



IEC 62271-100

Edition 3.0 2021-07

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**High-voltage switchgear and controlgear –  
Part 100: Alternating-current circuit-breakers**

**Appareillage à haute tension –  
Partie 100: Disjoncteurs à courant alternatif**





## 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 Varembé  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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](http://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 It also gives information on projects, replaced and withdrawn publications.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](http://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](http://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](mailto:sales@iec.ch).

#### IEC online collection - [oc.iec.ch](http://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](http://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](http://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 online collection - [oc.iec.ch](http://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](http://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.

#### Service Clients - [webstore.iec.ch/csc](http://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](mailto:sales@iec.ch).



IEC 62271-100

Edition 3.0 2021-07

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**High-voltage switchgear and controlgear –  
Part 100: Alternating-current circuit-breakers**

**Appareillage à haute tension –  
Partie 100: Disjoncteurs à courant alternatif**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 29.130.10

ISBN 978-2-8322-9885-5

**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 .....	11
1 Scope .....	13
2 Normative references .....	13
3 Terms and definitions .....	14
3.1 General terms and definitions .....	15
3.2 Assemblies .....	19
3.3 Parts of assemblies .....	19
3.4 Switching devices .....	19
3.5 Parts of circuit-breakers .....	21
3.6 Operational characteristics .....	25
3.7 Characteristic quantities .....	27
3.8 Index of definitions.....	43
4 Normal and special service conditions .....	47
5 Ratings.....	47
5.1 General.....	47
5.2 Rated voltage ( $U_r$ ) .....	48
5.3 Rated insulation level ( $U_d$ , $U_p$ , $U_s$ ) .....	48
5.4 Rated frequency ( $f_r$ ).....	48
5.5 Rated continuous current ( $I_r$ ) .....	48
5.6 Rated short-time withstand current ( $I_k$ ) .....	48
5.7 Rated peak withstand current ( $I_p$ ) .....	48
5.8 Rated duration of short-circuit ( $\tau_k$ ).....	48
5.9 Rated supply voltage of auxiliary and control circuits ( $U_a$ ) .....	48
5.10 Rated supply frequency of auxiliary and control circuits .....	48
5.11 Rated pressure of compressed gas supply for controlled pressure systems .....	48
5.101 Rated short-circuit breaking current ( $I_{sc}$ ) .....	49
5.102 Rated first-pole-to-clear factor ( $k_{pp}$ ) for terminal fault .....	52
5.103 Rated short-circuit making current .....	52
5.104 Rated operating sequence .....	52
5.105 Rated out-of-phase making and breaking current.....	52
5.106 Rated capacitive currents.....	53
6 Design and construction .....	55
6.1 Requirements for liquids .....	55
6.2 Requirements for gases .....	55
6.3 Earthing .....	55
6.4 Auxiliary and control equipment and circuits .....	56
6.5 Dependent power operation .....	56
6.6 Stored energy operation.....	56
6.7 Independent unlatched operation (independent manual or power operation) .....	56
6.8 Manually operated actuators .....	56
6.9 Operation of releases.....	56
6.10 Pressure/level indication .....	57
6.11 Nameplates.....	58

6.12	Locking devices .....	60
6.13	Position indication.....	60
6.14	Degrees of protection provided by enclosures.....	60
6.15	Creepage distances for outdoor insulators .....	60
6.16	Gas and vacuum tightness .....	60
6.17	Tightness for liquid systems.....	60
6.18	Fire hazard (flammability) .....	60
6.19	Electromagnetic compatibility (EMC).....	60
6.20	X-ray emission .....	60
6.21	Corrosion.....	60
6.22	Filling levels for insulation, switching and/or operation .....	61
6.101	Requirements for simultaneity of poles during single closing and single opening operations .....	61
6.102	General requirement for operation .....	61
6.103	Pressure limits of fluids for operation .....	61
6.104	Vent outlets .....	62
6.105	Time quantities .....	62
6.106	Mechanical loads .....	62
6.107	Circuit-breaker classification .....	63
7	Type tests .....	65
7.1	General.....	65
7.2	Dielectric tests .....	67
7.3	Radio interference voltage (RIV) test .....	72
7.4	Resistance measurement.....	72
7.5	Continuous current tests .....	73
7.6	Short-time withstand current and peak withstand current tests .....	74
7.7	Verification of the protection .....	74
7.8	Tightness tests .....	74
7.9	Electromagnetic compatibility tests (EMC) .....	74
7.10	Additional tests on auxiliary and control circuits .....	75
7.11	X-radiation test procedure for vacuum interrupters.....	75
7.101	Mechanical and environmental tests .....	75
7.102	Miscellaneous provisions for making and breaking tests .....	88
7.103	General considerations for making and breaking tests .....	106
7.104	Demonstration of arcing times.....	113
7.105	Short-circuit test quantities .....	132
7.106	Short-circuit test procedure .....	155
7.107	Terminal fault tests .....	157
7.108	Additional short-circuit tests .....	161
7.109	Short-line fault tests .....	164
7.110	Out-of-phase making and breaking tests .....	175
7.111	Capacitive current tests .....	177
7.112	Requirements for making and breaking tests on class E2 circuit-breakers having a rated voltage above 1 kV up to and including 52 kV .....	191
8	Routine tests .....	192
8.1	General.....	192
8.2	Dielectric test on the main circuit .....	193
8.3	Tests on auxiliary and control circuits .....	195

8.4	Measurement of the resistance of the main circuit.....	195
8.5	Tightness test .....	195
8.6	Design and visual checks.....	195
8.101	Mechanical operating tests .....	195
9	Guide to the selection of switchgear and controlgear (informative) .....	197
9.101	General.....	197
9.102	Selection of rated values for service conditions.....	199
9.103	Selection of rated values for fault conditions .....	201
9.104	Selection for electrical endurance in networks of rated voltage above 1 kV and up to and including 52 kV .....	205
9.105	Selection for switching of capacitive loads .....	205
10	Information to be given with enquiries, tenders and orders (informative) .....	205
10.1	General.....	205
10.2	Information with enquiries and orders .....	205
10.3	Information to be given with tenders.....	206
11	Transport, storage, installation, operation instructions and maintenance.....	208
11.1	General.....	208
11.2	Conditions during transport, storage and installation .....	208
11.3	Installation .....	208
11.4	Operating instructions .....	214
11.5	Maintenance .....	214
11.101	Resistors and capacitors.....	215
12	Safety.....	215
13	Influence of the product on the environment .....	215
Annex A (normative)	Calculation of TRVs for short-line faults from rated characteristics .....	216
A.1	Basic approach .....	216
A.2	Transient voltage on line side .....	219
A.3	Transient voltage on source side .....	219
A.4	Examples of calculations.....	223
Annex B (normative)	Tolerances on test quantities during type tests.....	226
Annex C (normative)	Records and reports of type tests.....	235
C.1	Information and results to be recorded .....	235
C.2	Information to be included in type test reports .....	235
Annex D (normative)	Method of determination of the prospective TRV .....	239
D.1	General.....	239
D.2	Drawing the envelope .....	239
D.3	Determination of parameters .....	240
Annex E (normative)	Methods of determining prospective TRV waves .....	243
E.1	General.....	243
E.2	General summary of the recommended methods.....	245
E.3	Detailed consideration of the recommended methods .....	246
E.4	Comparison of methods .....	257
Annex F (informative)	Requirements for breaking of transformer-limited faults by circuit-breakers with rated voltage higher than 1 kV .....	261
F.1	General.....	261
F.2	Circuit-breakers with rated voltage less than 100 kV .....	262

F.3	Circuit-breakers with rated voltage from 100 kV to 800 kV .....	264
F.4	Circuit-breakers with rated voltage higher than 800 kV.....	264
Annex G (normative)	Use of mechanical characteristics and related requirements .....	265
Annex H (normative)	Requirements for making and breaking test procedures for metal-enclosed and dead tank circuit-breakers .....	266
H.1	General.....	266
H.2	Reduced number of making and breaking units for testing purposes .....	266
H.3	Tests for single pole in one enclosure .....	267
H.4	Tests for three poles in one enclosure .....	270
Annex I (normative)	Requirements for circuit-breakers with opening resistors .....	272
I.1	General.....	272
I.2	Switching performance to be verified .....	272
I.3	Insertion time of the resistor.....	285
I.4	Current carrying performance .....	285
I.5	Dielectric performance .....	285
I.6	Mechanical performance .....	285
I.7	Requirements for the specification of opening resistors.....	285
I.8	Examples of recovery voltage waveshapes .....	285
Annex J (normative)	Verification of capacitive current breaking in presence of single or two-phase earth faults .....	292
J.1	General.....	292
J.2	Test voltage .....	292
J.3	Test current .....	292
J.4	Test-duty .....	293
J.5	Criteria to pass the tests .....	293
Bibliography.....		294
Figure 1	– Typical oscillogram of a three-phase short-circuit make-break cycle.....	29
Figure 2	– Circuit-breaker without switching resistors – Opening and closing operations.....	30
Figure 3	– Circuit breaker without switching resistors – Close-open cycle .....	31
Figure 4	– Circuit-breaker without switching resistors – Reclosing (auto-reclosing) .....	32
Figure 5	– Circuit-breaker with switching resistors – Opening and closing operations .....	33
Figure 6	– Circuit-breaker with switching resistors – Close-open cycle .....	34
Figure 7	– Circuit-breaker with switching resistors – Reclosing (auto-reclosing).....	35
Figure 8	– Determination of short-circuit making and breaking currents, and of percentage DC component.....	50
Figure 9	– Percentage DC component in relation to the time interval from the initiation of the short-circuit for the different time constants.....	51
Figure 10	– Example of wind velocity measurement .....	82
Figure 11	– Test sequence for low temperature test.....	84
Figure 12	– Test sequence for high temperature test .....	85
Figure 13	– Humidity test.....	87
Figure 14	– Example of reference mechanical characteristics (idealised curve) .....	91
Figure 15	– Reference mechanical characteristics of Figure 14 with the envelopes centred over the reference curve (+5 %, -5 %) .....	92

Figure 16 – Reference mechanical characteristics of Figure 14 with the envelope fully displaced upward from the reference curve (+10 %, -0 %) .....	93
Figure 17 – Reference mechanical characteristics of Figure 14 with the envelope fully displaced downward from the reference curve (+0 %, -10 %) .....	93
Figure 18 – Equivalent testing set-up for unit testing of circuit-breakers with more than one separate making and breaking units .....	95
Figure 19 – Earthing of test circuits for single-phase short-circuit tests, $k_{pp} = 1,5$ .....	96
Figure 20 – Earthing of test circuits for single-phase short-circuit tests, $k_{pp} = 1,3$ .....	97
Figure 21 – Test circuit for single-phase out-of-phase tests .....	97
Figure 22 – Test circuit for out-of-phase tests using two voltages separated by 120 electrical degrees .....	98
Figure 23 – Test circuit for out-of-phase tests with one terminal of the circuit-breaker earthed (subject to agreement of the manufacturer) .....	98
Figure 24 – Example of prospective test TRV with four-parameter envelope which satisfies the conditions to be met during type test – Case of specified TRV with four-parameter reference line .....	99
Figure 25 – Example of prospective test TRV with two-parameter envelope which satisfies the conditions to be met during type test: case of specified TRV with two-parameter reference line .....	100
Figure 26 – Example of prospective test TRV-waves and their combined envelope in two-part test .....	101
Figure 27 – Earthing of test circuits for three-phase short-circuit tests, $k_{pp} = 1,5$ .....	108
Figure 28 – Earthing of test circuits for three-phase short-circuit tests, $k_{pp} = 1,3$ .....	109
Figure 29 – Determination of power frequency recovery voltage .....	111
Figure 30 – Graphical representation of the time parameters for the demonstration of arcing times in three-phase tests of test-duty T100a .....	114
Figure 31 – Graphical representation of an example of the three valid symmetrical breaking operations for $k_{pp} = 1,5$ .....	115
Figure 32 – Graphical representation of the three valid symmetrical breaking operations for $k_{pp} = 1,2$ or $1,3$ .....	116
Figure 33 – Graphical representation of an example of the three valid asymmetrical breaking operations for $k_{pp} = 1,5$ .....	120
Figure 34 – Graphical representation of an example of the three valid asymmetrical breaking operations for $k_{pp} = 1,2$ or $1,3$ .....	121
Figure 35 – Example of a graphical representation of the three valid symmetrical breaking operations for single-phase tests in substitution of three-phase conditions for $k_{pp} = 1,5$ .....	125
Figure 36 – Example of a graphical representation of an example of the three valid symmetrical breaking operations for single-phase tests in substitution of three-phase conditions for $k_{pp} = 1,2$ or $1,3$ .....	126
Figure 37 – Example of a graphical representation of an example of the three valid asymmetrical breaking operations for single-phase tests in substitution of three-phase conditions for $k_{pp} = 1,5$ .....	128
Figure 38 – Example of a graphical representation of an example of the three valid asymmetrical breaking operations for single-phase tests in substitution of three-phase for $k_{pp} = 1,2$ and $1,3$ .....	129

Figure 39 – Graphical representation of the arcing window and the pole factor $k_p$ , determining the TRV of the individual pole, for systems with a $k_{pp}$ of 1,2.....	131
Figure 40 – Graphical representation of the arcing window and the pole factor $k_p$ , determining the TRV of the individual pole, for systems with a $k_{pp}$ of 1,3.....	131
Figure 41 – Graphical representation of the arcing window and the pole factor $k_p$ , determining the TRV of the individual pole, for systems with a $k_{pp}$ of 1,5.....	132
Figure 42 – Representation of a specified TRV by a 4-parameter reference line and a delay line .....	135
Figure 43 – Representation of a specified TRV by a two-parameter reference line and a delay line .....	136
Figure 44 – Basic circuit for terminal fault with ITRV .....	136
Figure 45 – Representation of ITRV in relationship to TRV .....	137
Figure 46 – Example of line transient voltage with time delay with non-linear rate of rise ....	151
Figure 47 – Necessity of additional single-phase tests and requirements for testing.....	162
Figure 48 – Basic circuit arrangement for short-line fault testing and prospective TRV-circuit-type a) according to 7.109.3: Source side and line side with time delay .....	166
Figure 49 – Basic circuit arrangement for short-line fault testing – circuit type b1) according to 7.109.3: Source side with ITRV and line side with time delay .....	167
Figure 50 – Basic circuit arrangement for short-line fault testing – circuit type b2) according to 7.109.3: Source side with time delay and line side without time delay .....	168
Figure 51 – Example of a line side transient voltage with time delay .....	169
Figure 52 – Flow chart for the choice of short-line fault test circuits .....	170
Figure 53 – Compensation of deficiency of the source side time delay by an increase of the excursion of the line side voltage .....	172
Figure 54 – Recovery voltage for capacitive current breaking tests .....	188
Figure 55 – Reclassification procedure for line and cable-charging current tests.....	190
Figure 56 – Reclassification procedure for capacitor bank current tests .....	191
Figure A.1 – Typical graph of line and source side TRV parameters – Line side and source side with time delay .....	218
Figure A.2 – Actual course of the source side TRV for short-line fault L <sub>90</sub> , L <sub>75</sub> and L <sub>60</sub> ...	221
Figure A.3 – Typical graph of line and source side TRV parameters – Line side and source side with time delay, source side with ITRV .....	222
Figure D.1 – Representation by four parameters of a prospective TRV of a circuit – Case D.2 c) 1) .....	241
Figure D.2 – Representation by four parameters of a prospective TRV of a circuit – Case D.2 c) 2) .....	241
Figure D.3 – Representation by four parameters of a prospective TRV of a circuit – Case D.2 c) 3) i) .....	242
Figure D.4 – Representation by two parameters of a prospective TRV of a circuit – Case D.2 c) 3) ii) .....	242
Figure E.1 – Effect of depression on the peak value of the TRV .....	244
Figure E.2 – Breaking with arc-voltage present .....	246
Figure E.3 – TRV in case of ideal breaking .....	247
Figure E.4 – Breaking with pronounced premature current-zero .....	247
Figure E.5 – Relationship between the values of current and TRV occurring in test and those prospective to the system.....	248

Figure E.6 – Breaking with post-arc current .....	249
Figure E.7 – Schematic diagram of power-frequency current injection apparatus .....	250
Figure E.8 – Sequence of operation of power-frequency current injection apparatus .....	251
Figure E.9 – Schematic diagram of capacitance injection apparatus .....	253
Figure E.10 – Sequence of operation of capacitor-injection apparatus .....	254
Figure F.1 – First example of transformer-limited fault (also called transformer-fed fault)....	261
Figure F.2 – Second example of transformer-limited fault (also called transformer-secondary fault) .....	262
Figure H.1 – Test configuration considered in Table H.1, Table H.2 and Table H.3 .....	268
Figure I.1 – Typical system configuration for breaking by a circuit-breaker with opening resistors.....	272
Figure I.2 – Test circuit for test-duties T60 and T100 .....	274
Figure I.3 – Test circuit for test-duties T10, T30 and OP2 .....	275
Figure I.4 – Example of an underdamped TRV for T100s(b), $U_r = 1\ 100\text{ kV}$ $I_{sc} = 50\text{ kA}$ , $f_r = 50\text{ Hz}$ .....	277
Figure I.5 – Example of an overdamped TRV for T10, $U_r = 1\ 100\text{ kV}$ $I_{sc} = 50\text{ kA}$ , $f_r = 50\text{ Hz}$ .....	278
Figure I.6 – Example of a test circuit for short-line fault test-duty L <sub>90</sub> .....	279
Figure I.7 – Example of real line simulation for short-line fault test-duty L <sub>90</sub> based on $U_r = 1\ 100\text{ kV}$ , $I_{sc} = 50\text{ kA}$ and $f_r = 50\text{ Hz}$ .....	280
Figure I.8 – Typical recovery voltage waveshape of capacitive current breaking on a circuit-breaker equipped with opening resistors .....	282
Figure I.9 – Typical recovery voltage waveshape of T10 (based on $U_r = 1\ 100\text{ kV}$ , $I_{sc} = 50\text{ kA}$ and $f_r = 50\text{ Hz}$ ) on the resistor switch of a circuit-breaker equipped with opening resistors.....	283
Figure I.10 – TRV waveshapes for high short-circuit current breaking operation .....	286
Figure I.11 – Currents in case of high short-circuit current breaking operation .....	287
Figure I.12 – TRV shapes for low short-circuit current breaking operation.....	288
Figure I.13 – Currents in case of low short-circuit current breaking operation.....	289
Figure I.14 – Voltage waveshapes for line-charging current breaking operation .....	290
Figure I.15 – Current waveshapes for line-charging current breaking operation .....	291
Table 1 – Preferred values of rated capacitive currents .....	54
Table 2 – Nameplate information .....	59
Table 3 – Examples of static horizontal and vertical forces for static terminal load .....	63
Table 4 – Number of mechanical operations .....	64
Table 5 – Type tests .....	66
Table 6 – Invalid tests .....	67
Table 7 – Test requirements for voltage tests as condition check for metal-enclosed circuit-breakers .....	70
Table 8 – Number of operating sequences .....	79
Table 9 – Standard values of ITRV – Rated voltages 100 kV and above .....	112

Table 10 – Last current loop parameters in three-phase tests and in single-phase tests in substitution for three-phase conditions in relation with short-circuit test-duty T100a – Tests for 50 Hz operation.....	117
Table 11 – Last current loop parameters in three-phase tests and in single-phase tests in substitution for three-phase conditions in relation with short-circuit test-duty T100a – Tests for 60 Hz operation.....	118
Table 12 – Prospective TRV parameters for single-phase tests in substitution for three-phase tests to demonstrate the breaking of the second-pole-to-clear for $k_{pp} = 1,3$ .....	122
Table 13 – Prospective TRV parameters for single-phase tests in substitution for three-phase tests to demonstrate the breaking of the third-pole-to-clear for $k_{pp} = 1,3$ .....	123
Table 14 – Standard multipliers for TRV values for second and third clearing poles .....	130
Table 15 – Arcing window for tests with symmetrical current.....	130
Table 16 – Values of prospective TRV for class S1 circuit-breakers rated for $k_{pp} = 1,5$ .....	138
Table 17 – Values of prospective TRV for class S1 circuit-breakers rated for $k_{pp} = 1,3$ .....	140
Table 18 – Values of prospective TRV for class S2 circuit-breakers rated for $k_{pp} = 1,5$ .....	142
Table 19 – Values of prospective TRV for class S2 circuit-breakers for rated for $k_{pp} = 1,3$ ..	144
Table 20 – Values of prospective TRV for circuit-breakers rated for $k_{pp} = 1,2$ or $1,3$ – Rated voltages of 100 kV and above.....	147
Table 21 – Values of prospective TRV for circuit-breakers rated for $k_{pp} = 1,5$ – Rated voltages of 100 kV to 170 kV .....	149
Table 22 – Values of prospective TRV for out-of-phase tests on class S1 circuit-breakers for $k_{pp} = 2,5$ .....	152
Table 23 – Values of prospective TRV for out-of-phase tests on class S1 circuit-breakers for $k_{pp} = 2,0$ .....	153
Table 24 – Values of prospective TRV for out-of-phase tests on class S2 circuit-breakers for $k_{pp} = 2,5$ .....	153
Table 25 – Values of prospective TRV for out-of-phase tests on class S2 circuit-breakers for $k_{pp} = 2,0$ .....	154
Table 26 – Values of prospective TRV for out-of-phase tests on circuit-breakers rated for $k_{pp} = 2,5$ – Rated voltages of 100 kV to 170 kV .....	154
Table 27 – Values of prospective TRV for out-of-phase tests on circuit-breakers rated for $k_{pp} = 2,0$ – Rated voltages of 100 kV and above .....	155
Table 28 – Prospective TRV parameters for single-phase and double-earth fault tests.....	163
Table 29 – Values of line characteristics for short-line faults .....	165
Table 30 – Values of prospective TRV for the supply circuit of short-line fault tests .....	174
Table 31 – Test-duties to demonstrate the out-of-phase rating.....	176
Table 32 – Specified values of $u_1$ , $t_1$ , $u_C$ and $t_2$ .....	179
Table 33 – Common requirements for test-duties .....	181
Table 34 – Operating sequence for electrical endurance test on class E2 circuit-breakers for auto-reclosing duty.....	192
Table 35 – Application of voltage for dielectric test on the main circuit.....	193
Table 36 – Test voltage for partial discharge test.....	194
Table A.1 – Ratios of voltage-drop and source-side TRV .....	218
Table B.1 – Tolerances on test quantities for type tests .....	227

Table E.1 – Methods for determination of prospective TRV .....	258
Table F.1 – Required values of prospective TRV for T30, for circuit-breakers intended to be connected to a transformer with a connection of small capacitance – Rated voltage higher than 1 kV and less than 100 kV for non-effectively earthed neutral systems .....	263
Table F.2 – Required values of prospective TRV for circuit-breakers with rated voltages higher than 800 kV intended to be connected to a transformer with a connection of low capacitance .....	264
Table H.1 – Three-phase capacitive current breaking in service conditions: voltages on the source-side, load-side, and recovery voltages.....	268
Table H.2 – Corresponding capacitive current-breaking tests in accordance with 7.111.7 for single-phase laboratory tests. Values of voltages on the source-side, load-side, and recovery voltages .....	269
Table H.3 – Capacitive current breaking in actual service conditions: maximum typical voltage values.....	271
Table I.1 – Results of the TRV calculation for terminal faults and out-of-phase .....	276
Table I.2 – Results of the TRV calculation for test-duty L <sub>90</sub> .....	280
Table I.3 – Results of the TRV calculations for test-duty T10 .....	283

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –****Part 100: Alternating-current circuit-breakers****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.

International Standard IEC 62271-100 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, Amendment 1:2012 and Amendment 2:2017. This edition constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

- the document has been updated to IEC 62271-1:2017;
- Amendments 1 and 2 have been included;
- the definitions have been updated, terms not used have been removed;
- Subclauses 7.102 through 7.108 have been restructured.

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

FDIS	Report on voting
17A/1299/FDIS	17A/1305/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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/standardsdev/publications](http://www.iec.ch/standardsdev/publications).

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

A list of all parts of 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 document will remain unchanged until the stability date indicated on the IEC website under [webstore.iec.ch](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.

**IMPORTANT – The “colour inside” logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.**

**HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –****Part 100: Alternating-current circuit-breakers****1 Scope**

This part of IEC 62271 is applicable to three-phase AC circuit-breakers designed for indoor or outdoor installation and for operation at frequencies of 50 Hz and/or 60 Hz on systems having voltages above 1 000 V. This document includes only direct testing methods for making-breaking tests. For synthetic testing methods refer to IEC 62271-101.

**NOTE** In a direct testing method one source is used to supply the voltage and current during the making and breaking tests.

This part of IEC 62271 is not applicable to:

- circuit-breakers with a closing mechanism for dependent manual operation;
- circuit-breakers intended for use on motive power units of electrical traction equipment; these are covered by IEC 60077 (all parts) [1]<sup>1</sup>;
- generator circuit-breakers installed between generator and step-up transformer; these are covered by the IEC 62271-37-013 [2];
- self-tripping circuit-breakers with tripping devices that cannot be made inoperative during testing. Tests on automatic circuit reclosers are covered by IEC 62271-111 [3];
- tests to prove the performance under abnormal conditions that are not described in this document are subject to agreement between manufacturer and user. Such abnormal conditions are, for example, cases where the voltage is higher than the rated voltage of the circuit-breaker, conditions which can occur due to sudden loss of load on long lines or cables.

**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 (IEV) – Part 151: Electrical and magnetic devices*

IEC 60050-151:2001/AMD1:2013

IEC 60050-151:2001/AMD2:2014

IEC 60050-151:2001/AMD3:2019

IEC 60050-151:2001/AMD4:2020

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

IEC 60050-441:1984/AMD1:2000

<sup>1</sup> Numbers in square brackets refer to the bibliography.

IEC 60050-442:1998, *International Electrotechnical Vocabulary (IEV) – Part 442: Electrical accessories*

IEC 60050-442:1998/AMD1:2015

IEC 60050-442:1998/AMD2:2015

IEC 60050-442:1998/AMD3:2019

IEC 60050-461:2008, *International Electrotechnical Vocabulary (IEV) – Part 461: Electric cables*

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

IEC 60050-601:1985/AMD1:1998

IEC 60050-601:1985/AMD2:2020

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

IEC 60059, *IEC standard current ratings*

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60255-151:2009, *Measuring relays and protection equipment – Part 151: Functional requirements for over/under current protection*

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

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

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*

IEC 62271-200:20<sup>—2</sup>, *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

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

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-151, IEC 60050-441, IEC 60050-442, IEC 60050-461, IEC 60050-601 and IEC 60050-614, some of which are recalled hereunder, 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>

<sup>2</sup> Under preparation. Stage at the time of publication: IEC RFDIS 62271-200:2021.