, respectively.

Before commencing making and breaking tests, no-load operations shall be made and details of the operating characteristics of the HSES, such as travel characteristics, closing time and opening time, shall be recorded.

If applicable, tests shall be performed at the minimum functional pressure for interruption and insulation.

6.105.4 Behaviour of HSES during the test

The HSES shall perform successfully without undue mechanical or electrical distress.