



IEC 60077-4

Edition 2.0 2019-10
REDLINE VERSION

INTERNATIONAL STANDARD



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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 45.060.01

ISBN 978-2-8322-7566-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	4
INTRODUCTION	
1 Scope	7
2 Normative references	8
3 Terms, definitions and abbreviated terms	8
3.1 Components	9
3.2 Component parts	10
3.3 Operational features	11
3.4 Making and breaking characteristics	11
3.5 Abbreviated terms	14
4 Classification	14
5 Characteristics	14
5.1 Summary of characteristics	14
5.2 Type of circuit-breaker	15
5.3 Rated values and limiting values for the main circuit	15
5.3.1 General	15
5.3.2 Rated voltages	15
5.3.3 Rated currents	15
5.3.4 Rated frequencies Rated operational frequency	16
5.3.5 Rated power factors	16
5.3.6 Short-circuit characteristics (<i>see also Annex B</i>)	16
5.4 Operational frequencies	18
5.5 Electric and pneumatic control circuits	19
5.6 Electric and pneumatic auxiliary circuits	19
5.7 Overcurrent release	19
5.8 Recovery voltages	19
6 Product information	19
6.1 Component documentation	19
6.2 Marking	19
7 Normal service conditions	19
8 Constructional and performance requirements	20
8.1 Constructional requirements	20
8.2 Performance requirements	20
8.2.1 Operating conditions	20
8.2.2 Temperature- <i>rise</i> limits	20
8.2.3 Operation following inactivity	20
8.2.4 Electromagnetic compatibility (EMC)	20
8.2.5 Acoustic noise emission	20
8.2.6 Dielectric properties Clearances	20
8.2.7 Creepage distances	20
8.2.8 Switching overvoltages	20
8.2.9 Operational performance capability	20
8.2.10 Ability to withstand vibration and shock	21
8.2.11 Ability to make and break under short-circuit conditions	21
9 Tests	21

9.1	Kind of tests.....	21
9.1.1	General	21
9.1.2	Type tests.....	22
9.1.3	Routine tests	22
9.1.4	Investigatory Investigation tests.....	22
9.2	Tests for Verification of constructional requirements	22
9.2.1	General	22
9.2.2	Type tests.....	22
9.2.3	Routine tests	22
9.3	Type tests for verification of performance requirements	23
9.3.1	Test sequences	23
9.3.2	General test conditions	23
9.3.3	Test sequence I: General performance characteristics.....	24
9.3.4	Test sequence II: Rated short-circuit making and breaking capacities.....	26
9.3.5	Test sequence III: Capability Ability to withstand vibration and shock	28
	Test sequence IV: Transient recovery voltage test.....	
9.3.6	Test sequence IV: Climatic conditions	29
9.3.7	Test sequence VI: Other tests.....	29
9.4	Routine tests for verification of performance requirements	29
9.4.1	General	29
9.4.2	Mechanical operation Functional test.....	30
9.4.3	Calibration of releases.....	30
9.4.4	Air-tightness (for pneumatic circuit-breaker)	30
9.4.5	Dielectric withstand	30
Annex A (informative)	Test circuit to verify the making and breaking capacities	31
Annex B (informative)	Determination of short-circuit making and breaking currents, and of percentage DC component.....	32
Bibliography.....	33	
Figure A.1 – Principle Diagram of the test circuit.....	31	
Figure B.1 – Determination of short-circuit making and breaking currents, and of percentage DC components	32	
Table – Determination of voltage for impulse test.....		
Table 1 – Standard values of transient recovery voltage – Representation by two parameters	18	
Table 2 – Operational performance capability	21	
Table 3 – List of type test sequences for performance requirements	23	
Table 4 – Tolerances on test values.....	24	
Table 5 – Standard values of prospective transient recovery voltage – Representation by two parameters	27	

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.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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.

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 document using a colour printer.

INTRODUCTION

~~This International Standard is Part 4 of the IEC 60077 series.~~

~~The purpose of this product standard is to give additional or amended requirements on AC circuit breakers as a supplement to those given by IEC 60077-2.~~

~~During preparation of this product standard, IEC 60056 and IEC 60694 have been considered and their requirements have been kept as far as it has been possible.~~

~~This product standard makes reference to the general rules for electrotechnical components given in IEC 60077-2, but for general conditions reference is made directly to IEC 60077-1.~~

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 ~~to be~~ 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 ~~have to~~ 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 ~~may~~ can be provided with devices for automatic opening under pre-determined conditions other than those of overcurrent, for example, undervoltage and reversal of power ~~current~~ 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 ~~should~~ comply with the relevant standard for electronics (IEC 60571).

NOTE 3 Certain of these rules ~~may~~, after agreement between the user and the manufacturer, ~~be~~ 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 ~~have to~~ comply with ~~IEC 60056~~ IEC 62271-100. For these, in order to ensure satisfactory operation, this document ~~should be~~ is used to specify only the particular requirements for rolling stock. In such cases, a specific document ~~should state~~ states the additional requirements with which the industrial circuit-breakers ~~are to~~ 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 60050(441):1984, International Electrotechnical Vocabulary (IEV) — Chapter 441: Switchgear, controlgear and Fuses~~

~~IEC 60056:2001, High-voltage alternating-current circuit-breaker*~~

IEC 60060-1:~~1989~~2010, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60077-1:~~1999~~2017, *Railway applications – Electric equipment for rolling stock. – Part 1: General service conditions and general rules*

IEC 60077-2:~~1999~~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 60571:1998, Railway applications – Electronic equipment used on rail vehicles~~

~~IEC 60694:1996, Common specification for high voltage switchgear and controlgear standards~~

~~IEC 60850:2000, Supply voltage of traction systems~~

IEC 61373:~~1999~~, *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:~~2004~~2008, *High-voltage switchgear and controlgear – Part 100: High-voltage 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*

* In preparation.

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**



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.

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*

SOMMAIRE

AVANT-PROPOS	34
1 Domaine d'application	36
2 Références normatives	37
3 Termes, définitions et termes abrégés	37
3.1 Composants	37
3.2 Parties de composant	38
3.3 Caractéristiques de fonctionnement	40
3.4 Caractéristiques de fermeture et de coupure	40
3.5 Termes abrégés	42
4 Classification	43
5 Caractéristiques	43
5.1 Sommaire des caractéristiques	43
5.2 Type de disjoncteur	43
5.3 Valeurs limites et valeurs assignées du circuit principal	43
5.3.1 Généralités	43
5.3.2 Tensions assignées	43
5.3.3 Courants assignés	44
5.3.4 Fréquence assignée d'emploi	44
5.3.5 Facteurs de puissance assignés	44
5.3.6 Caractéristiques de court-circuit	44
5.4 Fréquences de fonctionnement	46
5.5 Circuits de commande électriques et pneumatiques	47
5.6 Circuits auxiliaires électriques et pneumatiques	47
5.7 Déclencheur à maximum de courant	47
5.8 Tensions de rétablissement	47
6 Informations sur le produit	47
6.1 Documentation sur le composant	47
6.2 Marquage	48
7 Conditions normales de service	48
8 Exigences relatives à la construction et au fonctionnement	48
8.1 Exigences relatives à la construction	48
8.2 Exigences relatives au fonctionnement	48
8.2.1 Conditions de fonctionnement	48
8.2.2 Températures limites	48
8.2.3 Fonctionnement à la mise en service	48
8.2.4 Compatibilité électromagnétique (CEM)	48
8.2.5 Emission de bruit acoustique	48
8.2.6 Distances d'isolement dans l'air	48
8.2.7 Lignes de fuite	48
8.2.8 Surtensions de manœuvre	48
8.2.9 Aptitude au fonctionnement en service	48
8.2.10 Tenue aux vibrations et aux chocs	49
8.2.11 Aptitude à l'établissement et à la coupure en court-circuit	49
9 Essais	50
9.1 Types d'essais	50

9.1.1	Généralités	50
9.1.2	Essais de type	50
9.1.3	Essais individuels de série.....	50
9.1.4	Essais d'investigation	50
9.2	Vérification des exigences relatives à la construction.....	50
9.2.1	Généralités	50
9.2.2	Essais de type	50
9.2.3	Essais individuels de série.....	51
9.3	Essais de type pour la vérification des exigences relatives au fonctionnement	51
9.3.1	Séquences d'essais	51
9.3.2	Conditions générales d'essais	52
9.3.3	Séquence d'essais I: Caractéristiques générales de fonctionnement.....	52
9.3.4	Séquence d'essais II: Pouvoirs de fermeture et de coupure assignés en court-circuit	54
9.3.5	Séquence d'essais III: Tenue aux vibrations et aux chocs.....	56
9.3.6	Séquence d'essais IV: Conditions climatiques	57
9.3.7	Séquence d'essais V: Autres essais	57
9.4	Essais individuels de série pour la vérification des exigences relatives au fonctionnement	57
9.4.1	Généralités	57
9.4.2	Essai fonctionnel	57
9.4.3	Etalonnage des déclencheurs	57
9.4.4	Etanchéité (pour les disjoncteurs à air comprimé).....	57
9.4.5	Tenue diélectrique	57
Annexe A (informative)	Circuit d'essai pour la vérification des pouvoirs de fermeture et de coupure.....	58
Annexe B (informative)	Détermination des courants établis et de coupure sur court-circuit et du pourcentage de la composante continue	59
Bibliographie	60	
Figure A.1 – Schéma du circuit d'essai	58	
Figure B.1 – Détermination des courants établis et de coupure sur court-circuit et du pourcentage de composantes continues	59	
Tableau 1 – Valeurs normalisées de la tension transitoire de rétablissement – Représentation via deux paramètres	46	
Tableau 2 – Aptitude au fonctionnement	49	
Tableau 3 – Liste des séquences d'essais de type pour les exigences relatives au fonctionnement	51	
Tableau 4 – Tolérances des grandeurs d'essai	52	
Tableau 5 – Valeurs normalisées de la tension transitoire de rétablissement présumée – Représentation via deux paramètres	55	

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

APPLICATIONS FERROVIAIRES – ÉQUIPEMENTS ÉLECTRIQUES DU MATÉRIEL ROULANT –

Partie 4: Composants électrotechniques – Règles pour disjoncteurs à courant monophasé

AVANT-PROPOS

- 1) La Commission Electrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
- 2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
- 3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
- 4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
- 5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
- 6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
- 7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
- 8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
- 9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

La Norme internationale IEC 60077-4 a été établie par le comité d'études 9 de l'IEC: Matériels et systèmes électriques ferroviaires.

Cette deuxième édition annule et remplace la première édition, parue en 2003. Elle constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) les valeurs normalisées des tensions transitoires de rétablissement et la procédure d'essai sont revues;
- b) modification de la procédure de vérification de l'échauffement;

c) ajout de l'essai d'étanchéité comme essai de type et du mesurage de la résistance d'isolement.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
9/2538/FDIS	9/2554/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette Norme internationale.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Il convient qu'il soit lu conjointement avec l'IEC 60077-1 et l'IEC 60077-2.

Une liste de toutes les parties de la série IEC 60077, publiées sous le titre général *Applications ferroviaires – Équipements électriques du matériel roulant*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "<http://webstore.iec.ch>" dans les données relatives au document recherché. A cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

APPLICATIONS FERROVIAIRES – ÉQUIPEMENTS ÉLECTRIQUES DU MATÉRIEL ROULANT –

Partie 4: Composants électrotechniques – Règles pour disjoncteurs à courant monophasé

1 Domaine d'application

En complément des exigences générales de l'IEC 60077-2, la présente partie de l'IEC 60077 donne les règles relatives aux disjoncteurs à courant monophasé dont les contacts principaux sont destinés à être raccordés à des lignes aériennes de contact à courant monophasé. La tension nominale de ces circuits est conforme à l'IEC 60850.

En complément de l'IEC 60077-2, le présent document précise particulièrement:

- a) les caractéristiques des disjoncteurs;
- b) les conditions de service que les disjoncteurs supportent du point de vue:
 - du fonctionnement et du comportement en service normal;
 - du fonctionnement et du comportement en cas de court-circuit;
 - des propriétés diélectriques;
- c) les essais de conformité des composants avec les caractéristiques dans les conditions de service ainsi que les méthodes d'essai correspondantes à utiliser;
- d) les informations à donner ou à marquer sur le disjoncteur.

NOTE 1 Les disjoncteurs qui font l'objet du présent document peuvent être équipés de dispositifs d'ouverture automatique dans des conditions prédéterminées autres que celles de la surcharge, comme une tension insuffisante ou l'inversion de la direction du flux de puissance, par exemple. Le présent document ne traite pas de la vérification de tels fonctionnements dans de telles conditions prédéterminées.

NOTE 2 L'incorporation de composants électroniques ou de sous-ensembles électroniques dans les composants électrotechniques est maintenant une pratique courante.

Bien que le présent document ne soit pas applicable aux matériels électroniques, la présence de composants électroniques n'est pas une raison suffisante pour exclure ces composants électrotechniques du domaine d'application du document.

Les sous-ensembles électroniques inclus dans les disjoncteurs sont conformes à la norme correspondante applicable à l'électronique (IEC 60571).

NOTE 3 Après accord entre l'utilisateur et le constructeur, certaines de ces règles sont utilisées pour les composants électriques installés dans des véhicules autres que ceux du matériel roulant ferroviaire, telles que les locomotives pour les mines, les trolleybus, etc. Dans ces cas, des exigences supplémentaires peuvent être nécessaires.

Le présent document ne couvre pas les disjoncteurs industriels conformes à l'IEC 62271-100. Pour ces derniers, dans le but d'obtenir un fonctionnement satisfaisant, le présent document est employé uniquement pour spécifier les exigences particulières relatives au matériel roulant. Dans de tels cas, un document spécifique indique les exigences complémentaires auxquelles les disjoncteurs industriels se conforment, par exemple:

- pour être adaptés (par exemple tension de commande, conditions d'environnement, etc.);
- ou pour être installés et utilisés de sorte qu'ils n'aient pas à subir les conditions particulières du matériel roulant;
- ou pour subir des essais complémentaires afin de montrer que ces composants peuvent supporter de façon satisfaisante les conditions du matériel roulant.

2 Références normatives

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60060-1:2010, *Technique des essais à haute tension – Partie 1: Définitions et exigences générales*

IEC 60077-1:2017, *Applications ferroviaires – Equipements électriques du matériel roulant – Partie 1: Conditions générales de service et règles générales*

IEC 60077-2:2017, *Applications ferroviaires – Equipements électriques du matériel roulant – Partie 2: Composants électrotechniques – Règles générales*

IEC 60529, *Degrés de protection procurés par les enveloppes (Code IP)*

IEC 61373, *Applications ferroviaires – Matériel roulant – Essais de chocs et vibrations*

IEC 62271-1:2017, *Appareillage à haute tension – Partie 1: Spécifications communes pour appareillage à courant alternatif*

IEC 62271-100:2008, *Appareillage à haute tension – Partie 100: Disjoncteurs à courant alternatif*

IEC 62271-100:2008/AMD1:2012

IEC 62271-100:2008/AMD2:2017

IEC 62271-102, *Appareillage à haute tension – Partie 102: Sectionneurs et sectionneurs de terre à courant alternatif*