

© Copyright SEK Svensk Elstandard. Reproduction in any form without permission is prohibited.

Varvtalsstyrda elektriska drivsystem – Del 5-1: Elektrisk, termisk och mekanisk säkerhet

*Adjustable speed electrical power drive systems –
Part 5-1: Safety requirements –
Electrical, thermal and energy*

Som svensk standard gäller europastandarden EN IEC 61800-5-1:2023. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 61800-5-1:2023.

Nationellt förord

Europastandarden EN IEC 61800-5-1:2023

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 61800-5-1, Third edition, 2022^{*)} - Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy**

utarbetad inom International Electrotechnical Commission, IEC.

Tidigare fastställd svensk standard SS-EN 61800-5-1, utg 2:2007 med eventuella tillägg, ändringar och rättelser gäller ej fr o m 2026-10-20.

^{*)}Corrigendum No 1 (2023-09) till IEC 61800-5-1:2022 är inarbetat i standarden.

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a mätning, säkerhet och provning och för utförande, skötsel och dokumentation av elprodukter och elanläggningar.

Genom att utforma sådana standarder blir säkerhetsfordringar tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

SEK Svensk Elstandard

Box 1284
164 29 Kista
Tel 08-444 14 00
www.elstandard.se

English Version

**Adjustable speed electrical power drive systems - Part 5-1:
Safety requirements - Electrical, thermal and energy
(IEC 61800-5-1:2022 + COR1:2023)**

Entraînements électriques de puissance à vitesse variable -
Partie 5-1: Exigences de sécurité - Électrique, thermique et
énergétique
(IEC 61800-5-1:2022 + COR1:2023)

Elektrische Leistungsantriebssysteme mit einstellbarer
Drehzahl - Teil 5-1: Anforderungen an die Sicherheit -
Elektrische, thermische und energetische Anforderungen
(IEC 61800-5-1:2022 + COR1:2023)

This European Standard was approved by CENELEC on 2022-10-05. 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, Türkiye 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 22G/455/FDIS, future edition 3 of IEC 61800-5-1 + COR1, prepared by SC 22G "Adjustable speed electric power drive systems (PDS)" of IEC/TC 22 "Power electronic systems and equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61800-5-1:2023.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2024-04-20 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2026-10-20 document have to be withdrawn

This document supersedes EN 61800-5-1:2007 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.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 61800-5-1:2022 + COR1:2023 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 standard indicated:

IEC 60034-9:2021	NOTE	Approved as EN IEC 60034-9:— ¹ (not modified)
IEC 60060-1:2010	NOTE	Approved as EN 60060-1:2010 (not modified)
IEC 60068-1:2013	NOTE	Approved as EN 60068-1:2014 (not modified)
IEC 60068-2-14	NOTE	Approved as EN IEC 60068-2-14
IEC 60068-2-31:2008	NOTE	Approved as EN 60068-2-31:2008 (not modified)
IEC 60071-1:2019	NOTE	Approved as EN IEC 60071-1:2019 (not modified)
IEC 60073:2002	NOTE	Approved as EN 60073:2002 (not modified)
IEC 60085:2007	NOTE	Approved as EN 60085:2008 (not modified)
IEC 60112:2020	NOTE	Approved as EN IEC 60112:2020 (not modified)
IEC 60127-2:2014	NOTE	Approved as EN 60127-2:2014 (not modified)
IEC 60127-4:2005	NOTE	Approved as EN 60127-4:2005 (not modified)

¹ To be published. Stage at the time of publication: FprEN IEC 60034-9:2021.

IEC 60204-1:2016	NOTE	Approved as EN 60204-1:2018
IEC 60216 (series)	NOTE	Approved as EN 60216 (series)
IEC 60320-1	NOTE	Approved as EN IEC 60320-1
IEC 60335-1:2020	NOTE	Approved as EN IEC 60335-1:— ² (not modified)
IEC 60364 (series)	NOTE	Approved as HD 60364 (series)
IEC 60364-1:2005	NOTE	Approved as HD 60364-1:2008 + A11:2017
IEC 60364-4-44:2007	NOTE	Approved as HD 60364-4-444:2010
IEC 60364-4-44:2007/A1:2015	NOTE	Approved as HD 60364-4-443:2016
IEC 60364-5-52:2009	NOTE	Approved as HD 60364-5-52:2011 + A11:2017
IEC 60445:2021	NOTE	Approved as EN IEC 60445:2021 (not modified)
IEC 60664 (series)	NOTE	Approved as EN 60664 (series)
IEC 60695-10-3:2016	NOTE	Approved as EN 60695-10-3:2016 (not modified)
IEC 60695-11-5:2016	NOTE	Approved as EN 60695-11-5:2017 (not modified)
IEC 60721 (series)	NOTE	Approved as EN 60721 (series)
IEC 60947-2:2016	NOTE	Approved as EN 60947-2:2017 (not modified)
IEC 60947-7-2:2009	NOTE	Approved as EN 60947-7-2:2009 (not modified)
IEC 61082-1:2014	NOTE	Approved as EN 61082-1:2015 (not modified)
IEC 61140:2016	NOTE	Approved as EN 61140:2016 (not modified)
IEC 61148:2011	NOTE	Approved as EN 61148:2012 (not modified)
IEC 61439-1:2020	NOTE	Approved as EN IEC 61439-1:2021 (not modified)
IEC 61508 (series)	NOTE	Approved as EN 61508 (series)
IEC 61643-11:2011	NOTE	Approved as EN 61643-11:2012 + A11:2018
IEC 61643-12	NOTE	Approved as CLC/TS 61643-12
IEC 61800-1:2021	NOTE	Approved as EN IEC 61800-1:2021 (not modified)
IEC 61800-2:2021	NOTE	Approved as EN IEC 61800-2:2021 (not modified)
IEC 61800-3:2017	NOTE	Approved as EN IEC 61800-3:2018 (not modified)
IEC 61800-5-1:2007	NOTE	Approved as EN 61800-5-1:2007 (not modified) + A11:2021
IEC 61800-5-1:2007/A1:2016	NOTE	Approved as EN 61800-5-1:2007/A1:2017 (not modified)
IEC 61800-5-2	NOTE	Approved as EN 61800-5-2
IEC 61800-5-3	NOTE	Approved as EN IEC 61800-5-3
IEC/TR 61800-6:2003	NOTE	Approved as CLC/TR 61800-6:2007 (not modified)
IEC 61800-7 (series)	NOTE	Approved as EN 61800-7 (series)

² To be published. Stage at the time of publication: FprEN IEC 60335-1:2023.

EN IEC 61800-5-1:2023 (E)

IEC 61800-9 (series)	NOTE	Approved as EN 61800-9 (series)
IEC 61936-1:2021	NOTE	Approved as EN IEC 61936-1:2021 (not modified)
IEC 62311:2019	NOTE	Approved as EN IEC 62311:2020 (not modified)
IEC/IEEE 82079-1:2019	NOTE	Approved as EN IEC/IEEE 82079-1:2020 (not modified)
IEC 60076-1:2011	NOTE	Approved as EN 60076-1:2011 (not modified)
IEC 60127 (series)	NOTE	Approved as EN IEC 60127 (series)
IEC 60309-1	NOTE	Approved as EN IEC 60309-1
IEC 60317 (series)	NOTE	Approved as EN IEC 60317 (series)
IEC 60384-14:2013	NOTE	Approved as EN 60384-14:2013 (not modified)
IEC 60691:2015	NOTE	Approved as EN 60691:2016 (not modified)
IEC 60730 (series)	NOTE	Approved as EN IEC 60730 (series)
IEC 60738-1:2006	NOTE	Approved as EN 60738-1:2006 (not modified)
IEC 60747-5-5:2020	NOTE	Approved as EN IEC 60747-5-5:2020 (not modified)
IEC 60825 (series)	NOTE	Approved as EN 60825 (series)
IEC 60940:2015	NOTE	Approved as EN 60940:2015 (not modified)
IEC 60947 (series)	NOTE	Approved as EN IEC 60947 (series)
IEC 60947-7-1:2009	NOTE	Approved as EN 60947-7-1:2009 (not modified)
IEC 61008 (series)	NOTE	Approved as EN 61008 (series)
IEC 61009 (series)	NOTE	Approved as EN 61009 (series)
IEC 61010-1:2010	NOTE	Approved as EN 61010-1:2010 (not modified)
IEC 61051-2:2021	NOTE	Approved as EN IEC 61051-2:2021 (not modified)
IEC 61058-1:2016	NOTE	Approved as EN IEC 61058-1:2018 (not modified)
IEC 61071:2017	NOTE	Approved as EN 61071:— ³ (not modified)
IEC 61204-7:2016	NOTE	Approved as EN IEC 61204-7:2018 (not modified)
IEC 61558-2-16:2021	NOTE	Approved as EN IEC 61558-2-16:— ⁴ (not modified)
IEC 61810-1:2015	NOTE	Approved as EN 61810-1:2015 (not modified)
IEC 61984:2008	NOTE	Approved as EN 61984:2009 (not modified)
IEC 62368-1:2018	NOTE	Approved as EN IEC 62368-1:2020 (not modified) + A11:2020
IEC 62423:2009	NOTE	Approved as EN 62423:2012 + A11:2021

³ To be published. Stage at the time of publication: FprEN 61071:2017.

⁴ To be published. Stage at the time of publication: FprEN IEC 61558-2-16:2021.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60034	series	Rotating electrical machines	-	series
IEC 60034-1	2022	Rotating electrical machines - Part 1: Rating and performance	-	-
IEC 60034-5	2020	Rotating electrical machines - Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) - Classification	EN IEC 60034-5	2020
IEC 60050-112	-	International Electrotechnical Vocabulary - Part 112: Quantities and units	-	-
IEC 60050-113	-	International Electrotechnical Vocabulary - Part 113: Physics for electrotechnology	-	-
IEC 60050-114	-	International Electrotechnical Vocabulary - Part 114: Electrochemistry	-	-
IEC 60050-131	-	International Electrotechnical Vocabulary - Part 131: Circuit theory	-	-
IEC 60050-151	-	International Electrotechnical Vocabulary - Part 151: Electrical and magnetic devices	-	-
IEC 60050-161	-	International Electrotechnical Vocabulary. Chapter 161: Electromagnetic compatibility	-	-
IEC 60050-192	-	International electrotechnical vocabulary - Part 192: Dependability	-	-
IEC 60050-426	-	International Electrotechnical Vocabulary (IEV) - Part 426: Explosive atmospheres	-	-
IEC 60050-441	-	International Electrotechnical Vocabulary. Switchgear, controlgear and fuses	-	-
IEC 60050-442	-	International Electrotechnical Vocabulary - Part 442: Electrical accessories	-	-
IEC 60050-551	-	International Electrotechnical Vocabulary - Part 551: Power electronics	-	-

EN IEC 61800-5-1:2023 (E)

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-601	-	International Electrotechnical Vocabulary. Chapter 601: Generation, transmission and distribution of electricity - General	-	-
IEC 60050-826	-	International Electrotechnical Vocabulary - Part 826: Electrical installations	-	-
IEC 60050-903	-	International electrotechnical vocabulary_ - Part_903: Risk assessment	-	-
IEC 60068-2-1	2007	Environmental testing - Part 2-1: Tests - Test A: Cold	EN 60068-2-1	2007
IEC 60068-2-2	2007	Environmental testing - Part 2-2: Tests - Test B: Dry heat	EN 60068-2-2	2007
IEC 60068-2-6	2007	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	EN 60068-2-6	2008
IEC 60068-2-30	-	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)	EN 60068-2-30	-
IEC 60068-2-30	2005	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)	EN 60068-2-30	2005
IEC 60068-2-52	2017	Environmental testing - Part 2-52: Tests - Test Kb: Salt mist, cyclic (sodium chloride solution)	EN IEC 60068-2-52	2018
IEC 60068-2-68	1994	Environmental testing - Part 2-68: Tests - Test L: Dust and sand	EN 60068-2-68	1996
IEC 60068-2-78	2012	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state	EN 60068-2-78	2013
IEC 60204-11	2018	Safety of machinery - Electrical equipment of machines - Part 11: Requirements for equipment for voltages above 1 000 V AC or 1 500 V DC and not exceeding 36 kV	EN IEC 60204-11	2019
IEC 60320	-	Appliance couplers for household and similar general purposes	-	-
IEC 60364	series	Low-voltage electrical installations	HD 60364	series
+ A1	2017		-	-
IEC 60364-4-41 (mod)	2005	Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock	HD 60364-4-41	2017
-	-		+ A11	2017
-	-		+ A12	2019
IEC 60364-5-54	2011	Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements and protective conductors	HD 60364-5-54	2011
-	-		+ A11	2017
IEC 60417	-	Graphical symbols for use on equipment. Index, survey and compilation of the single sheets.	-	-

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60529	1989	Degrees of protection provided by enclosures (IP Code)	EN 60529	1991
-	-		+ corrigendum May	1993
+ A1	1999		+ A1	2000
+ A2	2013		+ A2	2013
IEC 60617	-	Standard data element types with associated classification scheme for electric components - Part 4: IEC reference collection of standard data element types and component classes	-	-
IEC 60664-1	2020	Insulation coordination for equipment within low-voltage supply systems - Part 1: Principles, requirements and tests	EN IEC 60664-1	2020
IEC 60664-3	2016	Insulation coordination for equipment within low-voltage systems - Part 3: Use of coating, potting or moulding for protection against pollution	EN 60664-3	2017
IEC 60664-4	2005	Insulation coordination for equipment within low-voltage systems - Part 4: Consideration of high-frequency voltage stress	EN 60664-4	2006
-	-		+ corrigendum Oct.	2006
IEC 60695-2-10	2021	Fire hazard testing - Part 2-10: Glowing/hot-wire based test methods - Glow-wire apparatus and common test procedure	EN IEC 60695-2-10	2021
IEC 60695-2-11	2021	Fire hazard testing - Part 2-11: Glowing/hot-wire based test methods - Glow-wire flammability test method for end products (GWEPT)	EN IEC 60695-2-11	2021
IEC 60695-2-13	2021	Fire hazard testing - Part 2-13: Glowing/hot-wire based test methods - Glow-wire ignition temperature (GWIT) test method for materials	EN IEC 60695-2-13	2021
IEC 60695-10-2	2014	Fire hazard testing - Part 10-2: Abnormal heat - Ball pressure test method	EN 60695-10-2	2014
IEC 60695-11-10	2013	Fire hazard testing - Part 11-10: Test flames - 50 W horizontal and vertical flame test methods	EN 60695-11-10	2013
IEC 60695-11-20	2015	Fire hazard testing - Part 11-20: Test flames - 500 W flame test method	EN 60695-11-20	2015
+ A1	1995		-	-
+ A2	1996		-	-
IEC 60721-3-3	1994	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 3: Stationary use at weatherprotected locations	-	-

EN IEC 61800-5-1:2023 (E)

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60721-3-4	2019	Classification of environmental conditions - Part 3-4: Classification of groups of environmental parameters and their severities - Stationary use at non-weatherprotected locations	EN IEC 60721-3-4	2019
IEC 60730-1 (mod)	2013	Automatic electrical controls - Part 1: General requirements	EN 60730-1	2016
+ A1	2015		+ A1	2019
+ A2	2020		+ A2	2022
IEC 60755	2017	General safety requirements for residual current operated protective devices	-	-
IEC 60799	2018	Electrical accessories - Cord sets and interconnection cord sets	EN IEC 60799	2021
IEC 60947-4-1	2018	Low-voltage switchgear and controlgear - Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters	EN IEC 60947-4-1	2019
IEC 60990	2016	Methods of measurement of touch current and protective conductor current	EN 60990	2016
IEC 61032	1997	Protection of persons and equipment by enclosures - Probes for verification	EN 61032	1998
IEC 61084	series	Cable trunking systems and cable ducting systems for electrical installations	-	series
IEC 61180	2016	High-voltage test techniques for low-voltage equipment - Definitions, test and procedure requirements, test equipment	EN 61180	2016
IEC 61189-3	2007	Test methods for electrical materials, printed boards and other interconnection structures and assemblies - Part 3: Test methods for interconnection structures (printed boards)	EN 61189-3	2008
IEC 61230	2008	Live working - Portable equipment for earthing or earthing and short-circuiting	EN 61230	2008
IEC 61386	series	Conduit systems for cable management	EN 61386	series
IEC 61558-1	2017	Safety of transformers, reactors, power supply units and combinations thereof – Part 1: General requirements and tests	EN IEC 61558-1	2019
IEC 62109-1	2010	Safety of power converters for use in photovoltaic power systems - Part 1: General requirements	EN 62109-1	2010
IEC 62271-102	2018	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches	EN IEC 62271-102	2018
IEC 62477-1	2022	Safety requirements for power electronic converter systems and equipment - Part 1: General	EN IEC 62477-1	2023
IEC 62477-2	2018	Safety requirements for power electronic converter systems and equipment - Part 2: Power electronic converters from 1 000 V AC or 1 500 V DC up to 36 kV AC or 54 kV DC	EN IEC 62477-2	2018

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
ISO 3746	-	Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane	EN ISO 3746	-
ISO 3864-1	2011	Graphical symbols - Safety colours and safety signs - Part 1: Design principles for safety signs and safety markings	-	-
ISO 7000	-	Graphical symbols for use on equipment - Registered symbols	-	-
ISO 7010	-	Graphical symbols - Safety colours and safety signs - Registered safety signs	-	-
ISO 9614-1	-	Acoustics - Determination of sound power levels of noise sources using sound intensity - Part 1: Measurement at discrete points	EN ISO 9614-1	2009



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2022 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 Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

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

About the IEC

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

About IEC publications

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

IEC publications search - webstore.iec.ch/advsearchform

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

IEC Just Published - webstore.iec.ch/justpublished

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

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

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

IEC Products & Services Portal - products.iec.ch

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

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

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

A propos des publications IEC

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

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

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

IEC Just Published - webstore.iec.ch/justpublished

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

Service Clients - webstore.iec.ch/csc

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

IEC Products & Services Portal - products.iec.ch

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

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Adjustable speed electrical power drive systems –
Part 5-1: Safety requirements – Electrical, thermal and energy**

**Entraînements électriques de puissance à vitesse variable –
Partie 5-1: Exigences de sécurité – Électrique, thermique et énergétique**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 13.110; 29.130.99; 29.200

ISBN 978-2-8322-4155-4

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

CONTENTS

FOREWORD.....	15
INTRODUCTION.....	17
0.1 General.....	17
0.2 Feedback from industry and national committees.....	19
0.3 Requirement covered by other relevant parts of the IEC 61800 series	19
1 Scope.....	20
2 Normative references	20
3 Terms and definitions	24
4 Protection against hazards	40
4.1 General.....	40
4.2 <i>Single-fault conditions</i> and <i>abnormal operating conditions</i>	41
4.3 Short-circuit and overload protection.....	42
4.3.1 General	42
4.3.2 Input short-circuit rating and available <i>output short-circuit current</i>	43
4.3.3 Short-circuit coordination (upstream protection).....	44
4.3.4 Protection by several devices	44
4.3.5 Motor overload and overtemperature protection	45
4.3.6 <i>BDM/CDM</i> providing current limiting control.....	46
4.4 Protection against electric shock.....	46
4.4.1 General	46
4.4.2 <i>Decisive voltage class (DVC)</i>	46
4.4.3 Provision for <i>basic protection</i>	53
4.4.4 Provision for <i>fault protection</i>	56
4.4.5 Provisions for <i>enhanced protection</i>	64
4.4.6 Protective measures	65
4.4.7 <i>Insulation</i>	67
4.4.8 Compatibility with residual current-operated protective devices (RCD).....	88
4.4.9 Capacitor discharge.....	89
4.4.10 Access conditions for high-voltage sections of <i>BDM/CDM/PDS</i> (<i>interlock</i>)	89
4.5 Protection against electrical energy hazards	91
4.5.1 General	91
4.5.2 Determination of hazardous electrical energy level	92
4.5.3 Limited power sources	92
4.6 Protection against fire and thermal hazards	94
4.6.1 General	94
4.6.2 Circuits and <i>components</i> representing a fire hazard	94
4.6.3 Selection of <i>components</i> to mitigate the risk of a fire hazard	94
4.6.4 Fire protection provided by <i>enclosures</i>	95
4.6.5 Temperature limits.....	96
4.7 Protection against mechanical hazards	98
4.7.1 General	98
4.7.2 Critical torsional speed	99
4.7.3 Transient torque analysis.....	99
4.7.4 Specific requirements for liquid cooled <i>BDM/CDM/PDS</i>	99
4.7.5 Mechanical hazards from rotating parts	101
4.7.6 Sharp edges	102

4.8	<i>BDM/CDM/PDS</i> with multiple sources of supply	102
4.8.1	General	102
4.8.2	<i>Low-voltage</i> DC link sharing	103
4.9	Protection against environmental stresses	103
4.9.1	General	103
4.9.2	Protection against corrosion	105
4.10	Protection against excessive acoustic noise hazards	105
4.10.1	General	105
4.10.2	Acoustic noise level	105
4.11	Wiring and connections	106
4.11.1	General	106
4.11.2	<i>Insulation</i> of conductors	107
4.11.3	Stranded wire	109
4.11.4	Routing and clamping	109
4.11.5	Identification of conductors and terminals of <i>mains supply</i> and <i>non-mains supply</i>	109
4.11.6	Splices and connections	110
4.11.7	Accessible connections	110
4.11.8	Interconnections between parts of the <i>PDS</i>	111
4.11.9	Supply connections for <i>permanently connected BDM/CDM/PDS</i>	111
4.11.10	Supply connections for pluggable <i>BDM/CDM/PDS</i>	111
4.11.11	Terminals	113
4.11.12	Provisions for connecting the shield of shielded wire or cable	116
4.12	Mechanical requirements for <i>enclosures</i>	117
4.12.1	General	117
4.12.2	Handles and manual controls	117
4.12.3	Cast metal <i>enclosure</i>	118
4.12.4	Sheet metal <i>enclosure</i>	118
4.12.5	Stability for floor-standing <i>BDM/CDM/PDS</i>	121
4.12.6	Wiring strain relief	121
4.12.7	Polymeric <i>enclosure</i> stress relief	122
4.12.8	Internal condensation or accumulation of water	122
4.12.9	Polymeric outdoor <i>enclosure</i> ultra-violet (UV) resistance	122
4.13	<i>Components</i>	123
4.13.1	<i>Components</i> general	123
4.13.2	<i>Components</i> representing a fire hazard	123
4.13.3	<i>Components</i> being part of an <i>enclosure</i>	123
4.13.4	<i>Components</i> representing a mechanical hazard	124
4.13.5	Wound <i>components</i>	124
4.13.6	Protective devices	124
4.14	Protection against electromagnetic fields	124
5	Test requirements	124
5.1	General	124
5.1.1	Test objectives and classification	124
5.1.2	Selection of test samples	125
5.1.3	Sequence of tests	125
5.1.4	Earthing conditions	125
5.1.5	General conditions for tests	125
5.1.6	Compliance	126

5.1.7	Test overview	126
5.2	Test specifications	129
5.2.1	<i>Visual inspections (type test, routine test and sample test)</i>	129
5.2.2	Mechanical tests.....	129
5.2.3	Electrical tests	138
5.2.4	<i>Abnormal operation</i> and simulated faults tests	157
5.2.5	Material tests	170
5.2.6	Environmental tests (<i>type tests</i>).....	174
5.2.7	Hydrostatic pressure test (<i>type test, routine test</i>).....	180
5.2.8	Electromagnetic fields (EMF) test (<i>type test</i>)	181
6	Information and marking requirements.....	181
6.1	General.....	181
6.1.1	Overview	181
6.1.2	Documentation in electronic form.....	184
6.1.3	Installation Instructions	185
6.2	Information for selection	185
6.2.1	General	185
6.2.2	Instructions and markings pertaining to <i>accessories</i>	187
6.3	Information for installation and commissioning	187
6.3.1	General	187
6.3.2	Mechanical considerations.....	187
6.3.3	Environment	187
6.3.4	Handling and mounting	188
6.3.5	<i>Enclosure</i> temperature	188
6.3.6	Open type <i>BDM/CDM</i>	188
6.3.7	Connections	189
6.3.8	Commissioning	191
6.3.9	Protection requirements.....	191
6.3.10	Motor and driven equipment	195
6.3.11	Field installed <i>components</i>	196
6.4	Information for intended use	196
6.4.1	General	196
6.4.2	Adjustment	196
6.4.3	Labels, signs, symbols and signals	196
6.4.4	Hot surface.....	198
6.4.5	Control and device marking	198
6.4.6	Stability for floor-standing <i>BDM/CDM/PDS</i>	199
6.5	Supplementary information	199
6.5.1	General	199
6.5.2	Capacitor discharge.....	199
6.5.3	Special operation mode – Auto restart/bypass connection	200
6.5.4	Other hazards.....	200
6.5.5	<i>BDM/CDM/PDS</i> with multiple sources of supply	200
6.5.6	PT/CT connection	200
6.5.7	Access conditions for <i>high-voltage BDM/CDM/PDS</i> during maintenance	200
Annex A (normative)	Additional information for protection against electric shock	202
A.1	General.....	202
A.2	Protection by means of <i>DVC As</i>	202
A.3	Protection by means of <i>protective impedance</i>	203

A.4	Protection by using limited voltages	204
A.5	Evaluation of the <i>working voltage</i> of circuits.....	204
A.5.1	General	204
A.5.2	Classification of the <i>working voltage</i>	205
A.5.3	AC <i>working voltage</i>	205
A.5.4	DC <i>working voltage</i>	206
A.5.5	Pulsating <i>working voltage</i>	207
A.6	The concept of protective measures according to 4.4.....	208
A.6.1	General	208
A.6.2	General concept of protection against electric shock	209
A.6.3	Examples of the use of elements of protective measures	210
Annex B (informative)	Considerations for the reduction of the pollution degree	215
B.1	General.....	215
B.2	Factors influencing the pollution degree	215
B.3	Reduction of influencing factors	215
Annex C (informative)	Symbols referred.....	216
C.1	Symbols used	216
C.2	Determination of contrast	218
Annex D (normative)	Evaluation of <i>clearance</i> and <i>creepage distances</i>	219
D.1	Measurement.....	219
D.2	Relationship of measurement to pollution degree	219
D.3	Examples	219
Annex E (normative)	Altitude correction for <i>clearances</i>	226
E.1	Correction factor for <i>clearances</i> at altitudes above 2 000 m	226
E.2	Test voltages for verifying <i>clearances</i> at different altitudes	226
Annex F (normative)	<i>Clearance</i> and <i>creepage distance</i> determination for frequencies greater than 30 kHz	228
F.1	General influence of the frequency on the withstand characteristics.....	228
F.2	<i>Clearance</i>	228
F.2.1	General	228
F.2.2	<i>Clearance</i> for inhomogenous fields	229
F.2.3	<i>Clearance</i> for approximately homogenous fields	230
F.3	<i>Creepage distance</i>	231
F.4	<i>Solid insulation</i>	232
F.4.1	General	232
F.4.2	Approximately uniform field distribution without air gaps or voids.....	232
F.4.3	Other cases	233
Annex G (informative)	Cross-sections of round conductors	234
Annex H (informative)	Guidelines for RCD compatibility	235
H.1	Selection of RCD type.....	235
H.2	Fault current waveforms.....	236
Annex I (informative)	Examples of overvoltage category reduction	240
I.1	General.....	240
I.2	<i>Protection to the surroundings</i> (see 4.4.7.2).....	240
I.2.1	Circuits connected directly to <i>mains supply</i> (see 4.4.7.2.3).....	240
I.2.2	Circuits connected to the <i>non-mains supply</i> (see 4.4.7.2.4)	243
I.2.3	<i>Insulation</i> between circuits (see 4.4.7.2.5)	243
I.3	<i>Functional insulation</i> (see 4.4.7.3)	244

I.4	Further examples	244
Annex J (informative)	Burn thresholds for touchable surfaces	246
J.1	General.....	246
J.2	Burn thresholds	246
Annex K (informative)	Table of electrochemical potentials	249
Annex L (informative)	Measuring instrument for touch current measurements	250
L.1	Measuring test circuit.....	250
L.2	Requirements for measuring instruments	250
Annex M (normative)	Test probes for determining access	251
Annex N (informative)	Guidance regarding short-circuit current	254
Annex O (informative)	Guidance for determination of <i>clearance</i> and <i>creepage distance</i>	255
O.1	Guideline for determination of <i>clearance</i>	255
O.2	Guideline for determination of <i>creepage distance</i>	256
O.3	Minimum <i>clearance</i> and <i>creepage distances</i> for material	257
Annex P (normative)	Protection of persons against electromagnetic fields for frequencies from 0 Hz up to 300 GHz	258
P.1	General influence of electromagnetic fields to persons.....	258
P.1.1	General	258
P.1.2	Low-frequency electric field effects (1 Hz to 100 kHz).....	258
P.1.3	Low-frequency magnetic field effects (1 Hz to 100 kHz).....	258
P.1.4	Low-frequency electric and magnetic field effects	258
P.1.5	High-frequency electromagnetic field effects (100 kHz to 300 GHz)	258
P.1.6	Current knowledge on low-level effects.....	259
P.1.7	Biological effects versus adverse health effects	259
P.1.8	Influence of EMF on passive and active medical implants	259
P.2	Recommendations from ICNIRP Guidelines against exposure to EMF	259
P.2.1	Adoption of exposure limits from ICNIRP	259
P.2.2	Limits of EMF exposure for transportation and storage	261
P.3	Protection of persons against exposure of EMF	261
P.3.1	General	261
P.3.2	EMF requirements for general public access areas.....	262
P.3.3	EMF requirements for <i>general-access areas</i> , <i>service-access areas</i> and <i>restricted-access areas</i>	262
P.3.4	EMF requirements for transportation and storage	262
P.4	Electromagnetic fields (EMF) test (<i>type test</i>).....	263
P.4.1	General test set up for EMF	263
P.4.2	EMF test.....	263
P.5	Electromagnetic fields (EMF) marking	263
Annex Q (informative)	Automatic disconnection of supply	264
Q.1	Maximum disconnection times	264
Q.2	Supplementary <i>protective equipotential bonding</i>	265
Annex R (informative)	Risk assessment according to IEC Guide 116	266
R.1	General.....	266
R.2	Risk assessment.....	266
Annex S (informative)	In-some-country requirements – United States of America voltages less than 1,5 kV AC or DC	268
S.0	General.....	268
S.1	Scope	268

S.2	Normative references.....	268
S.3	Terms and definitions.....	268
S.4	Protection against hazards.....	269
S.4.1	General	269
S.4.2	<i>Single-fault conditions</i> and <i>abnormal operating condition</i>	269
S.4.3	Short-circuit and overload protection	269
S.4.4	Protection against electric shock	271
S.4.5	Protection against electrical energy hazards.....	281
S.4.6	Protection against fire and thermal hazards.....	281
S.4.7	Protection against mechanical hazards.....	282
S.4.8	<i>BDM/CDM/PDS</i> with multiple sources of supply	284
S.4.9	Protection against environmental stresses.....	284
S.4.10	Protection against excessive acoustic noise hazards	284
S.4.11	Wiring and connections	284
S.4.12	Mechanical requirements for <i>enclosures</i>	294
S.4.200	Auxiliary device	306
S.4.201	<i>Accessories</i>	306
S.4.202	Provisions for mounting	306
S.4.203	Capacitors	306
S.5	Test requirements.....	307
S.5.1	General	307
S.5.2	Test specifications	308
S.6	Information and marking requirements	328
S.6.1	General	328
S.6.2	Information for selection	328
S.6.3	Information for installation and commissioning.....	329
S.6.4	Information for intended use	333
S.6.5	Supplementary information	333
S.200	Evaluation of clearance and <i>creepage distances</i>	334
S.200.1	<i>Clearance</i> and <i>creepage distances</i>	335
S.201	Normative references and component standards.....	337
S.202	IEC to USA standard references	340
S.203	Isolated secondary circuits and circuits supplied by battery	343
S.203.1	Isolated secondary circuits	343
S.203.2	Secondary circuits test	349
S.203.3	Circuits supplied by a battery.....	351
S.204	Full-load motor-running currents	351
Annex T (informative)	In-some-country requirements – Canada voltages up to 34,5 kV.....	354
T.0	General.....	354
T.1	Scope	354
T.2	Normative references.....	354
T.3	Terms and definitions.....	356
T.4	Protection against hazards.....	357
T.4.1	General	357
T.4.2	<i>Single-fault conditions</i> and <i>abnormal operating condition</i>	357
T.4.3	Short-circuit and overload protection	357
T.4.4	Protection against electric shock	358
T.4.5	Protection against electrical energy hazards.....	367
T.4.6	Protection against fire and thermal hazards	368

T.4.7	Protection against mechanical hazards	369
T.4.8	<i>BDM/CDM/PDS</i> with multiple sources of supply	369
T.4.9	Protection against environmental stresses	369
T.4.10	Protection against excessive acoustic noise hazards	369
T.4.11	Wiring and connections	369
T.4.12	Mechanical requirements for <i>enclosures</i>	382
T.4.13	<i>Components</i>	386
T.4.14	Protection against electromagnetic fields	391
T.5	Test requirements	391
T.5.1	General	391
T.5.2	Test specifications	391
T.6	Information and marking requirements	416
T.6.1	General	416
T.6.2	Information for selection	418
T.6.3	Information for installation and commissioning	419
T.6.4	Information for intended use	421
T.6.5	Supplementary information	423
T.200	IEC normative references replaced by CSA standards	423
	Bibliography	426
	Figure 1 – <i>PDS</i> hardware configuration within an <i>installation</i>	35
	Figure 2 – Time-voltage zones for <i>DVC A</i> s and <i>DVC B</i> circuits – DC	50
	Figure 3 – Time-voltage zones for <i>DVC A</i> s and <i>DVC B</i> circuits – AC peak	51
	Figure 4 – Time-voltage zones for conductive <i>accessible parts</i>	52
	Figure 5 – Example of a <i>protective class I BDM/CDM</i> arrangement and its associated <i>protective equipotential bonding</i>	58
	Figure 6 – Example of a <i>protective class I BDM/CDM</i> arrangement and its associated <i>protective equipotential bonding</i> through direct metallic contact	59
	Figure 7 – Example for interconnections within <i>BDM/CDM</i> and between parts of the <i>PDS</i>	106
	Figure 8 – Example for interconnections between parts of the <i>PDS</i> (<i>BDM/CDM</i> parts separated by field wiring)	107
	Figure 9 – Example arrangement of insulated conductors in a cable	108
	Figure 10 – Detachable <i>mains supply</i> cords and connections	112
	Figure 11 – Wire bending space	116
	Figure 12 – Supported and unsupported <i>enclosure</i> parts	119
	Figure 13 – Impact test using a steel ball	135
	Figure 14 – Voltage test procedures	146
	Figure 15 – Partial discharge test procedure	148
	Figure 16 – Electric strength test instrument	154
	Figure 17 – Mandrel	155
	Figure 18 – Initial position of mandrel	155
	Figure 19 – Final position of mandrel	155
	Figure 20 – Position of metal foil on insulating material	156
	Figure 21 – <i>Protective equipotential bonding</i> test set up	160
	Figure 22 – Example of short-circuit test between <i>BDM/CDM</i> motor power <i>port</i> and <i>protective earth</i> (motor separately earthed)	162

Figure 23 – Example of short-circuit test between <i>BDM/CDM</i> motor power <i>port</i> and <i>protective earth</i> (motor earthed through <i>BDM/CDM</i>).....	162
Figure 24 – Example of short-circuit test between <i>BDM/CDM</i> DC link power <i>port</i> and <i>protective earth</i>	163
Figure 25 – Interpolated values for Table 37	165
Figure 26 – Circuit for high-current arcing test	171
Figure 27 – Test fixture for hot-wire ignition test	172
Figure A.1 – Protection by <i>DVC</i> As with <i>enhanced protection</i>	202
Figure A.2 – Protection by means of <i>protective impedance</i>	203
Figure A.3 – Protection by using limited voltages	204
Figure A.4 – Typical waveform for AC <i>working voltage</i>	205
Figure A.5 – Typical waveform for DC <i>working voltage</i>	206
Figure A.6 – Typical waveform for pulsating <i>working voltage</i>	207
Figure A.7 – Protective measures according to 4.4.1 to 4.4.5 for protection against electric shock considering <i>protective class I</i> and <i>protective class II BDM/CDM/PDS</i>	209
Figure A.8 – Protective measures according to 4.4.1 to 4.4.5 for protection against electric shock considering <i>protective class III BDM/CDM/PDS</i> and <i>DVC</i> As circuits	210
Figure D.1 – Example of measurements including a groove	220
Figure D.2 – Example of measurements including a groove	220
Figure D.3 – Example of measurements including a groove	220
Figure D.4 – Example of measurements including a rib.....	220
Figure D.5 – Example of measurements providing protection of type 2.....	221
Figure D.6 – Example of measurements providing protection of type 1.....	221
Figure D.7 – Example of measurements providing protection of type 1.....	221
Figure D.8 – Example of measurements providing protection of type 1.....	222
Figure D.9 – Example of measurements including a barrier (cemented joint).....	222
Figure D.10 – Example of measurements including a barrier.....	222
Figure D.11 – Example of measurements including a gap	223
Figure D.12 – Example of measurements including a gap	223
Figure D.13 – Example of measurements including an floating conductive part.....	224
Figure D.14 – Example of measurements in inner layer of PWB.....	224
Figure D.15 – Example of measurements in an <i>enclosure</i> of insulating material.....	225
Figure F.1 – Diagram for dimensioning of <i>clearances</i> above 30 kHz	229
Figure F.2 – Diagram for dimensioning of <i>creepage distances</i> above 30 kHz	231
Figure F.3 – Permissible field strength for dimensioning of <i>solid insulation</i> according to Formula (F.1).....	233
Figure H.1 – Flow chart leading to selection of the RCD type upstream of a <i>PDS</i>	235
Figure H.2 – Symbols for marking depending on the type of RCD	236
Figure H.3 – Fault current waveforms in connections with <i>BDM/CDM/PDS</i>	239
Figure I.1 – <i>Basic protection</i> evaluation for circuits connected to the origin of the <i>installation mains supply</i>	240
Figure I.2 – <i>Basic protection</i> evaluation for circuits connected to the <i>mains supply</i>	241
Figure I.3 – <i>Basic protection</i> evaluation for single and three phase <i>BDM/CDM/PDS</i> not <i>permanently connected</i> to the <i>mains supply</i>	241
Figure I.4 – <i>Basic protection</i> evaluation for circuits connected to the origin of the <i>installation mains supply</i> where internal SPDs are used.....	241

Figure I.5 – <i>Basic protection</i> evaluation for circuits connected to the <i>mains supply</i> where internal SPDs are used.....	242
Figure I.6 – Example of <i>enhanced protection</i> evaluation for circuits connected to the <i>mains supply</i> where internal SPDs are used	242
Figure I.7 – Example of <i>enhanced protection</i> evaluation for circuits connected to the <i>mains supply</i> where internal SPDs are used	242
Figure I.8 – Example of <i>enhanced protection</i> evaluation for circuits connected to the <i>mains supply</i> where internal SPDs are used	243
Figure I.9 – <i>Basic protection</i> evaluation for circuits connected to the <i>non-mains supply</i>	243
Figure I.10 – <i>Basic protection</i> evaluation for circuits connected to the origin of the <i>installation non-mains supply</i>	243
Figure I.11 – <i>Functional insulation</i> evaluation within circuits affected by external transients.....	244
Figure I.12 – <i>Basic protection</i> evaluation for circuits connected to the <i>mains supply</i> and a non-mains circuit	244
Figure I.13 – <i>Insulation</i> evaluation for <i>accessible circuit</i> of <i>DVC As</i>	245
Figure J.1 – Burn threshold spread when the skin is in contact with a hot smooth surface made of bare (uncoated) metal.....	246
Figure J.2 – Rise in the burn threshold spread from Figure J.1 for metals which are coated by shellac varnish of a thickness of 50 µm, 100 µm and 150 µm.....	247
Figure J.3 – Rise in the burn threshold spread from Figure J.1 for metals coated with the specific materials	247
Figure J.4 – Burn threshold spread when the skin is in contact with a hot smooth surface made of ceramics, glass and stone materials	248
Figure J.5 – Burn threshold spread when the skin is in contact with a hot smooth surface made of plastics	248
Figure L.1 – Measuring test circuit	250
Figure M.1 – Sphere 50 mm probe according to IEC 61032:1997, test probe A	251
Figure M.2 – Jointed test finger according to IEC 61032:1997, test probe B.....	252
Figure M.3 – Test rod 2,5 mm according to IEC 61032:1997, test probe C	253
Figure M.4 – Sphere 12,5 mm test probe according to IEC 61032:1997, test probe 2.....	253
Figure O.1 – Flowchart <i>clearance</i>	255
Figure O.2 – Flowchart <i>creepage distance</i>	256
Figure S.1 – Articulate probe with web stop	298
Figure S.2 – Determination of current for circuits of 10 000 A and less	318
Figure S.3 – Peak let-through current	322
Figure S.4 – Application of Simpson's rule to fuse current oscillogram to obtain let-through I^2t	323
Figure S.5 – Clamped joint.....	334
Figure T.1 – Routing conductors through a metal barrier.....	376
Figure T.2 – Wire bending space	381
Figure T.3 – Test circuit using Formula T.1	400
Figure T.4 – Test circuit using Formula T.2	401
Figure T.5 – Test circuit using Formula T.3.....	401
Figure T.6 – Test circuit using Formula T.4	402
Figure T.7 – Typical test set sensitivity	403
Figure T.8 – Determination of current and power factor for circuits of 10 000 A and less.....	412

Table 1 – Alphabetical list of terms	25
Table 2 – Voltage limits for the <i>decisive voltage classes</i>	49
Table 3 – Protection requirements for circuits under consideration	53
Table 4 – <i>PE conductor</i> cross-section	60
Table 5 – Definitions of pollution degrees	68
Table 6 – <i>Impulse withstand voltage</i> and <i>temporary overvoltage</i> versus <i>system voltage</i> for <i>low-voltage</i> circuits	71
Table 7 – <i>Impulse withstand voltage</i> and <i>temporary overvoltage</i> versus <i>system voltage</i> for high-voltage circuits	71
Table 8 – <i>Clearance</i> for <i>functional insulation</i> , <i>basic insulation</i> or <i>supplementary insulation</i>	76
Table 9 – Insulating materials classification	79
Table 10 – <i>Creepage distances</i>	80
Table 11 – <i>Insulation</i> material requirements	83
Table 12 – Distance to uninsulated <i>live parts</i> for consideration of HWI, HAI and CTI	83
Table 13 – Generic materials for <i>insulation</i> material	84
Table 14 – Requirements based on thin sheet material thickness	85
Table 15 – Limits for power sources without an <i>overcurrent</i> protective device	93
Table 16 – Limits for power sources with an <i>overcurrent</i> protective device	93
Table 17 – Maximum measured temperatures for internal materials and <i>components</i>	96
Table 18 – Maximum measured temperatures for <i>accessible parts</i> of <i>BDM/CDM/PDS</i>	98
Table 19 – Minimum tubing wall thickness	100
Table 20 – Environmental service conditions	104
Table 21 – Wire bending space from terminals to <i>enclosure</i>	115
Table 22 – Thickness of sheet metal for <i>enclosures</i> : carbon steel or stainless steel	120
Table 23 – Thickness of sheet metal for <i>enclosures</i> : aluminium, copper or brass	121
Table 24 – Environmental conditions for tests	126
Table 25 – Test overview	127
Table 26 – Pull values for handles and manual control securement	136
Table 27 – Values for physical tests on strain relief of <i>enclosure</i>	137
Table 28 – <i>Impulse withstand voltage</i> test	139
Table 29 – <i>Impulse withstand voltage</i> test voltage for <i>low-voltage BDM/CDM/PDS</i>	140
Table 30 – <i>Impulse withstand voltage</i> test voltage for <i>high-voltage BDM/CDM/PDS</i>	141
Table 31 – AC or DC test voltage for circuits connected directly to <i>low-voltage mains supply</i>	143
Table 32 – AC or DC test voltage for circuits connected directly to <i>high-voltage mains supply</i>	143
Table 33 – AC or DC test voltage for circuits connected to <i>non-mains supply</i> without <i>temporary overvoltages</i>	144
Table 34 – Parameter for <i>BDM/CDM/PDS</i> AC or DC voltage test	147
Table 35 – Partial discharge test	148
Table 36 – <i>Prospective short-circuit current</i> for test vs <i>BDM/CDM</i> rated input current	158
Table 37 – Maximum tripping time for <i>electronic motor overload protection</i> test	164
Table 38 – Environmental tests	175

Table 39 – Preconditioning or recovery procedure for climatic tests (<i>type test</i>)	176
Table 40 – Dry heat test (steady state) (<i>type test</i>)	176
Table 41 – Cold test (<i>type test</i>)	177
Table 42 – Damp heat test (steady state) (<i>type test</i>)	177
Table 43 – Damp heat test (cyclic) (<i>type test</i>)	178
Table 44 – Vibration test	179
Table 45 – Salt mist test	179
Table 46 – Dust test	180
Table 47 – Sand test	180
Table 48 – Marking location	182
Table A.1 – Configurations for protection against electric shock	212
Table C.1 – Symbols used	216
Table D.1 – Width of grooves by pollution degree	219
Table E.1 – Correction factor for <i>clearances</i> at altitudes between 2 000 m and 20 000 m	226
Table E.2 – Test voltages for verifying <i>clearances</i> at different altitudes	227
Table F.1 – Minimum values of <i>clearances</i> in air at atmospheric pressure for inhomogeneous field conditions	230
Table F.2 – Multiplication factors for <i>clearances</i> in air at atmospheric pressure for approximately homogeneous field conditions	230
Table F.3 – Minimum values of <i>creepage distances</i> for different frequency ranges	232
Table G.1 – Standard cross-sections of round conductors	234
Table K.1 – Table of electrochemical potentials	249
Table O.1 – Minimum <i>clearance</i> and <i>creepage distances</i> for material	257
Table P.1 – Limits of EMF for general public exposure	260
Table P.2 – Limits of EMF for occupational exposure	261
Table P.3 – Limits for magnetic flux density of static magnetic fields	261
Table P.4 – EMF test overview	263
Table 41.1 – Maximum disconnection times	264
Table R.1 – Risk assessment	266
Table S.1 – Size of bonding conductor	273
Table S.2 – Duration of current flow for bonding-conductor test	273
Table S.3 – Bonding conductor short-circuit test capacity	273
Table S.4 – Maximum rating of <i>overcurrent</i> device	275
Table S.5 – Dimensions of bushings	277
Table S.6 – <i>BDM/CDM/PDS</i> intended for installation in a feeder circuit	277
Table S.7 – <i>Generic materials for barriers</i>	279
Table S.8 – Tubing wall thickness	283
Table S.9 – Ampacity of flexible cord	286
Table S.10 – Ampacities of insulated conductors	289
Table S.11 – Wire bending space at the terminals of enclosed power conversion equipment	291
Table S.12 – <i>Overcurrent</i> protective device	292
Table S.13 – Branch-circuit <i>short-circuit protective device</i>	293

Table S.14 – Openings in <i>enclosures</i>	299
Table S.15 – Addition to Table 3 of UL 50:2015: Thickness of sheet metal for <i>enclosures</i> – Carbon steel or stainless steel	301
Table S.16 – Addition to Table 4 of UL 50:2015: Thickness of sheet metal for <i>enclosures</i> – Aluminum, copper or brass	301
Table S.17 – Dimensions of knockout	304
Table S.18 – Values of voltage for tests	307
Table S.19 – AC or DC voltage test voltages	310
Table S.20 – Width of copper bus bars	311
Table S.21 – Production-line test conditions	312
Table S.22 – Power factor of test circuits for devices rated 600 V or less	326
Table S.23 – Minimum <i>clearances</i> and <i>creepage distances</i> at <i>field wiring terminals</i> up to 600 V	335
Table S.24 – Minimum <i>clearances</i> and <i>creepage distances</i> for <i>field wiring terminals</i> over 600 V	336
Table S.25 – <i>Clearances</i> and <i>creepage distances</i> at <i>field wiring terminals</i> for pollution degree 2 environments	337
Table S.26 – IEC normative reference standards that do not apply	341
Table S.27 – IEC normative references replaced by USA standards	342
Table S.28 – Secondary circuits, differences in evaluation	344
Table S.29 – Full-load motor-running currents in amperes corresponding to various AC horsepower ratings	352
Table S.30 – Full-load motor-running currents in amperes corresponding to various DC horsepower ratings	353
Table T.1 – Size and number of bonding conductors per termination	359
Table T.2 – Size of bonding conductor	359
Table T.3 – Minimum <i>clearance</i> and <i>creepage distances</i> on <i>field wiring terminals</i>	361
Table T.4 – Dimensions of bushings	362
Table T.5 – Test voltages for verifying <i>clearances</i>	365
Table T.6 – Test voltages for verifying <i>clearances</i> using AC RMS	365
Table T.7 – Generic material acceptable as a barrier	366
Table T.8 – Allowable ampacities of insulated copper conductors inside industrial control equipment <i>enclosures</i> (based on a <i>ambient temperature</i> of 40 °C)	370
Table T.9 – Ampacity correction factors for multiple conductor groupings	370
Table T.10 – Wiring space	371
Table T.11 – Wire-bending space	372
Table T.12 – Full-load motor-running currents in amperes corresponding to AC horsepower ratings	373
Table T.13 – Full-load motor-running currents in amperes corresponding to DC horsepower ratings	374
Table T.14 – Wire-bending space	376
Table T.15 – Test values for <i>BDM/CDM/PDS</i> wiring terminals	378
Table T.16 – Ampacity of conductors based on resistor duty cycle ratings	379
Table T.17 – Thickness of sheet metal for <i>enclosures</i> – Carbon steel or stainless steel	383
Table T.18 – Thickness of sheet metal for <i>enclosures</i> – Aluminum, copper, or brass	384
Table T.19 – Maximum acceptable rating of primary <i>overcurrent</i> device	388

Table T.20 – Minimum acceptable rating of secondary <i>overcurrent</i> device	388
Table T.21 – <i>Overcurrent</i> protective device – Copper conductors	389
Table T.22 – <i>High-Voltage BDM/CDM/PDS</i> dielectric strength test values, kV.....	391
Table T.23 – Tightening torque for testing conduit hubs of polymeric <i>enclosures</i>	394
Table T.24 – Bending moment	394
Table T.25 – Test circuit sensitivity formulas.....	400
Table T.26 – Ampacities of insulated conductors	405
Table T.27 – Size of copper busbar connections for temperature test	406
Table T.28 – Short-circuit test values.....	407
Table T.29 – Short-circuit power factor	411
Table T.30 – Translation of markings	416
Table T.31 – IEC normative references replaced by CSA standards.....	423

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –**Part 5-1: Safety requirements – Electrical, thermal and energy**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 61800-5-1 has been prepared by subcommittee 22G: Adjustable speed electric power drive systems (PDS), of IEC technical committee 22: Power electronic systems and equipment. It is an International Standard.

This third edition cancels and replaces the second edition published in 2007 and Amendment 1:2016. This edition constitutes a technical revision.

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

- a) harmonization with IEC 62477-1:2022;
- b) harmonization with UL 61800-5-1 and CSA C22.2 No. 274, including an annex with a list of national deviation which was considered not possible to harmonize within a reasonable timeframe;
- c) more detailed information about the evaluation of components according to this document and relevant safety component standards;
- d) updated requirement for mechanical hazards including multiple IP ratings.

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

Draft	Report on voting
22G/455/FDIS	22G/457/RVD

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

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

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

In this document, terms in *italic* are defined in Clause 3.

The reader's attention is drawn to the fact that

- Annex S and Annex T list all of the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this document.
- Due to the rules of ISO/IEC Directives, Part 2, the term "must" instead of the term "shall" is used in Annex S and Annex T.

A list of all parts of the IEC 61800 series, published under the general title *Adjustable speed electrical power drive systems*, is available on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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

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.

The contents of the corrigendum 1 (2023-09) have been included in this copy.

INTRODUCTION

0.1 General

This document contains the revision of IEC 61800-5-1:2007 and IEC 61800-5-1:2007/AMD1:2016.

Several important issues have influenced the scope and the chosen approach of the maintenance of IEC 61800-5-1:2007 in the development of this document.

The most significant changes compared to IEC 61800-5-1:2007 are the following.

a) Structure and content is based on IEC 62477-1 considering modifications and new topics such as the following

- Clause 1: Scope updated to include radio emitting/transmitting *BDM/CDM/PDS*.
- 4.1, 5.1, 6.1: "Intended use" included.
- 4.2: Single fault/abnormal operation analysis (significantly reworked).
- 4.3: Short-circuit and overload protection included as new subclause.
- 4.4 and Annex A: Protection against electric shock updated according to IEC 61140:2016 and IEC 60364-4-41, including insulation coordination according to IEC 60664 (all parts) considering the following:
 - 4.4.2 – Decisive voltage classification (especially DVC As for dry, wet and salt-water wet); Table 2 and Table 3 reworked;
 - 4.4.3 – Basic protection (reworked);
 - 4.4.4 – Fault protection (reworked);
 - 4.4.5 – Enhanced protection (reworked);
 - 4.4.7 – Insulation (reworked):
 - 4.4.7.1.2 – Working voltage (new);
 - 4.4.7.1.8 – Components bridging insulation (new);
 - 4.4.7.7 – *clearance* and *creepage distances* for functional insulation on PWB and component assemblies (reworked);
 - 4.4.7.8 – Solid insulation (new/reworked);
 - 4.4.7.9 – Connection of parts of solid insulation (cemented joints) (new);
 - 4.4.8/Annex H – Compatibility with RCD (reworked);
 - 4.4.10 – Access conditions for *high-voltage PDS* (new).
- 4.5: Protection against energy hazards (new).
- 4.6: Protection against fire and thermal hazards (new).
- 4.7: Protection against mechanical hazards (new).
- 4.8: *BDM/CDM/PDS* with multiple sources of supply (new).
- 4.9: Protection against environmental stresses (new) (in alignment with IEC 61800-2).
- 4.11: Wiring and connections updated (significantly reworked).
- 4.12: Enclosure updated (significantly reworked).
- 4.13 Bibliography: Evaluation of components (new).
- 4.14 Annex P: Protection against electromagnetic fields (new).
- Clause 5: Updated with some additional/modified test requirement:
 - 5.2.2.2 – Non-accessibility test (significantly reworked);
 - 5.2.2.3 – Ingress protection test (IP rating) (significantly reworked);

- 5.2.2.4 – Enclosure integrity tests (new);
- 5.2.2.5 – Wall or ceiling mounted *BDM/CDM/PDS* test (new);
- 5.2.2.6 – Handles and manual control securement test (new);
- 5.2.2.7 – Strain relief test (new);
- 5.2.3.7 – Touch current measurement test (reworked);
- 5.2.3.9 – Limited power source (new);
- 5.2.3.11 – Protective equipotential bonding test (new);
- 5.2.3.12 – Input test (new);
- 5.2.3.13 – Thin sheet material test (new);
- 5.2.3.14 – Test procedure for determination of working voltage (new);
- 5.2.3.16 – Preconditioning of material (reworked);
- 5.2.4.4 – Protective equipotential bonding short-circuit test (new);
- 5.2.4.9 – Output overload test (new);
- 5.2.4.13.5 – Covering of openings for cooling air test (type test) (new);
- 5.2.5.6 – Cemented joints test (new);
- 5.2.7 – Hydrostatic pressure test (new);
- 5.2.8 – Electromagnetic fields (EMF) test (new).
- Clause 6: – Update with more specific marking.
 - Structure aligned with IEC 62477-1 as close as possible;
 - Table 48 simplified.
- Annex A – Additional information for protection against electric shock (reworked).
- Annex C – Symbols referred (reworked).
- Annex E – Altitude correction for *clearances* (reworked).
- Annex F – *Clearance* and *creepage distance* determination for frequencies greater than 30 kHz (reworked).
- Annex H – Guidelines for RCD compatibility (reworked).
- Annex M – Test probes for determining access (new).
- Annex O – Guidance for determination of *clearance* and *creepage distance* (new).
- Annex P – Protection of persons against electromagnetic fields for frequencies from 0 Hz up to 300 GHz (new).
- Annex Q – Automatic disconnection of supply (new).
- Annex R – Guide 116 risk evaluation included (new).
- Bibliography – Relevant component safety standards (new).

b) Harmonization with UL 61800-5-1

Complete document is modified taken into consideration UL 61800-5-1 US National deviations. US National deviations from UL 61800-5-1 not possible to harmonize have been placed in Annex S.

c) Harmonization with CSA C22.2 No. 274

- Due to a short time frame, only some few topics have been harmonized.
- Canadian National deviations from CSA C22.2 No. 274 not possible to harmonize have been placed in Annex T.

d) Harmonization with UL 347A

- Some few relevant topics have been harmonized considering safety aspects related to *high-voltage BDM/CDM/PDS*.

Further harmonization is expected to be adopted in IEC 61800-5-1 considering the content of UL 61800-5-1, CSA C22.2 No 274 and UL 347A in future editions of IEC 61800-5-1.

0.2 Feedback from industry and national committees

The use of IEC 61800-5-1:2007 by manufacturers and test institutes since its release has identified several topics which are considered useful to implement, or topics which need further information for a better understanding of the intent of the specific requirement. These topics are also implemented in this document.

0.3 Requirement covered by other relevant parts of the IEC 61800 series

- general requirements for DC *power drive systems* are covered in IEC 61800-1;
- general requirements for AC *power drive systems* are covered in IEC 61800-2;
- EMC aspects are covered in IEC 61800-3;
- functional safety aspects are covered in IEC 61800-5-2;
- functional safety aspects for encoders are covered in IEC 61800-5-3;
- type of load duty aspects are covered in IEC TR 61800-6;
- communication profiles aspects are covered in IEC 61800-7 (all parts);
- *power interface* voltage aspects are covered in IEC TS 61800-8;
- ecodesign aspects are covered in IEC 61800-9 (all parts);

The following document is not part of the IEC 61800 series, but is used often as part of the BDM:

- active infeed converters in IEC TS 62578.

ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –

Part 5-1: Safety requirements – Electrical, thermal and energy

1 Scope

This part of IEC 61800 specifies requirements for adjustable speed electrical *power drive systems (PDS)* or their elements, with respect to electrical, thermal, fire, mechanical, energy and other relevant hazards. It does not cover the driven equipment except for interface requirements. It applies to adjustable speed electrical *PDS* which include the power conversion, *basic drive module (BDM)/complete drive module (CDM)* control, and a motor or motors.

Excluded are traction and electric vehicle *BDM/CDM*.

It applies to low-voltage adjustable speed electrical *PDS* intended to feed a motor or motors from a *BDM/CDM* connected to phase-to-phase voltages of up to and including 1,0 kV AC (50 Hz or 60 Hz) and up to and including 1,5 kV DC.

It also applies to high-voltage adjustable speed electrical *PDS* intended to feed a motor or motors from a *BDM/CDM* connected to phase-to-phase voltages of up to and including 35 kV AC (50 Hz or 60 Hz) and up to and including 52 kV DC.

NOTE 1 At the time of publication of this document, the technical upper voltage limit for DC motors is 2,25 kV DC.

NOTE 2 Above voltage and frequency limits reflect the scope of IEC 61800-1 and IEC 61800-2.

NOTE 3 For adjustable speed electrical *PDS* not covered by the scope of this document, applicable requirements of other standards, for example IEC 62477-1 and IEC 62477-2, can be used.

This document also applies to *PDS* which intentionally emit or receive radio waves for the purpose of radio communication.

Motors for driven equipment (see Figure 1) are covered by IEC 60034 (all parts).

NOTE 4 In some cases, safety requirements of the *PDS* (for example, protection against access to hazardous parts) can necessitate the use of special components and/or additional measures.

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 60034 (all parts), *Rotating electrical machines*

IEC 60034-1:2022, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-5:2020, *Rotating electrical machines – Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) – Classification*

IEC 60050-112, *International Electrotechnical Vocabulary (IEV) – Part 112: Quantities and units* (available at www.electropedia.org)

IEC 60050-113, *International Electrotechnical Vocabulary (IEV) – Part 113: Physics for electrotechnology* (available at www.electropedia.org)

IEC 60050-114, *International Electrotechnical Vocabulary (IEV) – Part 114: Electrochemistry* (available at www.electropedia.org)

IEC 60050-131, *International Electrotechnical Vocabulary (IEV) – Part 131: Circuit theory* (available at www.electropedia.org)

IEC 60050-151, *International Electrotechnical Vocabulary (IEV) – Part 151: Electrical and magnetic devices* (available at www.electropedia.org)

IEC 60050-161, *International Electrotechnical Vocabulary (IEV) – Part 161: Electromagnetic compatibility* (available at www.electropedia.org)

IEC 60050-192, *International Electrotechnical Vocabulary (IEV) – Part 192: Dependability* (available at www.electropedia.org)

IEC 60050-426, *International Electrotechnical Vocabulary (IEV) – Part 426: Explosive atmospheres* (available at www.electropedia.org)

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

IEC 60050-442, *International Electrotechnical Vocabulary (IEV) – Part 442: Electrical accessories* (available at www.electropedia.org)

IEC 60050-551, *International Electrotechnical Vocabulary (IEV) – Part 551: Power electronics* (available at www.electropedia.org)

IEC 60050-601, *International Electrotechnical Vocabulary (IEV) – Part 601: Generation, transmission and distribution of electricity – General* (available at www.electropedia.org)

IEC 60050-826, *International Electrotechnical Vocabulary (IEV) – Part 826: Electrical installations* (available at www.electropedia.org)

IEC 60050-903, *International Electrotechnical Vocabulary (IEV) – Part 903: Risk assessment* (available at www.electropedia.org)

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

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

IEC 60068-2-68:1994, *Environmental testing – Part 2-68: Tests – Test L: Dust and sand*

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

IEC 60204-11:2018, *Safety of machinery – Electrical equipment of machines – Part 11: Requirements for equipment for voltages above 1 000 V AC or 1 500 V DC and not exceeding 36 kV*

IEC 60320 (all parts), *Appliance couplers for household and similar general purposes*

IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*
IEC 60364-4-41:2005/AMD1:2017

IEC 60364-5-54:2011, *Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*
IEC 60364-5-54:2011/AMD1:2021

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

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 60664-1:2020, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60664-3:2016, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution*

IEC 60664-4:2005, *Insulation coordination for equipment within low-voltage systems – Part 4: Consideration of high-frequency voltage stress*

IEC 60695-2-10:2021, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC 60695-2-11:2021, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

IEC 60695-2-13:2021, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials*

IEC 60695-10-2:2014, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test method*

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

IEC 60695-11-20:2015, *Fire hazard testing – Part 11-20: Test flames – 500 W flame test method*

IEC 60721-3-3:1994, *Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weatherprotected locations*¹

IEC 60721-3-3:1994/AMD1:1995

IEC 60721-3-3:1994/AMD2:1996

IEC 60721-3-4:2019, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Stationary use at non-weatherprotected locations*

IEC 60730-1:2013, *Automatic electrical controls – Part 1: General requirements*

IEC 60730-1:2013/AMD1:2015

IEC 60730-1:2013/AMD2:2020

IEC 60755:2017, *General safety requirements for residual current operated protective devices*

IEC 60799:2018, *Electrical accessories – Cord sets and interconnection cord sets*

IEC 60947-4-1:2018, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

IEC 60990:2016, *Methods of measurement of touch current and protective conductor current*

IEC 61032:1997, *Protection of persons and equipment by enclosures – Probes for verification*

IEC 61084 (all parts), *Cable trunking systems and cable ducting systems for electrical installations*

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

IEC 61189-3:2007, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 3: Test methods for interconnection structures (printed boards)*

IEC 61230:2008, *Live working – Portable equipment for earthing or earthing and short-circuiting*

IEC 61386 (all parts), *Conduit systems for cable management*

IEC 61558-1:2017, *Safety of power transformers, reactors, power supply units and combinations thereof – Part 1: General requirements and tests*

IEC 62109-1:2010, *Safety of power converters for use in photovoltaic power systems – Part 1: General requirements*

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

IEC 62477-1:2022, *Safety requirements for power electronic converter systems and equipment – Part 1: General*

¹ This publication has been withdrawn.

IEC 62477-2:2018, *Safety requirements for power electronic converter systems and equipment – Part 2: Power electronic converters from 1 000 V AC or 1 500 V DC up to 36 kV AC or 54 kV DC*

ISO 3864-1:2011, *Graphical symbols – Safety colours and safety signs – Part 1: Design principles for safety signs and safety markings*

ISO 3746:2010, *Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane*

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

ISO 7010, *Graphical symbols – Safety colours and safety signs – Registered safety signs* (available at <https://www.iso.org/obp>)

ISO 9614-1:1993, *Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 1: Measurement at discrete points*