

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Railway applications – Electric equipment for rolling stock –
Part 4: Electrotechnical components – Rules for AC circuit-breakers**
(standards.iteh.ai)

**Applications ferroviaires – Équipements électriques du matériel roulant –
Partie 4: Composants électrotechniques – Règles pour disjoncteurs
à courant monophasé**
64889beb6f4b/iec-60077-4-2019





THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2019 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 It also gives information on projects, replaced and withdrawn publications.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.

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 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67,000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

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.

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.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Railway applications – Electric equipment for rolling stock –
Part 4: Electrotechnical components – Rules for AC circuit-breakers**

**Applications ferroviaires – Équipements électriques du matériel roulant –
Partie 4: Composants électrotechniques – Règles pour disjoncteurs
à courant monophasé**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 45.060.01

ISBN 978-2-8322-7508-5

**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	4
1 Scope	6
2 Normative references	7
3 Terms, definitions and abbreviated terms	7
3.1 Components	7
3.2 Component parts	8
3.3 Operational features	9
3.4 Making and breaking characteristics	10
3.5 Abbreviated terms	12
4 Classification	12
5 Characteristics	13
5.1 Summary of characteristics	13
5.2 Type of circuit-breaker	13
5.3 Rated values and limiting values for the main circuit	13
5.3.1 General	13
5.3.2 Rated voltages	13
5.3.3 Rated currents	13
5.3.4 Rated operational frequency	14
5.3.5 Rated power factors	14
5.3.6 Short-circuit characteristics	14
5.4 Operational frequencies	16
5.5 Electric and pneumatic control circuits	16
5.6 Electric and pneumatic auxiliary circuits	17
5.7 Overcurrent release	17
5.8 Recovery voltages	17
6 Product information	17
6.1 Component documentation	17
6.2 Marking	17
7 Normal service conditions	17
8 Constructional and performance requirements	17
8.1 Constructional requirements	17
8.2 Performance requirements	18
8.2.1 Operating conditions	18
8.2.2 Temperature limits	18
8.2.3 Operation following inactivity	18
8.2.4 Electromagnetic compatibility (EMC)	18
8.2.5 Acoustic noise emission	18
8.2.6 Clearances	18
8.2.7 Creepage distances	18
8.2.8 Switching overvoltages	18
8.2.9 Operational performance capability	18
8.2.10 Ability to withstand vibration and shock	19
8.2.11 Ability to make and break under short-circuit conditions	19
9 Tests	19
9.1 Kind of tests	19

9.1.1	General	19
9.1.2	Type tests.....	20
9.1.3	Routine tests	20
9.1.4	Investigation tests.....	20
9.2	Verification of constructional requirements.....	20
9.2.1	General	20
9.2.2	Type tests.....	20
9.2.3	Routine tests	20
9.3	Type tests for verification of performance requirements	20
9.3.1	Test sequences	20
9.3.2	General test conditions	21
9.3.3	Test sequence I: General performance characteristics.....	22
9.3.4	Test sequence II: Rated short-circuit making and breaking capacities.....	23
9.3.5	Test sequence III: Ability to withstand vibration and shock.....	25
9.3.6	Test sequence IV: Climatic conditions	26
9.3.7	Test sequence V: Other tests.....	26
9.4	Routine tests for verification of performance requirements	26
9.4.1	General	26
9.4.2	Functional test.....	26
9.4.3	Calibration of releases.....	27
9.4.4	Air-tightness (for pneumatic circuit-breaker)	27
9.4.5	Dielectric withstand.....	27
Annex A (informative)	Test circuit to verify the making and breaking capacities	28
Annex B (informative)	Determination of short-circuit making and breaking currents, and of percentage DC component.....	29
Bibliography.....		30
Figure A.1	– Diagram of the test circuit	28
Figure B.1	– Determination of short-circuit making and breaking currents, and of percentage DC components	29
Table 1	– Standard values of transient recovery voltage – Representation by two parameters	16
Table 2	– Operational performance capability	19
Table 3	– List of type test sequences for performance requirements	21
Table 4	– Tolerances on test values.....	22
Table 5	– Standard values of prospective transient recovery voltage – Representation by two parameters	24

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RAILWAY APPLICATIONS –
ELECTRIC EQUIPMENT FOR ROLLING STOCK –****Part 4: Electrotechnical components –
Rules for AC 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 60077-4 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This second edition cancels and replaces the first edition, issued in 2003. It constitutes a technical revision.

This edition includes the following main technical changes with regard to the previous edition:

- a) standard values of transient recovery voltages and test procedure are reviewed;
- b) procedure of verification of temperature rise is changed;
- c) air-tightness test as type test, insulation resistance measurement are added.

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

FDIS	Report on voting
9/2538/FDIS	9/2554/RVD

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

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

This document should be read in conjunction with IEC 60077-1 and IEC 60077-2.

A list of all parts in the IEC 60077 series, published under the general title *Railway applications – Electric equipment for rolling stock*, 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 "<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.

ITEH STANDARD PREVIEW
(standards.iteh.ai)

[IEC 60077-4:2019](https://standards.iteh.ai/catalog/standards/sist/0e37bdf1-44e2-4233-83a9-64889beb6f4b/iec-60077-4-2019)

<https://standards.iteh.ai/catalog/standards/sist/0e37bdf1-44e2-4233-83a9-64889beb6f4b/iec-60077-4-2019>

RAILWAY APPLICATIONS – ELECTRIC EQUIPMENT FOR ROLLING STOCK –

Part 4: Electrotechnical components – Rules for AC circuit-breakers

1 Scope

In addition to the general requirements of IEC 60077-2, this part of IEC 60077 gives rules for AC circuit-breakers, the main contacts of which are connected to AC overhead contact lines; the nominal voltage of these circuits being in accordance with IEC 60850.

This document, together with IEC 60077-2, states specifically:

- a) the characteristics of the circuit-breakers;
- b) the service conditions with which circuit-breakers comply with reference to:
 - operation and behaviour in normal service;
 - operation and behaviour in short-circuit;
 - dielectric properties;
- c) the tests for confirming the compliance of the components with the characteristics under the service conditions and the methods to be adopted for these tests;
- d) the information to be marked on, or given with the circuit-breaker.

NOTE 1 Circuit-breakers which are dealt with in this document can be provided with devices for automatic opening under pre-determined conditions other than those of overcurrent, for example, undervoltage and reversal of power flow direction. This document does not deal with the verification of operation under such predetermined conditions.

NOTE 2 The incorporation of electronic components or electronic sub-assemblies into electrotechnical components is now common practice.

Although this document is not applicable to electronic equipment, the presence of electronic components does not provide a reason to exclude such electrotechnical components from the scope.

Electronic sub-assemblies included in the circuit-breakers comply with the relevant standard for electronics (IEC 60571).

NOTE 3 Certain of these rules, after agreement between the user and the manufacturer, are used for electrotechnical components installed on vehicles other than rail rolling stock such as mine locomotives, trolleybuses, etc. In this case, particular additional requirements can be necessary.

This document does not cover industrial circuit-breakers which comply with IEC 62271-100. For these, in order to ensure satisfactory operation, this document is used to specify only the particular requirements for rolling stock. In such cases, a specific document states the additional requirements with which the industrial circuit-breakers comply, for example:

- either to be adapted (e.g. for control voltage, environmental conditions, etc.);
- or to be installed and used so that they do not have to endure specific rolling stock conditions;
- or to be additionally tested to prove that these components can withstand satisfactorily the rolling stock conditions.

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 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60077-1:2017, *Railway applications – Electric equipment for rolling stock. – Part 1: General service conditions and general rules*

IEC 60077-2:2017, *Railway applications – Electric equipment for rolling stock. – Part 2: Electrotechnical components – General rules*

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

IEC 61373, *Railway applications – Rolling stock equipment – Shock and Vibration tests*

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

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

IEC 62271-100:2008/AMD1:2012

IEC 62271-100:2008/AMD2:2017

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

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in Clause 3 of IEC 60077-1:2017 and Clause 3 of IEC 60077-2:2017, 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>

3.1 Components

3.1.1

indoor circuit-breaker

circuit-breaker designed solely for protected installation against wind, rain, snow, abnormal dirt deposits, abnormal conditions, ice and hoarfrost

3.1.2

outdoor circuit-breaker

circuit-breaker suitable for installation in open air, i.e. capable of withstanding wind, rain, snow, dirt deposits, condensation, ice and hoarfrost

3.1.3

oil circuit-breaker

circuit-breaker in which the contacts open and close in oil

Note 1 to entry: Typical examples of oil circuit-breakers are live tank minimum oil circuit-breakers and dead tank bulk oil circuit-breakers.

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-14-28]

3.1.4

vacuum circuit-breaker

circuit-breaker in which the contacts open and close within a highly evacuated envelope

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-14-29]

3.1.5

air-blast circuit-breaker, <for rolling stock>

circuit-breaker in which the contacts open in a blast of air

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-14-32, modified – “gas-blast” has been deleted. “the gas used is air” has been replaced with “the contacts open in a blast of air”.]

3.1.6

air circuit-breaker

circuit-breaker in which the contacts open and close in air

3.1.7

gas circuit-breaker

circuit-breaker in which the contacts open and close in a gas other than air at atmospheric or higher pressure

<https://standards.iteh.ai/catalog/standards/sist/0e37bdf1-44e2-4233-83a9-64889beb6f4b/iec-60077-4-2019>

Note 1 to entry: An example of a gas circuit-breaker is the sulphur hexafluoride circuit-breaker.

3.1.8

semiconductor circuit-breaker

circuit-breaker designed to make and break the current in an electric circuit by means of the controlled conductivity of a semiconductor

Note 1 to entry: There can be mechanical contacts associated with these semiconductor devices.

[SOURCE: IEC 60050-811:2017, 811-29-42]

3.2 Component parts

3.2.1

release, <for a circuit breaker>

device which releases the holding means and permits the opening or closing of the circuit-breaker

Note 1 to entry: A circuit-breaker can be activated by several releases each becoming operational according to specified conditions.

Note 2 to entry: These releases can be mechanically or electrically connected to the switching device.

[SOURCE: IEC 60050-811:2017, 811-29-44]

3.2.2

overcurrent release

release which permits a mechanical switching device to open with or without time-delay when the current in the release exceeds a predetermined value

Note 1 to entry: This value can in some cases depend upon the rate-of-rise of current.

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-16-33]

3.2.3

definite time-delay overcurrent release

overcurrent release which operates with a definite time-delay, which may be adjustable, but is independent of the value of the overcurrent

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-16-34]

3.2.4

direct overcurrent release

overcurrent release directly energised by the current in the main circuit of a mechanical switching device

[SOURCE: IEC 60050-441:1984/AMD1:2000,441-16-36]

3.2.5

indirect overcurrent release, <for a circuit-breaker>

overcurrent release initiated by the current in the main circuit of a mechanical switching device through a current sensor

[SOURCE: IEC 60050-441:1984/AMD1:2000,441-16-37, modified – “energized” and “a current transformer or a shunt” have been replaced with “initiated” and “a current sensor”.]

3.2.6

anti-pumping device

device which prevents reclosing after a close-open operation as long as the device initiating closing is maintained in the position for closing

Note 1 to entry: The opening operation may be either an opening command or a tripping operation.

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-16-48, modified – Note 1 to entry has been added.]

3.2.7

enclosure, <of an assembly>

part of an assembly providing a specified degree of protection of equipment against external influences and a specified degree of protection against approach to or contact with live parts and against contact with moving parts

Note 1 to entry: The enclosure may also provide a protection of adjacent parts against the influence of the circuit-breaker (for example, arcing).

[SOURCE: IEC 60050-441:1984/AMD1:2000,441-13-01, modified – Note 1 to entry has been added.]

3.2.8

integral enclosure

enclosure forming an integral part of the circuit-breaker

3.3 Operational features

3.3.1

trip-free circuit-breaker

circuit-breaker, the moving main contacts of which return to and remain in the open position when the opening (i.e. tripping) operation is initiated after the initiation of the closing operation even if the closing command is maintained

Note 1 to entry: To ensure proper breaking of the current which may have been established, it may be necessary that the contacts momentarily reach the closed position.

Note 2 to entry: The trip free operation may require an anti-pumping device.

3.3.2 current setting, <of an overcurrent release>

value of the operating current for which the release is adjusted and in accordance with which its operating conditions are defined

Note 1 to entry: A release may have more than one current setting.

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-16-46, modified – Note 1 to entry has been added.]

3.3.3 current setting range, <of an overcurrent release>

range between the minimum and maximum values over which the current setting of the release can be adjusted

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-16-47]

3.3.4 tripping operation

opening operation of a circuit-breaker initiated by a release

3.4 Making and breaking characteristics

NOTE See Annex B.

3.4.1 opening time, <of a mechanical switching device>

interval of time between the specified instant of initiation of the opening operation and the instant when the arcing contacts have separated in all poles

Note 1 to entry: The instant of initiation of the opening operation is specified by the manufacturer for all the opening commands other than overcurrent.

Note 2 to entry: The opening time includes the operating time of any auxiliary equipment necessary to open the circuit-breaker and forming an integral part of the circuit-breaker.

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-36, modified – Note 1 to entry has been modified and Note 2 to entry has been added.]

3.4.2 prospective current, <of a circuit and with respect to a switching device or a fuse>

current that would flow in the circuit if each pole of the switching device or the fuse were replaced by a conductor of negligible impedance

Note 1 to entry: This term is commonly associated with fault conditions.

Note 2 to entry: The prospective current is composed of an RMS AC value plus a DC component (if any).

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-01, modified – Notes to entry have been replaced.]

3.4.3 prospective peak current

peak value of a prospective current during the transient period following initiation

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-02, modified – Note has been deleted.]

3.4.4**prospective symmetrical current**, <of an AC circuit>

prospective current when it is initiated at such an instant that no transient phenomenon follows the initiation

Note 1 to entry: The prospective symmetrical current is expressed by its RMS value.

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-03, modified – Note 1 has been deleted.]

3.4.5**breaking current**, <of a switching device or a fuse >

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

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-07]

3.4.6**breaking capacity**, <of a switching device or a fuse>

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

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-08, modified – Notes have been deleted.]

3.4.7**making capacity**, <of a switching device or a fuse>

value of prospective making current that a switching device is capable of making at a stated voltage under prescribed conditions of use and behaviour

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-09, modified – Note has been deleted.]

3.4.8**short-circuit making capacity**

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

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-10]

3.4.9**short-circuit breaking capacity**

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

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-11]

3.4.10**short-time withstand current**

current that a circuit or a switching device in the closed position can carry during a specified short time under specified conditions of use and behaviour

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-17]

3.4.11**peak withstand current**

value of peak current that a circuit or a switching device in the closed position can withstand under prescribed conditions of use and behaviour

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-18]

3.4.12**recovery voltage**

voltage which appears across the terminals of a pole of a switching device or a fuse after the breaking of the current

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-25, modified – Note has been deleted.]

3.4.13**transient recovery voltage**

recovery voltage during the time in which it has a significant transient character

Note 1 to entry: The transient recovery voltage may be oscillatory or non-oscillatory or a combination of these depending on the characteristics of the circuit and the switching device.

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-26, modified – The second sentence of Note 1 to entry has been deleted. Note 2 to entry has been deleted.]

3.4.14**prospective transient recovery voltage**, <of a circuit>

transient recovery voltage following the breaking of the prospective symmetrical current by an ideal switching device

Note 1 to entry: The definition assumes that the switching device or the fuse, for which the prospective transient recovery voltage is sought, is replaced by an ideal switching device, i.e. having instantaneous transition from zero to infinite impedance at the very instant of zero current, i.e. at the "natural" zero. For circuits where the current can follow several different paths, e.g. a polyphase circuit, the definition further assumes that the breaking of the current by the ideal switching device takes place only in the pole considered.

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-29]

3.4.15**power-frequency recovery voltage**

recovery voltage after the transient voltage phenomena have subsided

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-27]

3.5 Abbreviated terms

AC	Alternating Current
DC	Direct Current
EMC	Electromagnetic Compatibility
RMS	Root Mean Square (value)
RRRV	Rate of Rise of Recovery Voltage
TRV	Transient Recovery Voltage

4 Classification

This clause is intended to list the characteristics of a circuit-breaker on which information is given by the manufacturer and which shall be verified by testing where relevant.

The circuit-breakers are classified:

- according to their operational frequency C1, C2 or C3. The characteristics of these operational frequencies are given in 5.4;
- according to the type of design, i.e. outdoor or indoor circuit-breaker;
- according to the degree of protection provided by the enclosure (see IEC 60529).

5 Characteristics

5.1 Summary of characteristics

The characteristics of a circuit-breaker shall be stated in terms of the following, as applicable:

- type of circuit-breaker (5.2);
- rated values and limiting values for the main circuit (5.3);
- operational frequencies (5.4);
- electric and pneumatic control circuits (5.5);
- electric and pneumatic auxiliary circuits (5.6);
- overcurrent release (5.7);
- peak value of the recovery voltage (5.8).

5.2 Type of circuit-breaker

It is necessary to state:

- the kind of device (e.g. air-blast circuit-breaker, air circuit-breaker, vacuum circuit-breaker, gas circuit-breaker, oil circuit-breaker, semiconductor circuit-breaker, etc.);
- the type of design (see Clause 4);
- the degree of protection provided by the enclosure (see Clause 4);
- operational features (e.g. trip-free circuit-breaker direct or indirect overcurrent release, time-delay overcurrent release).

5.3 Rated values and limiting values for the main circuit

5.3.1 General

Rated values are assigned by the manufacturer but it is not necessary to establish all the ratings listed.

5.3.2 Rated voltages

A component is defined by the following rated voltages given in 5.2 of IEC 60077-1:2017:

- rated operational voltage (U_r);

NOTE 1 A circuit-breaker has more than one rated operational voltage or has a rated operational voltage range.

- rated insulation voltage (U_{Nm});

NOTE 2 When no rated insulation voltage has been assigned to a circuit-breaker, the rated insulation voltage is considered to be equal to the highest value of the rated operational voltage.

- rated impulse voltage (U_{Ni});
- power-frequency test voltage (U_a).

5.3.3 Rated currents

A component is defined by the following rated currents given in 5.4 of IEC 60077-1:2017 and 5.3.3 of IEC 60077-2:2017:

- rated operational current (I_r) at the rated power factor $T2$ (see 5.3.5);

NOTE 1 A circuit-breaker can have more than one rated operational current or can have a rated operational current range.

- conventional free air thermal current (I_{th});
- conventional free air thermal current for DC (I_{th_DC});