

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**High-voltage switchgear and controlgear –
Part 105: Alternating current switch-fuse combinations for rated voltages above
1 kV up to and including 52 kV**

**Appareillage à haute tension –
Partie 105: Combinés interrupteurs-fusibles pour courant alternatif de tensions
assignées supérieures à 1 kV et jusqu'à 52 kV inclus**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2021 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC online collection - oc.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC online collection - oc.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**High-voltage switchgear and controlgear –
Part 105: Alternating current switch-fuse combinations for rated voltages above
1 kV up to and including 52 kV**

**Appareillage à haute tension –
Partie 105: Combinés interrupteurs-fusibles pour courant alternatif de tensions
assignées supérieures à 1 kV et jusqu'à 52 kV inclus**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.130.10

ISBN 978-2-8322-9864-0

Warning! Make sure that you obtained this publication from an authorized distributor. Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.
--

CONTENTS

FOREWORD	5
1 Scope	7
2 Normative references	8
3 Terms and definitions	8
3.1 General terms and definitions	8
3.2 Assemblies of switchgear and controlgear	8
3.3 Parts of assemblies	8
3.4 Switching devices	8
3.5 Parts of switchgear and controlgear	9
3.6 Operational characteristics of switchgear and controlgear	10
3.7 Characteristic quantities	10
3.101 Fuses	13
4 Normal and special service conditions	14
5 Ratings	14
5.1 General	14
5.2 Rated voltage (U_r)	15
5.3 Rated insulation level (U_d , U_p , U_s)	15
5.4 Rated frequency (f_r)	15
5.5 Rated continuous current (I_r)	15
5.6 Rated short-time withstand current (I_k)	15
5.7 Rated peak withstand current (I_p)	15
5.8 Rated duration of short-circuit (t_k)	15
5.9 Rated supply voltage of auxiliary and control circuits (U_a)	15
5.10 Rated supply frequency of auxiliary and control circuits	15
5.11 Rated pressure of compressed gas supply for controlled pressure systems	15
5.101 Rated short-circuit breaking current	16
5.102 Rated short-circuit making current	16
5.103 Rated transfer current (striker operation) ($I_{rtransfer}$)	16
5.104 Rated take-over current for release-operated combinations (I_{rto})	16
6 Design and construction	16
6.1 Requirements for liquids in switch-fuse combinations	16
6.2 Requirements for gases in switch-fuse combinations	16
6.3 Earthing of switch-fuse combinations	16
6.4 Auxiliary and control equipment and circuits	17
6.5 Dependent power operation	17
6.6 Stored energy operation	17
6.7 Independent unlatched operation (independent manual or power operation)	17
6.8 Manually operated actuators	17
6.9 Operation of releases	17
6.10 Pressure/level indication	17
6.11 Nameplates	17
6.12 Locking devices	19
6.13 Position indication	19
6.14 Degrees of protection provided by enclosures	19

6.15	Creepage distances for outdoor insulators	19
6.16	Gas and vacuum tightness	19
6.17	Tightness for liquid systems	19
6.18	Fire hazard (flammability)	19
6.19	Electromagnetic compatibility (EMC)	19
6.20	X-ray emission	19
6.21	Corrosion	19
6.22	Filling levels for insulation, switching and/or operation	19
6.101	Linkages between the fuse striker(s) and the switch release	19
6.102	Low over-current conditions (long fuse-pre-arcing time conditions)	19
7	Type tests	20
7.1	General	20
7.1.1	Basics	20
7.1.2	Information for identification of test objects	20
7.1.3	Information to be included in type-test reports	20
7.2	Dielectric tests	21
7.3	Radio interference voltage (RIV) test	21
7.4	Resistance measurement	21
7.5	Continuous current tests	21
7.6	Short-time withstand current and peak withstand current tests	21
7.7	Verification of the protection	21
7.8	Tightness tests	21
7.9	Electromagnetic compatibility tests (EMC)	21
7.10	Additional tests on auxiliary and control circuits	21
7.11	X-radiation test for vacuum interrupters	21
7.101	Making and breaking tests	22
7.101.1	General	22
7.101.2	Conditions for performing the tests	22
7.101.3	Test-duty procedures	28
7.101.4	Behaviour of the combination during tests	33
7.101.5	Condition of the apparatus after testing	34
7.102	Mechanical operation tests	35
7.103	Mechanical shock tests on fuses	35
7.104	Thermal test with long pre-arcing time of fuse	35
7.105	Extension of validity of type tests	36
7.105.1	Dielectric	36
7.105.2	Continuous current tests	36
7.105.3	Making and breaking	36
8	Routine tests	36
8.101	Mechanical operating tests	37
9	Guide to the selection of switch-fuse combinations (informative)	37
9.101	Guide to the selection of switch-fuse combination for transformer protection	37
9.101.1	General	37
9.101.2	Rated short-circuit breaking current	38
9.101.3	Primary fault condition caused by a solid short-circuit on the transformer secondary terminals	38
9.102	Coordination of switch and fuses for extension of the reference list of fuses	39
9.102.1	General	39
9.102.2	Rated continuous current	39

9.102.3	Low over-current performance	39
9.102.4	Transfer current	39
9.102.5	Take-over current	39
9.102.6	Extension of the validity of type tests	40
10	Information to be given with enquiries, tenders and orders (informative)	40
10.1	General	40
10.2	Information with enquiries and orders	40
10.3	Information with tenders	40
11	Transport, storage, installation, operating instructions and maintenance	40
12	Safety	41
13	Influence of the product on the environment	41
Annex A (informative)	Example of the coordination of fuses, switch and transformer	42
Annex B (normative)	Procedures for determining transfer current	45
B.1	Background	45
B.2	Mathematical determination of ΔT	45
B.3	Simplified method for determination of transfer current	48
Annex C (normative)	Tolerances on test quantities for type tests	50
Bibliography		52
Figure 1	– Arrangement of test circuits for test duties $TD_{I_{SC}}$ and $TD_{I_{Wmax}}$	23
Figure 2	– Arrangement of test circuits for test-duty $TD_{I_{transfer}}$	24
Figure 3	– Arrangement of test circuits for test-duty $TD_{I_{to}}$	24
Figure 4	– Determination of power-frequency recovery voltage	26
Figure 5	– Representation of a specified TRV by a two-parameter reference line and a delay line	27
Figure 6	– Example of a two-parameter reference line for a TRV	28
Figure 7	– Characteristics for determining take-over current	32
Figure 8	– Transfer current in relation to the primary fault current I_{SC} due to a solid short circuit in the transformer secondary terminal	38
Figure A.1	– Characteristics relating to the protection of an 11 kV, 400 kVA transformer	43
Figure A.2	– Discrimination between HV and LV fuses	44
Figure B.1	– Practical determination of the transfer current	46
Figure B.2	– Determination of the transfer current with the iterative method	48
Table 1	– Nameplate information	18
Table 2	– Summary of the conditions for combining tests and alternative procedures	23
Table 3	– Values of prospective TRV for test-duty $TD_{I_{transfer}}$ based on practice in Europe	30
Table 4	– Values of prospective TRV for test-duty $TD_{I_{transfer}}$ based on practice in the United States of America	31
Table 5	– Summary of test parameters for test duties	33
Table C.1	– Tolerances on test quantities for type tests	50

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –**Part 105: Alternating current switch-fuse combinations
for rated voltages above 1 kV up to and including 52 kV**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). 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. 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 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 IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62271-105 has been prepared by subcommittee 17A: Switching devices, of IEC technical committee 17: High-voltage switchgear and controlgear. It is an International Standard.

This third edition cancels and replaces the second edition published in 2012. This edition constitutes a technical revision.

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

- a) the document has been updated to be in alignment with the second edition of IEC 62271-1:2017;
- b) rated TRV has been removed (TRV is only a test parameter), as in the latest revision of IEC 62271-100;

- c) differentiation has been introduced between requirements expressed for fulfilling the function expected from a switch-fuse combination, from requirements only relevant when the function is performed by a stand-alone device. The goal is to avoid duplication or conflicts of requirements with a standard dealing with assemblies, when the function is implemented within such an assembly.

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

FDIS	Report on voting
17A/1300/FDIS	17A/1306/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

This document is to be read in conjunction with IEC 62271-1:2017, to which it refers and which is applicable unless otherwise specified. In order to simplify the indication of corresponding requirements, the same numbering of clauses and subclauses is used as in IEC 62271-1:2017. 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 series, 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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 105: Alternating current switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV

1 Scope

This part of IEC 62271 applies to three-pole units for public and industrial distribution systems which are functional assemblies of switches composed of switches or switch-disconnectors and current-limiting fuses designed so as to be capable of

- breaking, at the rated voltage, any current up to and including the rated short-circuit breaking current;
- making, at the rated voltage, circuits to which the rated short-circuit breaking current applies.

It does not apply to combinations of fuses with circuit-breakers, contactors or circuit switchers, nor for combinations for motor-circuits nor to combinations incorporating single capacitor bank switches.

This document applies to combinations designed with rated voltages above 1 kV up to and including 52 kV for use on three-phase alternating current systems of either 50 Hz or 60 Hz.

In this document, the word "combination" is used for a combination in which the components constitute a functional assembly. Each association of a given type of switch and a given type of fuse defines one type of switch-fuse combination. Different types of fuses can be combined with one type of switch, which give several combinations with different characteristics, in particular concerning the rated continuous currents.

A switch-fuse combination is therefore defined by its type designation and a list of selected fuses defined by the manufacturer, the so-called "reference list of fuses". Compliance with this document of a given combination means that every combination using one of the selected fuses is proven to be in compliance with this document.

The fuses are incorporated in order to extend the short-circuit breaking rating of the combination beyond that of the switch alone. They are fitted with strikers in order both to open automatically all three poles of the switch on the operation of a fuse and to achieve a correct operation at values of fault current above the minimum melting current but below the minimum breaking current of the fuses. In addition to the fuse strikers, the combination can be fitted with either an over-current release or a shunt release.

NOTE In this document the term "fuse" is used to designate either the fuse or the fuse-link where the general meaning of the text does not result in ambiguity.

Fuses are in accordance with IEC 60282-1:2020.

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

Switches, including their specific mechanism, are in accordance with IEC 62271-103 except for the short-time current and short-circuit making requirements where the current-limiting effects of the fuses are taken into account.

Earthing switches forming an integral part of a combination are covered by IEC 62271-102.

In addition, switches which include other functions (not covered by IEC 62271-103) are covered by their relevant standards (e.g. IEC 62271-102 for disconnectors and earthing switches).

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.

Clause 2 of IEC 62271-1:2017 applies with the following additions:

IEC 60050-441, *International Electrotechnical Vocabulary (IEV) – Part 441: Switchgear, controlgear and fuses* (available at <http://www.electropedia.org>)

IEC 60282-1:2020, *High-voltage fuses – Part 1: Current-limiting fuses*

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

IEC 62271-100:2021, *High-voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers*

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

IEC 62271-103:2021, *High-voltage switchgear and controlgear – Part 103: Switches for rated voltages above 1 kV up to and including 52 kV*

3 Terms and definitions

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

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

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

NOTE Some of the terms given in IEC 60050-441 are listed hereunder.

3.1 General terms and definitions

Subclause 3.1 of IEC 62271-1:2017 applies.

3.2 Assemblies of switchgear and controlgear

Subclause 3.2 of IEC 62271-1:2017 applies.

3.3 Parts of assemblies

Subclause 3.3 of IEC 62271-1:2017 applies.

3.4 Switching devices

Subclause 3.4 of IEC 62271-1:2017 applies, with the following additions: