

**Jõupooljuht-muundussüsteemide ja -muundusseadmete
ohutusnõuded. Osa 1: Üldnõuded**

**Safety requirements for power electronic converter
systems and equipment - Part 1: General**

EESTI STANDARDI EESSÕNA	NATIONAL FOREWORD
See Eesti standard EVS-EN 62477-1:2012 sisaldab Euroopa standardi EN 62477-1:2012 ingliskeelset teksti.	This Estonian standard EVS-EN 62477-1:2012 consists of the English text of the European standard EN 62477-1:2012.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 05.10.2012.	Date of Availability of the European standard is 05.10.2012.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

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

ICS 29.200

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:
Aru 10, 10317 Tallinn, Eesti; www.evs.ee; telefon 605 5050; e-post info@evs.ee

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

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.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:
Aru 10, 10317 Tallinn, Estonia; www.evs.ee; phone 605 5050; e-mail info@evs.ee

**Safety requirements for power electronic converter systems
and equipment -
Part 1: General
(IEC 62477-1:2012)**

Exigences de sécurité applicables
aux systèmes et matériels électroniques
de conversion de puissance -
Partie 1: Généralités
(CEI 62477-1:2012)

Sicherheitsanforderungen an
Leistungshalbleiter-Umrichtersysteme
und -betriebsmittel -
Teil 1: Allgemeines
(IEC 62477-1:2012)

This European Standard was approved by CENELEC on 2012-08-28. 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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

CENELEC

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

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 22/200/FDIS, future edition 1 of IEC 62477-1, prepared by IEC/TC 22 "Power electronic systems and equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62477-1:2012.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2013-05-28
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2015-08-28

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

Endorsement notice

The text of the International Standard IEC 62477-1:2012 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 60073:2002	NOTE	Harmonised as EN 60073:2002 (not modified).
IEC 60085	NOTE	Harmonised as EN 60085.
IEC 60216 Series	NOTE	Harmonised as EN 60216 Series (not modified).
IEC 60309-1	NOTE	Harmonised as EN 60309-1.
IEC 60664-5:2007	NOTE	Harmonised as EN 60664-5:2007 (not modified).
IEC 60695-11-5	NOTE	Harmonised as EN 60695-11-5.
IEC 60721 Series	NOTE	Harmonised as EN 60721 Series (not modified).
IEC 60947-7-1	NOTE	Harmonised as EN 60947-7-1.
IEC 60947-7-2	NOTE	Harmonised as EN 60947-7-2.
IEC 60950-1	NOTE	Harmonised as EN 60950-1.
IEC 61008 Series	NOTE	Harmonised as EN 61008 Series (partly modified).
IEC 61009 Series	NOTE	Harmonised as EN 61009 Series (partly modified).
IEC 61082-1	NOTE	Harmonised as EN 61082-1.
IEC 61140:2001	NOTE	Harmonised as EN 61140:2002 (not modified).
IEC 61508 Series	NOTE	Harmonised as EN 61508 Series (not modified).
IEC 61558-1	NOTE	Harmonised as EN 61558-1.
IEC 61558-2-16	NOTE	Harmonised as EN 61558-2-16.
IEC 61643-12	NOTE	Harmonised as CLC/TS 61643-12.
IEC 62079:2001	NOTE	Harmonised as EN 62079:2001 (not modified).
IEC 62423:2009	NOTE	Harmonised as EN 62423:2012 (modified).

CONTENTS

FOREWORD.....	8
INTRODUCTION.....	10
1 Scope.....	11
2 Normative references.....	12
3 Terms and definitions	14
4 Protection against hazards.....	23
4.1 General.....	23
4.2 Fault and abnormal conditions	24
4.3 Short circuit and overload protection	25
4.3.1 General	25
4.3.2 Specification of input short-circuit withstand strength and output short circuit current ability.....	26
4.3.3 Short-circuit coordination (backup protection).....	27
4.3.4 Protection by several devices	27
4.4 Protection against electric shock.....	27
4.4.1 General	27
4.4.2 <i>Decisive voltage class</i>	27
4.4.3 Provision for <i>basic protection</i>	32
4.4.4 Provision for <i>fault protection</i>	34
4.4.5 <i>Enhanced protection</i>	40
4.4.6 Protective measures	41
4.4.7 Insulation.....	43
4.4.8 Compatibility with residual current-operated protective devices (RCD).....	58
4.4.9 Capacitor discharge	58
4.5 Protection against electrical energy hazards.....	59
4.5.1 Operator access areas.....	59
4.5.2 Service access areas.....	60
4.6 Protection against fire and thermal hazards.....	60
4.6.1 Circuits representing a fire hazard.....	60
4.6.2 Components representing a fire hazard	60
4.6.3 <i>Fire enclosures</i>	61
4.6.4 Temperature limits	65
4.6.5 Limited power sources	68
4.7 Protection against mechanical hazards	69
4.7.1 General	69
4.7.2 Specific requirements for liquid cooled <i>PECS</i>	70
4.8 Equipment with multiple sources of supply	71
4.9 Protection against environmental stresses	72
4.10 Protection against sonic pressure hazards	73
4.10.1 General	73
4.10.2 Sonic pressure and sound level.....	73
4.11 Wiring and connections	73
4.11.1 General	73
4.11.2 Routing.....	73
4.11.3 Colour coding	73
4.11.4 Splices and connections	74

4.11.5	Accessible connections	74
4.11.6	Interconnections between parts of the <i>PECS</i>	74
4.11.7	Supply connections	75
4.11.8	Terminals	75
4.12	<i>Enclosures</i>	76
4.12.1	General	76
4.12.2	Handles and manual controls	76
4.12.3	Cast metal	77
4.12.4	Sheet metal	77
4.12.5	Stability test for <i>enclosure</i>	80
5	Test requirements	81
5.1	General	81
5.1.1	Test objectives and classification	81
5.1.2	Selection of test samples	81
5.1.3	Sequence of tests	81
5.1.4	Earthing conditions	81
5.1.5	General conditions for tests	81
5.1.6	Compliance	82
5.1.7	Test overview	83
5.2	Test specifications	84
5.2.1	Visual inspections (<i>type test</i> , <i>sample test</i> and <i>routine test</i>)	84
5.2.2	Mechanical tests	84
5.2.3	Electrical tests	88
5.2.4	Abnormal operation and simulated faults tests	102
5.2.5	Material tests	106
5.2.6	Environmental tests (<i>type tests</i>)	110
5.2.7	Hydrostatic pressure test (<i>type test</i> and <i>routine test</i>)	115
6	Information and marking requirements	115
6.1	General	115
6.2	Information for selection	117
6.3	Information for installation and commissioning	118
6.3.1	General	118
6.3.2	Mechanical considerations	118
6.3.3	Environment	118
6.3.4	Handling and mounting	118
6.3.5	<i>Enclosure</i> temperature	118
6.3.6	Connections	119
6.3.7	Protection requirements	119
6.3.8	Commissioning	121
6.4	Information for use	121
6.4.1	General	121
6.4.2	Adjustment	121
6.4.3	Labels, signs and signals	121
6.5	Information for maintenance	123
6.5.1	General	123
6.5.2	Capacitor discharge	124
6.5.3	Auto restart/bypass connection	124
6.5.4	Other hazards	124
6.5.5	Equipment with multiple sources of supply	124

Annex A (normative) Additional information for protection against electric shock	125
Annex B (informative) Considerations for the reduction of the pollution degree.....	145
Annex C (informative) Symbols referred to in IEC 62477-1.....	146
Annex D (normative) Evaluation of clearance and creepage distances	147
Annex E (informative) Altitude correction for clearances	155
Annex F (normative) Clearance and creepage distance determination for frequencies greater than 30 kHz.....	156
Annex G (informative) Cross-sections of round conductors	162
Annex H (informative) Guidelines for RCD compatibility	163
Annex I (informative) Examples of overvoltage category reduction	167
Annex J (informative) Burn thresholds for touchable surfaces	174
Annex K (informative) Table of electrochemical potentials	177
Annex L (informative) Measuring instrument for <i>touch current</i> measurements	178
Annex M (informative) Test probes for determining access	179
Bibliography	182
Figure 1 – Touch time-d.c. peak voltage zones of <i>ventricular fibrillation</i> in dry skin condition	30
Figure 2 – Touch time- d.c. peak voltage zones of <i>ventricular fibrillation</i> in water-wet skin condition.....	31
Figure 3 – Touch time- d.c. peak voltage zones of <i>ventricular fibrillation</i> in saltwater-wet skin condition.....	31
Figure 4 – Example of a <i>PECS</i> assembly and its associated <i>protective equipotential bonding</i>	36
Figure 5 – Example of a <i>PECS</i> assembly and its associated <i>protective equipotential bonding</i>	37
Figure 6 – <i>Fire enclosure</i> bottom openings below an unenclosed or partially enclosed fire-hazardous component.....	63
Figure 7 – <i>Fire enclosure</i> baffle construction	64
Figure 8 – Supported and unsupported <i>enclosure</i> parts	78
Figure 9 – Impact test using a steel ball.....	86
Figure 10 – Voltage test procedures	93
Figure 11 – Protective equipotential bonding impedance test for separate unit with power fed from the <i>PECS</i> with protection for the power cable	99
Figure 12 – Protective equipotential bonding impedance test for sub-assembly with accessible parts and with power fed from the <i>PECS</i>	100
Figure 13 – Circuit for high-current arcing test.....	107
Figure 14 – Test fixture for hot-wire ignition test	108
Figure A.1 – Protection by <i>DVC As</i> with <i>protective separation</i>	125
Figure A.2 – Protection by means of <i>protective impedance</i>	126
Figure A.3 – Protection by using limited voltages	127
Figure A.4 – Touch time- d.c. voltage zones for dry skin condition	130
Figure A.5 – Touch time- d.c. voltage zones for water-wet skin condition	130
Figure A.6 – Touch time- d.c. voltage for saltwater-wet skin condition.....	131
Figure A.7 – Touch time- d.c. voltage zones of dry skin condition.....	132
Figure A.8 – Touch time- d.c. voltage zones of water-wet skin condition	132

Figure A.9 – Touch time- d.c. voltage zones of saltwater-wet skin condition	133
Figure A.10 – Touch time- d.c. voltage zones of dry skin condition	134
Figure A.11 – Touch time- d.c. voltage zones of water-wet skin condition.....	134
Figure A.12 – Touch time- a.c. voltage zones for dry skin condition	135
Figure A.13 – Touch time- a.c. voltage zones of water-wet skin condition.....	136
Figure A.14 – Touch time- a.c. voltage of saltwater-wet skin condition	136
Figure A.15 – Touch time- a.c. voltage zones of dry skin condition.....	137
Figure A.16 – Touch time- a.c. voltage zones of water-wet skin condition.....	138
Figure A.17 – Touch time- a.c. voltage zones of saltwater-wet skin condition	138
Figure A.18 – Touch time- a.c. voltage zones of dry skin condition.....	139
Figure A.19 – Touch time- a.c. voltage zones of water-wet skin condition.....	140
Figure A.20 – Typical waveform for a.c. <i>working voltage</i>	141
Figure A.21 – Typical waveform for d.c. <i>working voltage</i>	141
Figure A.22 – Typical waveform for pulsating <i>working voltage</i>	142
Figure F.1 – Diagram for dimensioning of clearances	157
Figure F.2 – Diagram for dimensioning of creepage distances	159
Figure F.3 – Permissible field strength for dimensioning of solid <i>insulation</i> according to Equation (1)	161
Figure H.1 – Flow chart leading to selection of the RCD type upstream of a <i>PECS</i>	163
Figure H.2 – Fault current waveforms in connections with power electronic converter devices	165
Figure I.1 – <i>Basic insulation</i> evaluation for circuits connected to the origin of the <i>installation mains supply</i>	167
Figure I.2 – <i>Basic insulation</i> evaluation for circuits connected to the <i>mains supply</i>	168
Figure I.3 – <i>Basic insulation</i> evaluation for single and three phase equipment not <i>permanently connected</i> to the <i>mains supply</i>	168
Figure I.4 – <i>Basic insulation</i> evaluation for circuits connected to the origin of the <i>installation mains supply</i> where internal <i>SPDs</i> are used	168
Figure I.5 – <i>Basic insulation</i> evaluation for circuits connected to the <i>mains supply</i> where internal <i>SPDs</i> are used	169
Figure I.6 – Example of <i>protective separation</i> evaluation for circuits connected to the <i>mains supply</i> where internal <i>SPDs</i> are used	169
Figure I.7 – Example of <i>protective separation</i> evaluation for circuits connected to the <i>mains supply</i> where internal <i>SPDs</i> are used	170
Figure I.8 – Example of <i>protective separation</i> evaluation for circuits connected to the <i>mains supply</i> where internal <i>SPDs</i> are used	170
Figure I.9 – <i>Basic insulation</i> evaluation for circuits not connected directly to the <i>mains supply</i>	170
Figure I.10 – <i>Basic insulation</i> evaluation for circuits not connected directly to the supply mains.....	171
Figure I.11 – Functional <i>insulation</i> evaluation within circuits affected by external transients.....	171
Figure I.12 – <i>Basic insulation</i> evaluation for circuits both connected and not connected directly to the <i>mains supply</i>	172
Figure I.13 – <i>Insulation</i> evaluation for accessible circuit of DVC A	172
Figure I.14 – <i>PEC</i> with mains and non- <i>mains supply</i> without galvanic separation.....	173

Figure I.15 – Transformer (basic) isolated <i>PEC</i> inverter with <i>SPD</i> and transformer to reduce impulse voltage for functional and <i>basic insulation</i>	173
Figure J.1 – Burn threshold spread when the skin is in contact with a hot smooth surface made of bare (uncoated) metal	174
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	175
Figure J.3 – Rise in the burn threshold spread from Figure J.1 for metals coated with the specific materials	175
Figure J.4 – Burn threshold spread when the skin is in contact with a hot smooth surface made of ceramics, glass and stone materials	176
Figure J.5 – Burn threshold spread when the skin is in contact with a hot smooth surface made of plastics	176
Figure K.1 – Electrochemical potentials (V)	177
Figure L.1 – Measuring instrument	178
Figure M.1 – Sphere 50 mm probe (IPXXA)	179
Figure M.2 – Jointed test finger (IPXXB)	180
Figure M.3 – Test rod 2,5 mm (IP3X)	181
Table 1 – Alphabetical list of terms	15
Table 2 – Selection of <i>DVC</i> for touch voltage to protect against <i>ventricular fibrillation</i>	28
Table 3 – Selection of body contact area	29
Table 4 – Selection of humidity condition of the skin	29
Table 5 – Steady state voltage limits for the <i>decisive voltage classes</i>	29
Table 6 – Protection requirements for circuit under consideration	32
Table 7 – <i>PE conductor</i> cross-section ^a	38
Table 8 – Definitions of pollution degrees	43
Table 9 – Impulse withstand voltage and <i>temporary overvoltage</i> versus system voltage	46
Table 10 – Clearance distances for <i>functional, basic</i> or <i>supplementary insulation</i>	51
Table 11 – Creepage distances (in millimetres)	53
Table 12 – Generic materials for the direct support of uninsulated <i>live parts</i>	55
Table 13 – Permitted openings in <i>fire enclosure</i> bottoms	64
Table 14 – Maximum measured total temperatures for internal materials and components	66
Table 15 – Maximum measured temperatures for accessible parts of the <i>PECS</i>	68
Table 16 – Limits for sources without an overcurrent protective device	69
Table 17 – Limits for power sources with an overcurrent protective device	69
Table 18 – Environmental service conditions	72
Table 19 – Wire bending space from terminals to <i>enclosure</i>	76
Table 20 – Thickness of sheet metal for <i>enclosures</i> : carbon steel or stainless steel	79
Table 21 – Thickness of sheet metal for <i>enclosures</i> : aluminium, copper or brass	80
Table 22 – Test overview	83
Table 23 – Pull values for handles and manual control securement	88
Table 24 – Impulse voltage test	89
Table 25 – Impulse test voltage	90
Table 26 – AC or d.c. test voltage for circuits connected directly to <i>mains supply</i>	91

Table 27 – A.c. or d.c. test voltage for circuits connected to <i>non-mains supply</i> without <i>temporary overvoltages</i>	92
Table 28 – Partial discharge test	95
Table 29 – Test duration for <i>protective equipotential bonding</i> test	101
Table 30 – Environmental tests	111
Table 31 – Dry heat test (steady state)	112
Table 32 – Damp heat test (steady state)	113
Table 33 – Vibration test	114
Table 34 – Salt mist test.....	114
Table 35 – Dust and sand test.....	115
Table 36 – Information requirements	116
Table A.1 – Selection of touch voltage sets to protect against <i>ventricular fibrillation</i>	128
Table A.2 – Selection of touch voltage sets to protect against <i>muscular reaction</i>	129
Table A.3 – Selection of touch voltage sets to protect against <i>startle reaction</i>	129
Table A.4 – Examples for protection against electrical shock	144
Table C.1 – Symbols used.....	146
Table D.1 – Width of grooves by pollution degree	147
Table E.1 – Correction factor for clearances at altitudes between 2 000 m and 20 000 m	155
Table E.2 – Test voltages for verifying clearances at different altitudes	155
Table F.1 – Minimum values of clearances in air at atmospheric pressure for inhomogeneous field conditions (Table 1 of IEC 60664-4:2005)	158
Table F.2 – Multiplication factors for clearances in air at atmospheric pressure for approximately homogeneous field conditions	158
Table F.3 – Minimum values of creepage distances for different frequency ranges (Table 2 of IEC 60664-4:2005)	160
Table G.1 – Standard cross-sections of round conductors	162

INTRODUCTION

This International Standard relates to products that include power electronic converters, with a rated system voltage not exceeding 1 000 V a.c. or 1 500 V d.c. It specifies requirements to reduce risks of fire, electric shock, thermal, energy and mechanical hazards, except functional safety as defined in IEC 61508. The objectives of this document are to establish a common terminology and basis for the safety requirements of products that contain power electronic converters across several IEC technical committees.

This standard has been developed with the intention:

- to be used as a reference document for product committees inside TC 22 in the development of product standards for power electronic converter systems and equipment;
- to replace IEC 62103 as a product family standard providing minimum requirements for safety aspects of power electronic converter systems and equipment in apparatus for which no product standard exists; and

NOTE The scope of IEC 62103 contains reliability aspects, which are not covered by this standard.

- to be used as a reference document for product committees outside TC 22 in the development of product standards of power electronic converter systems and equipment intended renewable energy sources. TC 82, TC 88, TC 105 and TC 114, in particular, have been identified as relevant technical committees at the time of publication.

Technical committees using this document should carefully consider the relevance of each paragraph in this document for the product under consideration and reference, add, replace or modify requirement as relevant. Product specific topics not covered by this document are in the responsibility of the technical committees using this document as reference document.

This group safety standard will not take precedence on any product specific standard according to IEC Guide 104. IEC Guide 104 provides information about the responsibility of product committees to use group safety standards for the development of their own product standards.

SAFETY REQUIREMENTS FOR POWER ELECTRONIC CONVERTER SYSTEMS AND EQUIPMENT –

Part 1: General

1 Scope

This part of IEC 62477 applies to Power Electronic Converter Systems (PECS) and equipment, their components for *electronic power conversion* and electronic power switching, including the means for their control, protection, monitoring and measurement, such as with the main purpose of converting electric power, with rated system voltages not exceeding 1 000 V a.c. or 1 500 V d.c.

This document may also be used as a reference standard for product committees producing product standards for:

- adjustable speed electric power drive systems (PDS);
- standalone uninterruptible power systems (UPS);
- low voltage stabilized d.c. power supplies.

For PECS for which no product standard exists, this standard provides minimum requirements for safety aspects.

This part of IEC 62477 has the status of a group safety publication in accordance with IEC Guide 104 for power electronic converter systems and equipment for solar, wind, tidal, wave, fuel cell or similar energy sources.

According to IEC Guide 104, one of the responsibilities of technical committees is, wherever applicable, to make use of basic safety publications and/or group safety publications in the preparation of their product standards.

This International Standard:

- establishes a common terminology for safety aspects relating to PECS and equipment;
- establishes minimum requirements for the coordination of safety aspects of interrelated parts within a PECS;
- establishes a common basis for minimum safety requirements for the PEC portion of products that contain PEC;
- specifies requirements to reduce risks of fire, electric shock, thermal, energy and mechanical hazards, during use and operation and, where specifically stated, during service and maintenance;
- specifies minimum requirements to reduce risks with respect to pluggable and permanently connected equipment, whether it consists of a system of interconnected units or independent units, subject to installing, operating and maintaining the equipment in the manner prescribed by the manufacturer.

This International Standard does not cover:

- telecommunications apparatus other than power supplies to such apparatus;
- functional safety aspects as covered by e.g. IEC 61508;
- electrical equipment and systems for railways applications and electric vehicles.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at <<http://www.electropedia.org>>)

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

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

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

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

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

IEC 60068-2-78:2001, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60112:2003, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60216-4-1, *Electrical insulating materials – Thermal endurance properties – Part 4-1: Ageing ovens – Single-chamber ovens*

IEC 60364-1, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

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

IEC 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*

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

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

IEC/TS 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*

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

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

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

IEC 60664-3:2003, *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 60695-2-11:2000, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*

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

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

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

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

IEC 60730-1, *Automatic electrical controls for household and similar use – Part 1: General requirements*

IEC/TR 60755, *General requirements for residual current operated protective devices*

IEC 60949, *Calculation of thermally permissible short-circuit currents, taking into account non-adiabatic heating effects*

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

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

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

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

IEC 60990:1999, *Methods of measurement of touch current and protective conductor current*

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

IEC 61180-1:1992, *High-voltage test techniques for low-voltage equipment – Part 1: Definitions, test and procedure requirements*

IEC Guide 104:2010, *The preparation of safety publications and the use of basic safety publications and group safety publications*

IEC Guide 117:2010, *Electrotechnical equipment – Temperatures of touchable hot surfaces*

ISO 3864-1, *Graphical symbols – Safety colours and safety signs – Part 1: Design principles for safety signs in workplaces and public areas*

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*

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

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*

ISO 9772, *Cellular plastics – Determination of horizontal burning characteristics of small specimens subjected to a small flame*

ANSI/ASTM E84 – 11b, *Standard test method for surface burning characteristics of building materials*

ASTM E162 – 11a, *Standard test method for surface flammability of materials using a radiant heat energy source*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-111:1996, IEC 60050-151:2001, IEC 60050-161:1990, IEC 60050-191:1990, IEC 60050-441:1984, IEC 60050-442:1998, IEC 60050-551:1998, IEC 60050-601:1985 and IEC 60664-1:2007, and the following apply.

Table 1 provides an alphabetical cross-reference listing of terms.