

**MADALPINGELISED LÜLITUS- JA JUHTIMISAPARAADID.
OSA 1: ÜLDREEGLID**

**Low-voltage switchgear and controlgear –
Part 1: General rules (IEC 60947-1:2020)**

EESTI STANDARDI EESSÕNA**NATIONAL FOREWORD**

See Eesti standard EVS-EN IEC 60947-1:2021 sisaldab Euroopa standardi EN IEC 60947-1:2021 ning selle paranduste AC:2023 ja AC:2024 ingliskeelset teksti.	This Estonian standard EVS-EN IEC 60947-1:2021 consists of the English text of the European standard EN IEC 60947-1:2021 and its corrigendae AC:2023 and AC:2024.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas. Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 19.02.2021.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation. Date of Availability of the European standard is 19.02.2021.
Parandusega AC:2023 lisatud või muudetud teksti algus ja lõpp on tekstis tähistatud sümbolitega AC AC . Parandusega AC:2024 lisatud või muudetud teksti algus ja lõpp on tekstis tähistatud sümbolitega AC₂ AC₂ . Standard on kättesaadav Eesti Standardimis- ja Akrediteerimiskeskusest.	The start and finish of text introduced or altered by corrigendum AC:2024 is indicated in the text by tags AC AC . The start and finish of text introduced or altered by corrigendum AC:2024 is indicated in the text by tags AC₂ AC₂ . The standard is available from the Estonian Centre for Standardisation and Accreditation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 29.130.20

<p>Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardimis- ja Akrediteerimiskeskusele</p> <p>Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardimis- ja Akrediteerimiskeskuse kirjaliku loata on keelatud.</p> <p>Kui Teil on küsimusi standardite autoriõiguse kaitse kohta, võtke palun ühendust Eesti Standardimis- ja Akrediteerimiskeskusega: Koduleht www.evs.ee; telefon 605 5050; e-post info@evs.ee</p> <p>The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation and Accreditation</p> <p>No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation and Accreditation.</p> <p>If you have any questions about standards copyright protection, please contact the Estonian Centre for Standardisation and Accreditation: Homepage www.evs.ee; phone +372 605 5050; e-mail info@evs.ee</p>
--

English Version

**Low-voltage switchgear and controlgear - Part 1: General rules
(IEC 60947-1:2020)**

Appareillage à basse tension - Partie 1: Règles générales
(IEC 60947-1:2020)

Nieder Spannungsschaltgeräte - Teil 1: Allgemeine
Festlegungen
(IEC 60947-1:2020)

This European Standard was approved by CENELEC on 2020-05-27. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 121A/337/FDIS, future edition 6 of IEC 60947-1, prepared by SC 121A "Low-voltage switchgear and controlgear" of IEC/TC 121 "Switchgear and controlgear and their assemblies for low voltage" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60947-1:2021.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2021-08-19 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2024-02-19 document have to be withdrawn

This document supersedes EN 60947-1:2007 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with EU Directive(s) see informative Annex ZZ, which is an integral part of this document.

Endorsement notice

The text of the International Standard IEC 60947-1:2020 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60034-12:2016	NOTE	Harmonized as EN 60034-12:2017 (not modified)
IEC 60068 (series)	NOTE	Harmonized as EN 60068 (series)
IEC 60079 (series)	NOTE	Harmonized as EN IEC 60079 (series)
IEC 60112	NOTE	Harmonized as EN IEC 60112
IEC 60364-4-44:2007	NOTE	Harmonized as HD 60364-4-444:2010 (modified)
IEC 60364-4-44:2007/A1:2015	NOTE	Harmonized as HD 60364-4-443:2016 (modified)
IEC 60664-3	NOTE	Harmonized as EN 60664-3
IEC 60695-11-5:2016	NOTE	Harmonized as EN 60695-11-5:2017 (not modified)
IEC 60721 (series)	NOTE	Harmonized as EN 60721 (series)
IEC 60721-3 (series)	NOTE	Harmonized as EN 60721-3 (series)
IEC 60721-3-0	NOTE	Harmonized as EN IEC 60721-3-0
IEC 60947 (series)	NOTE	Harmonized as EN IEC 60947 (series)

IEC 60947-3	NOTE	Harmonized as EN 60947-3
IEC 60947-4-1	NOTE	Harmonized as EN IEC 60947-4-1
IEC 60947-4-3	NOTE	Harmonized as EN 60947-4-3
IEC 60947-5-2	NOTE	Harmonized as EN IEC 60947-5-2
IEC 60947-5-3	NOTE	Harmonized as EN 60947-5-3
IEC 60947-5-5	NOTE	Harmonized as EN 60947-5-5
IEC 60947-5-7	NOTE	Harmonized as EN 60947-5-7
IEC 60947-6-1	NOTE	Harmonized as EN 60947-6-1
IEC 60947-6-2	NOTE	Harmonized as EN 60947-6-2
IEC 60947-7-1:2009	NOTE	Harmonized as EN 60947-7-1:2009 (not modified)
IEC 60998-2-2:2002	NOTE	Harmonized as EN 60998-2-2:2004 (modified)
IEC 61095	NOTE	Harmonized as EN 61095
IEC 61293	NOTE	Harmonized as EN IEC 61293
IEC 61439-1:2011	NOTE	Harmonized as EN 61439-1:2011 (not modified)
IEC 61508 (series)	NOTE	Harmonized as EN 61508 (series)
IEC 61508-3	NOTE	Harmonized as EN 61508-3
IEC 61508-6	NOTE	Harmonized as EN 61508-6
IEC 62075:2012	NOTE	Harmonized as EN 62075:2012 (not modified)
IEC 62208:2011	NOTE	Harmonized as EN 62208:2011 (not modified)
IEC 62430:2009	NOTE	Harmonized as EN 62430:2009 (not modified)
IEC 62443 (series)	NOTE	Harmonized as EN IEC 62443 (series)
IEC/IEEE 82079-1	NOTE	Harmonized as EN IEC/IEEE 82079-1
ISO 13715:2017	NOTE	Harmonized as EN ISO 13715:2019 (not modified)
ISO 14001:2015	NOTE	Harmonized as EN ISO 14001:2015 (not modified)
ISO 14020	NOTE	Harmonized as EN ISO 14020
ISO 14021	NOTE	Harmonized as EN ISO 14021
ISO 14024	NOTE	Harmonized as EN ISO 14024
ISO 14025	NOTE	Harmonized as EN ISO 14025
ISO 14040:2006	NOTE	Harmonized as EN ISO 14040:2006 (not modified)
ISO 14063	NOTE	Harmonized as EN ISO 14063
ISO 50001:2018	NOTE	Harmonized as EN ISO 50001:2018 (not modified)

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Low-voltage switchgear and controlgear –
Part 1: General rules**

**Appareillage à basse tension –
Partie 1: Règles générales**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2020 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



**Low-voltage switchgear and controlgear –
Part 1: General rules**

**Appareillage à basse tension –
Partie 1: Règles générales**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.130.20

ISBN 978-2-8322-8026-3

**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.**

This document is a preview generated by EVS

CONTENTS

FOREWORD.....	13
INTRODUCTION.....	15
1 Scope.....	16
2 Normative references.....	16
3 Terms, definitions, symbols and reference clauses	20
3.1 General.....	20
3.2 Alphabetical index of definitions	20
3.3 General terms and definitions	25
3.4 Switching devices	29
3.5 Parts of switching devices	33
3.6 Operation of switching devices	38
3.7 Characteristic quantities	43
3.8 Tests	53
3.9 Ports.....	54
3.10 Symbols and references clauses for characteristics described in this document.....	54
4 Classification.....	55
5 Characteristics	55
5.1 Summary of the characteristics.....	55
5.2 Type of equipment	55
5.3 Rated and limiting values for the main circuit	56
5.3.1 Rated voltages.....	56
5.3.2 Currents	57
5.3.3 Rated frequency.....	58
5.3.4 Rated duties	58
5.3.5 Characteristics under normal load and overload conditions (see 8.2.4)	60
5.3.6 Short-circuit characteristics	61
5.3.7 Pole impedance of the switching device (Z)	61
5.4 Utilization category.....	61
5.5 Control circuits.....	62
5.5.1 Electrically or electronically controlled circuits	62
5.5.2 Air-supply control circuits (pneumatic or electro-pneumatic)	62
5.6 Auxiliary circuits.....	62
5.7 Relays and releases.....	63
5.8 Co-ordination with short-circuit protective devices (SCPD)	63
6 Product information	63
6.1 Nature of information.....	63
6.2 Marking.....	64
6.3 Instructions for installation, operation and maintenance, decommissioning and dismantling.....	65
6.4 Environmental information	66
7 Normal service, mounting and transport conditions	66
7.1 Normal service conditions	66
7.1.1 Ambient air temperature	66
7.1.2 Altitude	66

7.1.3	Atmospheric conditions	66
7.1.4	Shock and vibration	67
7.2	Conditions during transport and storage	68
7.3	Mounting.....	68
8	Constructional and performance requirements	68
8.1	Constructional requirements	68
8.1.1	General	68
8.1.2	Materials.....	68
8.1.3	Current-carrying parts and their connections.....	69
8.1.4	Clearances and creepage distances	70
8.1.5	Actuator	70
8.1.6	Indication of the contact position	70
8.1.7	Additional requirements for equipment suitable for isolation	71
8.1.8	Terminals.....	73
8.1.9	Additional requirements for equipment provided with a neutral pole	74
8.1.10	Provisions for protective earthing	74
8.1.11	Dedicated enclosures for equipment	75
8.1.12	Degrees of protection of enclosed equipment	76
8.1.13	Conduit pull-out, torque and bending with metallic conduits.....	76
8.2	Performance requirements	76
8.2.1	Operating conditions	76
8.2.2	Temperature-rise	78
8.2.3	Dielectric properties	79
8.2.4	Ability to make, carry and break currents under no-load, normal load and overload conditions	82
8.2.5	Ability to make, carry and break short-circuit currents	83
8.2.6	Pole impedance	83
8.2.7	Leakage currents of equipment suitable for isolation	83
8.3	Electromagnetic compatibility (EMC).....	84
8.3.1	General	84
8.3.2	Immunity.....	84
8.3.3	Emission.....	84
9	Tests.....	85
9.1	Kinds of test.....	85
9.1.1	General	85
9.1.2	Type tests.....	85
9.1.3	Routine tests.....	86
9.1.4	Sampling tests	86
9.1.5	Special tests	86
9.2	Compliance with constructional requirements.....	86
9.2.1	General	86
9.2.2	Test of materials to abnormal heat and fire	87
9.2.3	Equipment	87
9.2.4	Enclosures for equipment.....	87
9.2.5	Mechanical and electrical properties of terminals	87
9.2.6	Verification of the effectiveness of indication of the main contact position of equipment suitable for isolation	90
9.2.7	Vacant.....	92
9.2.8	Conduit pull-out test, torque test and bending test with metallic conduits	92

9.2.9	Test of earth continuity for protective earth	93
9.3	Performance	94
9.3.1	Test sequences.....	94
9.3.2	General test conditions	94
9.3.3	Performance under no-load, normal load and overload conditions	96
9.3.4	Performance under short-circuit conditions	109
9.4	Tests for EMC	114
9.4.1	General	114
9.4.2	Immunity.....	114
9.4.3	Emission.....	115
Annex A (informative)	Harmonisation of utilization categories for low-voltage switchgear and controlgear	147
Annex B (Vacant)	150
Annex C (normative)	Degrees of protection of enclosed equipment	151
C.1	General.....	151
C.2	Object.....	151
C.3	Definitions.....	151
C.4	Designation.....	151
C.5	Degrees of protection against access to hazardous parts and against ingress of solid foreign objects indicated by the first characteristic numeral	151
C.6	Degrees of protection against ingress of water indicated by the second characteristic numeral	151
C.7	Degrees of protection against access to hazardous parts indicated by the additional letter	152
C.8	Supplementary letters	152
C.9	Examples of designations with IP Code	152
C.10	Marking.....	152
C.11	General requirements for tests	152
C.12	Tests for protection against access to hazardous parts indicated by the first characteristic numeral	153
C.13	Tests for protection against ingress of solid foreign objects indicated by the first characteristic numeral	153
C.13.4	Dust test for first characteristic numerals 5 and 6	153
C.13.5.2	Acceptance conditions for first characteristic numeral 5.....	153
C.14	Tests for protection against water indicated by second characteristic numeral	154
C.14.1	Test means.....	154
C.14.2	Test conditions	154
C.14.3	Acceptance conditions	154
C.15	Tests for protection against access to hazardous parts indicated by additional letter	154
C.16	Summary of responsibilities of relevant technical committees	154
Annex D (informative)	Examples of clamping units and relationship between clamping unit and connecting device.....	158
D.1	Clamping unit in a connecting device	158
D.2	Examples of clamping units	159
Annex E (informative)	Description of a method for adjusting the load circuit	166
Annex F (informative)	Determination of short-circuit power-factor or time-constant	168
F.1	Determination of short-circuit power-factor.....	168
F.1.1	Method I – Determination from DC component.....	168

F.1.2	Method II – Determination with pilot generator	169
F.2	Determination of short-circuit time-constant (oscillographic method)	169
Annex G (informative)	Measurement of creepage distances and clearances	170
G.1	Basic principles	170
G.2	Use of ribs	170
Annex H (informative)	Correlation between the nominal voltage of the supply system and the rated impulse withstand voltage of equipment	177
Annex J (informative)	Items subject to agreement between manufacturer and user	179
Annex K (normative)	Procedure to determine reliability data for electromechanical devices used in functional safety applications	180
K.1	General	180
K.1.1	Overview	180
K.1.2	Object	180
K.1.3	General requirements	180
K.2	Terms, definitions and symbols	181
K.2.1	Terms and definitions	181
K.2.2	Symbols	182
K.3	Method based on durability test results	182
K.3.1	General method	182
K.3.2	Test requirements	182
K.3.3	Number of samples	182
K.3.4	Characterization of a failure mode	182
K.3.5	Weibull modelling	183
K.3.6	Useful life and upper limit of failure rate	185
K.3.7	Reliability data	186
K.4	Data information	186
K.5	Example	187
K.5.1	Test results	187
K.5.2	Weibull distribution and median rank regression	187
K.5.3	Useful life and failure rate	188
Annex L (normative)	Terminal marking and distinctive number	190
L.1	General	190
L.2	Terminal marking of impedances (alphanumeric)	190
L.2.1	Coils	190
L.2.2	Electromagnetic releases	191
L.2.3	Interlocking electromagnets	191
L.2.4	Indicating light devices	192
L.3	Terminal marking of contact elements for switching devices with two positions (numerical)	192
L.3.1	Contact elements for main circuits (main contact elements)	192
L.3.2	Contact elements for auxiliary circuit (auxiliary contact elements)	192
L.4	Terminal marking of overload protection devices	194
L.5	Distinctive number	195
L.6	Marking of terminals for external associated electronic circuit components, contacts and complete devices	195
L.6.1	Marking of terminals for external associated electronic circuit components and contacts	195
L.6.2	Marking of terminals for external complete devices	198
Annex M (normative)	Flammability test	201

M.1	Hot wire ignition test (HWI).....	201
M.1.1	Test sample.....	201
M.1.2	Description of test apparatus.....	201
M.1.3	Conditioning.....	202
M.1.4	Test procedure.....	202
M.2	Arc ignition test (AI).....	202
M.2.1	Test sample.....	202
M.2.2	Description of test apparatus.....	202
M.2.3	Conditioning.....	203
M.2.4	Test procedure.....	203
M.3	HWI and AI requirements.....	204
Annex N (normative)	Requirements and tests for equipment with protective separation.....	205
N.1	General.....	205
N.2	Terms and definitions.....	205
N.3	Requirements.....	207
N.3.1	General.....	207
N.3.2	Dielectric requirements.....	207
N.3.3	Construction requirements.....	207
N.4	Tests.....	208
N.4.1	General.....	208
N.4.2	Dielectric tests.....	208
N.4.3	Examples of constructional measures.....	208
Annex O (informative)	Environmentally conscious design.....	210
O.1	General.....	210
O.2	Object.....	210
O.3	Terms and definitions.....	211
O.4	General considerations.....	213
O.5	Fundamentals requirements of environmentally conscious design (ECD).....	216
O.6	Environmentally conscious design process (ECD process).....	217
O.6.1	General.....	217
O.6.2	Process steps of ECD.....	217
O.7	Tools for including ECD in product design and development.....	218
O.8	Relevant ISO technical committees.....	218
Annex P (informative)	Terminal lugs for low voltage switchgear and controlgear connected to copper conductors.....	219
Annex Q (normative)	Special tests – Tests for environmental categories.....	220
Q.1	General.....	220
Q.2	Classification of equipment.....	220
Q.3	Tests.....	221
Q.3.1	General test conditions.....	221
Q.3.2	Test sequences.....	221
Annex R (normative)	Application of the metal foil for dielectric testing on accessible parts during operation or adjustment.....	226
R.1	General.....	226
R.2	Object.....	226
R.3	Definition of zones.....	227
R.3.1	General.....	227

R.3.2	Application of metal foil on accessible parts during normal operation or adjustment.....	227
Annex S (normative)	Digital inputs and outputs.....	234
S.1	General.....	234
S.2	Terms and definitions.....	234
S.3	Functional requirements.....	234
S.3.1	Rated values and operating ranges.....	234
S.3.2	Digital I/Os.....	235
S.4	Verification of input/output requirements.....	243
S.4.1	General.....	243
S.4.2	Verification of digital inputs.....	244
S.4.3	Verification of digital outputs.....	244
S.4.4	Behaviour of the equipment.....	245
S.5	General information to be provided by the manufacturer.....	246
S.5.1	Information on digital inputs (current sinking).....	246
S.5.2	Information on digital outputs for alternating currents (current sourcing).....	246
S.5.3	Information on digital outputs for direct current (current sourcing).....	247
S.6	Digital input standard operating range equations.....	247
Annex T (normative)	Extended functions within electronic overload relays.....	249
T.1	Object.....	249
T.1.1	General.....	249
T.1.2	Ground/earth fault detection function.....	249
T.2	Terms and definitions.....	249
T.3	Classification of electronic overload relays.....	250
T.4	Types of relays with ground/earth fault detection function.....	250
T.5	Performance requirements.....	250
T.5.1	Limits of operation of ground/earth fault electronic overload relays.....	250
T.5.2	Limits of operation of ground/earth fault current sensing electronic relays Type CII(-A and -B).....	251
T.5.3	Limits of operation of voltage asymmetry relays.....	251
T.5.4	Limits of operation of phase reversal relays.....	251
T.5.5	Limits of operation of current imbalance relays.....	251
T.5.6	Limits of operation of over-voltage relays and releases.....	251
T.6	Tests.....	252
T.6.1	Limits of operation of ground/earth fault current sensing electronic relays Types CI and CII (-A and -B).....	252
T.6.2	Verification of inhibit function of ground/earth fault current sensing electronic relays Type CII (-A and -B).....	252
T.6.3	Current asymmetry relays.....	252
T.6.4	Voltage asymmetry relays.....	252
T.6.5	Phase reversal relays.....	253
T.6.6	Over-voltage relays.....	253
T.7	Routine and sampling tests.....	253
Annex U (informative)	Examples of control circuit configurations.....	254
U.1	External control device.....	254
U.1.1	Definition.....	254
U.1.2	Diagrammatic representation of an external control device.....	254
U.1.3	Parameters of an external control device.....	254
U.2	Control circuit configurations.....	255

U.2.1	Equipment with external control supply	255
U.2.2	Equipment with several external control supplies	255
U.2.3	Equipment with bus interface (may be combined with other circuit configurations)	256
Annex V (informative) Power management with switchgear and controlgear for electrical energy efficiency		257
V.1	General.....	257
V.2	Object.....	257
V.3	Terms and definitions	257
V.4	Electrical energy efficiency and safety	258
V.5	Principles on electrical energy efficiency (system approach)	258
V.5.1	General	258
V.5.2	Strategy of energy management.....	258
V.5.3	Power management with automation and control	258
V.6	Energy efficiency application	259
V.6.1	Saving of semiconductor losses.....	259
V.6.2	Power factor correction	259
V.6.3	Load shedding	259
V.6.4	Motor control for fixed speed applications	259
Annex W (normative) Procedure to establish material declaration		260
W.1	General.....	260
W.2	Object.....	260
W.3	Reference document	260
W.4	Terms and definitions	260
W.5	Material declaration requirements	261
W.5.1	General reporting requirements	261
W.5.2	Additional reporting requirements	262
W.6	Example of material declaration made according to W.5.....	262
Annex X (normative) Co-ordination between circuit-breaker or CPS and another short-circuit protective device associated in the same circuit		268
X.1	General.....	268
X.2	Object.....	268
X.3	General requirements for the co-ordination of a circuit-breaker or CPS with another SCPD.....	269
X.3.1	General considerations	269
X.3.2	Take-over current (I_B).....	269
X.3.3	Behaviour of C_1 in association with another SCPD	269
X.4	Type and characteristics of the associated SCPD	269
X.5	Verification of selectivity.....	270
X.5.1	General	270
X.5.2	Consideration of selectivity by desk study.....	270
X.5.3	Selectivity determined by test.....	271
X.6	Verification of back-up protection.....	272
X.6.1	Determination of the take-over current.....	272
X.6.2	Verification of back-up protection	272
X.6.3	Tests for verification of back-up protection.....	273
X.6.4	Results to be obtained	274
Annex ZA (normative) Normative references to international publications with their corresponding European publications		279

Annex ZZA (informative) Relationship between this European standard and the essential requirements of Directive 2014/30/EU [2014 OJ L96] aimed to be covered	284
Annex ZZB (informative) Relationship between this European standard and the safety objectives of Directive 2014/35/EU [2014 OJ L96] aimed to be covered	285
Bibliography	287
Figure 1 – Test equipment for flexion test (see 9.2.5.3 and Table 5).....	132
Figure 2 – Gauges of form A and form B (see 9.2.5.5.2 and Table 7)	132
Figure 3 – Diagram of the test circuit for the verification of making and breaking capacities of a single-pole equipment on single-phase AC or on direct current (see 9.3.3.5.2).....	133
Figure 4 – Diagram of the test circuit for the verification of making and breaking capacities of a two-pole equipment on single-phase AC or on direct current (see 9.3.3.5.2).....	134
Figure 5 – Diagram of the test circuit for the verification of making and breaking capacities of a three-pole equipment (see 9.3.3.5.2).....	135
Figure 6 – Diagram of the test circuit for the verification of making and breaking capacities of a four-pole equipment (see 9.3.3.5.2).....	136
Figure 7 – Schematic illustration of the recovery voltage across contacts of the first phase to clear under ideal conditions (see 9.3.3.5.2, item e))	137
Figure 8 – Diagram of a load circuit adjustment method	138
Figure 9 – Diagram of the test circuit for the verification of short-circuit making and breaking capacities of a single-pole equipment on single-phase AC or on direct current (see 9.3.4.1.2)	139
Figure 10 – Diagram of the test circuit for the verification of short-circuit making and breaking capacities of a two-pole equipment on single-phase AC or on direct current (see 9.3.4.1.2)	140
Figure 11 – Diagram of the test circuit for the verification of short-circuit making and breaking capacities of a three-pole equipment (see 9.3.4.1.2).....	141
Figure 12 – Diagram of the test circuit for the verification of short-circuit making and breaking capacities of a four-pole equipment (see 9.3.4.1.2).....	142
Figure 13 – Example of short-circuit making and breaking test record in the case of a single-pole equipment on single-phase AC (see 9.3.4.1.8)	143
Figure 14 – Verification of short-circuit making and breaking capacities on direct current (see 9.3.4.1.8)	144
Figure 15 – Determination of the prospective breaking current when the first calibration of the test circuit has been made at a current lower than the rated breaking capacity (see 9.3.4.1.8, item b)).....	145
Figure 16 – Actuator test force (see 9.2.6.2.1 and Table 17)	146
Figure D.1 – Clamping unit in a connecting device.....	158
Figure D.2 – Screw clamping units	159
Figure D.3 – Pillar clamping units.....	160
Figure D.4 – Stud clamping units.....	161
Figure D.5 – Saddle clamping units	162
Figure D.6 – Lug clamping units	163
Figure D.7 – Mantle clamping units	164
Figure D.8 – Screwless-type clamping units (sketches).....	165
Figure E.1 – Determination of the actual value of the factor γ	167

Figure G.1 – Measurement of ribs	171
Figure G.2 – Creepage distance across the fixed and moving insulation of contact carriers.....	171
Figure G.3 – Example 1	172
Figure G.4 – Example 2	172
Figure G.5 – Example 3	172
Figure G.6 – Example 4	173
Figure G.7 – Example 5	173
Figure G.8 – Example 6	173
Figure G.9 – Example 7	174
Figure G.10 – Example 8	174
Figure G.11 – Example 9	175
Figure G.12 – Example 10.....	175
Figure G.13 – Example 11.....	176
Figure K.1 – Plot of Weibull median rank regression	189
Figure M.1 – Test fixture for hot wire ignition test	201
Figure M.2 – Circuit for arc ignition test	203
Figure N.1 – Example of application with component connected between separated circuits	209
Figure O.1 – Conceptual relationship between provisions in product standards and the environmental impacts associated with the product during its life cycle	215
Figure O.2 – Overview of ECD process	216
Figure P.1 – Dimensions	219
Figure R.1 – Operating mechanism outside the enclosure	228
Figure R.2 – Application of the metallic foil to operating areas around switch actuator	229
Figure R.3 – Example of finger protected location for hazardous-live-parts in push-button vicinity	230
Figure R.4 – Example I of application of the foil	230
Figure R.5 – Example II of application of the foil	231
Figure R.6 – Example III of application of the foil	231
Figure R.7 – Application of metal foil on holes and grooves	232
Figure R.8 – Operating space for actuation by rotary means	233
Figure S.1 – I/O parameters	236
Figure S.2 – <i>U-I</i> operation regions of current-sinking inputs	237
Figure S.3 – Temporary overload waveform for digital AC outputs.....	240
Figure S.4 – Temporary overload waveform for digital DC outputs	243
Figure T.1 – Test circuit for the verification of the operating characteristic of a ground/earth fault current sensing electronic relay	253
Figure U.1 – Diagrammatic representation of an external control device.....	254
Figure U.2 – Single supply and control input.....	255
Figure U.3 – Separate supply and control inputs.....	255
Figure U.4 – Equipment with several external control supplies	255
Figure U.5 – Equipment with bus interface.....	256

Figure W.1 – Example of Main and Business information, graphical representation of the XML code	264
Figure W.2 – Example of product information, graphical representation of the XML code	265
Figure W.3 – Example of declarable substances information, graphical representation of the XML code	266
Figure W.4 – Example of material classes information, graphical representation of the XML code	267
Figure X.1 – Overcurrent co-ordination between a circuit-breaker or CPS and a fuse or back-up protection by a fuse: operating characteristics	274
Figure X.2 – Total selectivity between two circuit-breakers or a circuit-breaker and a CPS	275
Figure X.3 – Back-up protection by a circuit-breaker or CPS – Operating characteristics	276
Figure X.4 – Example of test circuit for conditional short-circuit breaking capacity tests showing cable connections for a 3-pole circuit-breaker or CPS (C ₁)	277
Figure X.5 – Example of test circuit for the verification of selectivity	278
Table 1 – Nominal cross-sections of round copper conductors and approximate relationship between mm ² and AWG/kcmil sizes (see 8.1.8.2)	116
Table 2 – Temperature-rise limits of terminals (see 8.2.2.2 and 9.3.3.3.4)	117
Table 3 – Temperature-rise limits of accessible parts (see 8.2.2.3 and 9.3.3.3.4)	117
Table 4 – Tightening torques for the verification of the mechanical strength of screw-type terminals (see 9.2.5.2 and 9.3.2.1)	118
Table 5 – Test values for flexion and pull-out tests for round copper conductors (see 9.2.5.4.1)	119
Table 6 – Test values for pull-out test for flat copper conductors (see 9.2.5.4.2)	119
Table 7 – Maximum conductor cross-sections and corresponding gauges (see 9.2.5.5.1)	120
Table 8 – Relationship between conductor cross-section and diameter	121
Table 9 – Test copper conductors for test currents up to 400 A inclusive (see 9.3.3.3.4)	122
Table 10 – Test copper conductors for test currents above 400 A and up to 800 A inclusive (see 9.3.3.3.4)	123
Table 11 – Test copper bars for test currents above 400 A and up to 3 150 A inclusive (see 9.3.3.3.4)	123
Table 12 – Impulse withstand test voltages	124
Table 13 – Minimum clearances in air	124
Table 14 – Test voltages across the open contacts of equipment suitable for isolation	125
Table 15 – Minimum creepage distances	126
Table 16 – Values of power-factors and time-constants corresponding to test currents, and ratio <i>n</i> between peak and RMS values of current (see 9.3.4.3, item a))	127
Table 17 – Actuator test force (see 9.2.6.2.1)	127
Table 18 – Tolerances on test quantities (see 9.3.4.3, item a))	127
Table 19 – Dielectric test voltage corresponding to the rated insulation voltage	128
Table 20 – Test values for conduit pull-out test (see 9.2.8.2)	128
Table 21 – Test values for conduit bending test (see 9.2.8.3)	128
Table 22 – Test values for conduit torque test (see 9.2.8.2 and 9.2.8.4)	129

Table 23 – Tests for EMC – Immunity (see 9.4.1)	130
Table 24 – Acceptance criteria when EM disturbances are present	131
Table 25 – Cross-sectional area of a copper protective conductor	131
Table A.1 – Utilization categories used in the IEC 60947 series	147
Table C.1 – IP Codes (1 of 3).....	155
Table G.1 – Minimum widths of grooves	170
Table H.1 – Correspondence between the nominal voltage of the supply system and the equipment rated impulse withstand voltage, in case of overvoltage protection by surge-arresters according to IEC 60099-1	178
Table K.1 – Failure modes of devices	183
Table K.2 – Example of 15 sorted ascending times to failure of contactors	187
Table K.3 – Example median rank calculation.....	188
Table M.1 – HWI and AI characteristics for materials necessary to retain current carrying parts in position	204
Table M.2 – HWI and AI characteristics for materials other than those covered by Table M.1	204
Table P.1 – Examples of terminal lugs for low voltage switchgear and controlgear connected to copper conductors.....	219
Table Q.1 – Test sequences (1 of 4)	222
Table S.1 – Rated values and operating ranges of incoming power supply	235
Table S.2 – Standard operating ranges for digital inputs (current sinking)	238
Table S.3 – Rated values and operating ranges for current sourcing digital AC outputs	239
Table S.4 – Rated values and operating ranges (direct current) for current-sourcing digital DC outputs	242
Table S.5 – Overload and short-circuit tests for digital outputs	245
Table T.1 – Tripping time of ground/earth fault electronic overload relays	250
Table W.1 – Example of main and business information in tabular form.....	263
Table W.2 – Example of product information in tabular form.....	264
Table W.3 – Example of declarable substances information in tabular form	265
Table W.4 – Example of material classes information in tabular form	267
Table ZZA.1 — Correspondence between this European standard and Annex I of Directive 2014/30/EU [2014 OJ L96].....	284
Table ZZB.1 — Correspondence between this European standard and Annex I of Directive 2014/35/EU [2014 OJ L96].....	285

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 1: General rules

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 60947-1 has been prepared by subcommittee 121A: Low-voltage switchgear and controlgear, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low voltage.

This sixth edition cancels and replaces the fifth edition published in 2007, Amendment 1:2010 and Amendment 2:2014. This edition constitutes a technical revision.

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

- DC values testing improvement;
- update of EMC tests;
- Annex B deletion;
- update of requirements for environmental tests (Table Q.1);
- improvement of Annex R (new examples);
- deletion of digital input Type 2, and introduction of Type 3 in Annex S;

- example for materials declaration (Annex W);
- new Annex X (co-ordination between short-circuit protective devices associated in the same circuit) created.

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

FDIS	Report on voting
121A/337/FDIS	121A/344/RVD

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

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

A list of all the parts in the IEC 60947 series, under the general title *Low-voltage switchgear and controlgear*, can be found on the IEC website.

The following differing practices of a less permanent nature exist in the countries indicated below.

5.3.6.4 Rated conditional short-circuit current (I_q , alternatively I_{cc}) (North America)

6.2 Marking (USA and Canada)

8.1.3 Current-carrying parts and their connections (USA)

8.1.7.1 Additional constructional requirements (USA)

8.1.10.1 (North America)

9.2.6.2.2 Dependent power operation (USA)

9.2.6.2.3 Independent power operation (Canada and USA)

Figure 4 (USA and Canada)

Figure 5 (USA and Canada)

Figure 10 (USA and Canada)

Figure 11 (USA and Canada)

Figure X.4 (USA and Canada)

Figure X.5 (USA and Canada)

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication 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.

INTRODUCTION

The purpose of this document is to harmonize as far as practicable all rules and requirements of a general nature applicable to low-voltage switchgear and controlgear in order to obtain uniformity of requirements and tests throughout the corresponding range of equipment and to avoid the need for testing to different standards.

All those parts of the various equipment standards which can be considered as general have therefore been gathered in this document together with specific subjects of wide interest and application, e.g. temperature-rise, dielectric properties, etc.

For each type of low-voltage switchgear and controlgear, only two main documents are necessary to determine all requirements and tests:

- 1) this document, referred to as "Part 1" or "IEC 60947-1" in the specific standards covering the various types of low-voltage switchgear and controlgear;
- 2) the relevant equipment standard hereinafter referred to as the "relevant product standard" or "product standard of this series".

For a general rule to apply to a specific product standard, it will be explicitly referred to by the latter, by quoting the relevant clause or subclause number of this document followed by "IEC 60947-1" e.g. "7.2.3 of IEC 60947-1:20xx".

A specific product standard will only deviate from the general rules when there is substantial technical justification.

NOTE All references to "product standards" in this document means "product standards of IEC 60947 series".

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 1: General rules

1 Scope

This document applies, when required by the relevant product standard, to low-voltage switchgear and controlgear hereinafter referred to as "equipment" or "device" and intended to be connected to circuits, the rated voltage of which does not exceed 1 000 V AC or 1 500 V DC.

This document states the general rules and common safety requirements for low-voltage switchgear and controlgear, including:

- definitions;
- characteristics;
- information supplied with the equipment;
- normal service, mounting and transport conditions, decommissioning and dismantling;
- constructional and performance requirements;
- verification of characteristics and performance;
- energy efficiency aspects (see Annex V);
- environmental aspects.

This document does not apply to:

- low-voltage switchgear and controlgear assemblies which are dealt with in IEC 61439 series, as applicable;
- terminals for connection of aluminium conductors;

NOTE Terminals for aluminium conductors are under consideration for the next revision.

- use within explosive atmospheres (see IEC 60079 series);
- software and firmware requirements for functional safety application (see IEC 61508-3);
- cyber security aspects (see IEC 62443 series).

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 60038:2009, *IEC standard voltages*

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-6:2007, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

AC IEC 60068-2-52:2017, *Environmental testing – Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)* AC

IEC 60068-2-78:2012, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60073:2002, *Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators*

IEC 60085:2007, *Electrical insulation – Thermal evaluation and designation*

IEC 60092-504:2016, *Electrical installations in ships – Part 504: Automation, control and instrumentation*

IEC 60216-2, *Electrical insulating materials – Thermal endurance properties – Part 2: Determination of thermal endurance properties of electrical insulating materials – Choice of test criteria*

IEC 60228:2004, *Conductors of insulated cables*

IEC 60269-1:2006, *Low-voltage fuses – Part 1: General requirements*

IEC 60269-1:2006/AMD1:2009

IEC 60269-1:2006/AMD2:2014

IEC 60300-3-5:2001, *Dependability management – Part 3-5: Application guide – Reliability test conditions and statistical test principles*

IEC TR 60344:2007, *Calculation of d.c. resistance of plain and coated copper conductors of low-frequency cables and wires – Application guide*

IEC 60417, *Graphical symbols for use on equipment* (available at <http://www.graphical-symbols.info/equipment>)

IEC 60445:2017, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors*

IEC 60447:2004, *Basic and safety principles for man-machine interface, marking and identification – Actuating principles*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP code)*

IEC 60529:1989/AMD1:1999

IEC 60529:1989/AMD2:2013

IEC 60617, *Graphical symbols for diagrams* (available at <http://std.iec.ch/iec60617>)

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60695-2-10:2013, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC 60695-2-11:2014, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

IEC 60695-2-12, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*

IEC 60695-11-10:2013, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60947-2:2016, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*
IEC 60947-2:2016/AMD1:2019

IEC 60947-4-2, *Low-voltage switchgear and controlgear – Part 4-2: Contactors and motor-starters – AC semiconductor motor controllers and starters*

IEC 60947-5 (all parts), *Low-voltage switchgear and controlgear – Part 5: Control circuit devices and switching elements*

IEC 60947-5-1, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 60947-8, *Low-voltage switchgear and controlgear – Part 8: Control units for built-in thermal protection (PTC) for rotating electrical machines*

IEC 60981:2019, *Extra heavy-duty electrical rigid steel conduits*

IEC 60999-1:1999, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm² up to 35 mm² (included)*

IEC 60999-2:2003, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 2: Particular requirements for clamping units for conductors above 35 mm² up to 300 mm² (included)*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-4-34, *Electromagnetic compatibility (EMC) – Part 4-34: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current more than 16 A per phase*

IEC 61000-6-2:2016, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments*

IEC 61000-6-5, *Electromagnetic compatibility (EMC) – Part 6-5: Generic standards – Immunity for equipment used in power station and substation environment*

IEC 61131-2:2017, *Industrial-process measurement and control – Programmable controllers – Part 2: Equipment requirements and tests*

IEC 61140:2016, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61180:2016, *High-voltage test techniques for low-voltage equipment – Definitions, test and procedure requirements, test equipment*

IEC 61439 (all parts), *Low-voltage switchgear and controlgear assemblies*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61557-2, *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures – Part 2: Insulation resistance*

IEC 61649:2008, *Weibull analysis*

IEC 62061:2005, *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*

IEC 62061:2005/AMD1:2012

IEC 62061:2005/AMD2:2015

IEC 62474:2018, *Material declaration for products of and for the electrotechnical industry*

CISPR 11, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*

CISPR 32, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

ISO 3864-2, *Graphical symbols – Safety colours and safety signs – Part 2: Design principles for product safety labels*

ISO 7000, *Graphical symbols for use on equipment – Registered symbols* (available at <http://www.graphical-symbols.info/equipment>)

ISO 13849-1:2015, *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*