IEC 61439-1

Edition 3.0 2020-05

INTERNATIONAL STANDARD

colour inside

REDLINE VERSION

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.130.20

ISBN 978-2-8322-8337-0

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

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 8
INTRODUCTION 10
1 Scope 11
2 Normative references 12
3 Terms and definitions 15
3.1 General terms 16
3.2 Constructional units of assemblies 18
3.3 External design of assemblies 19
3.4 Structural parts of assemblies 20
3.5 Conditions of installation of assemblies 21
3.6 Insulation characteristics 22
3.7 Protection against electric shock 25
3.8 Characteristics 29
3.9 Verification 33
3.10 Manufacturer 34
4 Symbols and abbreviations 34
5 Interface characteristics 35
5.1 General 35
5.2 Voltage ratings 35
5.2.1 Rated voltage (U_n) (of the assembly) 35
5.2.2 Rated operational voltage (U_e) (of a circuit of an assembly) 35
5.2.3 Rated insulation voltage (U_i) (of a circuit of an assembly) 36
5.2.4 Rated impulse withstand voltage (U_{imp}) (of the assembly) 36
5.3 Current ratings 36
5.3.1 Rated current of an assembly (I_{nA}) 36
5.3.2 Rated current of a main outgoing circuit (I_{nc}) 37
5.3.3 Group rated current of a main circuit (I_{ng}) 37
5.3.4 Rated peak withstand current (I_{pk}) 38
5.3.5 Rated short-time withstand current (I_{cw}) (of a main circuit of an assembly) 38
5.3.6 Rated conditional short-circuit current (I_{cc}) (of an assembly or a circuit of an assembly) 38
5.4 Rated diversity factor (RDF) 38
5.5 Rated frequency (f_n) 39
5.6 Other characteristics 39
6 Information 40
6.1 Assembly designation marking 40
6.2 Documentation 40
6.2.1 Information relating to the assembly 40
6.2.2 Instructions for handling, installation, operation and maintenance 40
6.3 Device and/or component identification 41
7 Service conditions 41
7.1 Normal service conditions 41
7.1.1 Climatic conditions 41
~~Ambient air temperature~~ .....
~~Humidity conditions~~ .....

7.1.2 Pollution degree 42
~~Altitude~~ .....
7.2 Special service conditions 43
7.3 Conditions during transport, storage and installation 43
8 Constructional requirements 43
8.1 Strength of materials and parts 43
8.1.1 General 43
8.1.2 Protection against corrosion 44
8.1.3 Properties of insulating materials 44
8.1.4 Resistance to ultra-violet (UV) radiation 45
8.1.5 Mechanical strength 45
8.1.6 Lifting provision 45
8.2 Degree of protection provided by an assembly enclosure 45
8.2.1 Protection against mechanical impact (IK code) 45
8.2.2 Protection against contact with live parts, ingress of solid foreign bodies and water (IP code) 46
8.2.3 Assembly with removable parts 46
8.3 Clearances and creepage distances 47
8.3.1 General 47
8.3.2 Clearances 47
8.3.3 Creepage distances 48
8.4 Protection against electric shock 48
8.4.1 General 48
8.4.2 Basic protection 48
8.4.3 Fault protection 49
8.4.4 ~~Protection by total insulation~~ Additional requirements for class II assemblies 52
8.4.5 Limitation of steady-state touch currents and charge 54
8.4.6 Operating and servicing conditions 54
8.5 Incorporation of switching devices and components 56
8.5.1 Fixed parts 56
8.5.2 Removable parts 56
8.5.3 Selection of switching devices and components 56
8.5.4 Installation of switching devices and components 57
8.5.5 Accessibility 57
8.5.6 Barriers 58
8.5.7 Direction of operation and indication of switching positions 58
8.5.8 Indicator lights and push-buttons 58
8.5.9 Power factor correction banks 58
8.6 Internal electrical circuits and connections 58
8.6.1 Main circuits 58
8.6.2 Auxiliary circuits 59
8.6.3 Bare and insulated conductors 59
8.6.4 Selection and installation of non-protected live conductors to reduce the possibility of short-circuits 60
8.6.5 Identification of the conductors of main and auxiliary circuits 60
8.6.6 Identification of the protective conductor (PE, PEL, PEM, PEN) and of the neutral conductor (N) and the mid-point conductor (M) of the main circuits 60

8.6.7 Conductors in AC circuits passing through ferromagnetic enclosures or plates 61
8.7 Cooling 61
8.8 Terminals for external ~~conductors~~ cables 61
9 Performance requirements 63
9.1 Dielectric properties 63
9.1.1 General 63
9.1.2 Power-frequency withstand voltage 63
9.1.3 Impulse withstand voltage 63
9.1.4 Protection of surge protective devices 64
9.2 Temperature-rise limits 64
9.2.1 General 64
9.2.2 Adjustment of rated currents for alternative ambient air temperatures 64
9.3 Short-circuit protection and short-circuit withstand strength 65
9.3.1 General 65
9.3.2 Information concerning short-circuit withstand strength 65
9.3.3 Relationship between peak current and short-time current 66
9.3.4 Coordination of protective devices 66
9.4 Electromagnetic compatibility (EMC) 66
10 Design verification 67
10.1 General 67
10.2 Strength of materials and parts 68
10.2.1 General 68
10.2.2 Resistance to corrosion 68
10.2.3 Properties of insulating materials 70
10.2.4 Resistance to ultraviolet (UV) radiation 72
10.2.5 Lifting 73
10.2.6 Verification of protection against mechanical impact (IK code) 74
10.2.7 Marking 74
10.2.8 Mechanical operation 74
10.3 Degree of protection of assemblies (IP Code) 75
10.4 Clearances and creepage distances 76
10.5 Protection against electric shock and integrity of protective circuits 76
10.5.1 ~~Effectiveness of the protective circuit~~ General 76
10.5.2 Effective earth continuity between the exposed-conductive-parts of the class I assembly and the protective circuit 76
10.5.3 Short-circuit withstand strength of the protective circuit 76
10.6 Incorporation of switching devices and components 77
10.6.1 General 77
10.6.2 Electromagnetic compatibility 77
10.7 Internal electrical circuits and connections 77
10.8 Terminals for external conductors 77
10.9 Dielectric properties 78
10.9.1 General 78
10.9.2 Power-frequency withstand voltage 78
10.9.3 Impulse withstand voltage 79
10.9.4 Testing of enclosures made of insulating material 81
10.9.5 External door or cover mounted operating handles of insulating material 81

10.9.6 Testing of conductors and hazardous live parts covered by insulating material to provide protection against electric shock 81
10.10 ~~Verification of~~ Temperature-rise 82
10.10.1 General 82
10.10.2 Verification by testing 82
10.10.3 ~~Derivation of ratings for similar variants~~ Verification by comparison 89
10.10.4 Verification assessment 92
10.11 Short-circuit withstand strength 96
10.11.1 General 96
10.11.2 Circuits of assemblies which are exempted from the verification of the short-circuit withstand strength 97
10.11.3 Verification by comparison with a reference design – Using a checklist 97
10.11.4 Verification by comparison with a reference design(s) – Using calculation 97
10.11.5 Verification by test 98
10.12 Electromagnetic compatibility (EMC) 104
~~Mechanical operation ..... ~~
11 Routine verification 105
11.1 General 105
11.2 Degree of protection against contact with hazardous live parts, ingress of solid foreign bodies and water of enclosures 105
11.3 Clearances and creepage distances 105
11.4 Protection against electric shock and integrity of protective circuits 106
11.5 Incorporation of built-in components 106
11.6 Internal electrical circuits and connections 106
11.7 Terminals for external conductors 106
11.8 Mechanical operation 106
11.9 Dielectric properties 106
11.10 Wiring, operational performance and function 107
Annex A (normative) Minimum and maximum cross-section of copper ~~conductors~~ cables suitable for connection to terminals for external ~~conductors~~ cables (see 8.8) 117
Annex B (normative) Method of calculating the cross-sectional area of protective conductors with regard to thermal stresses due to currents of short duration 118
Annex C (informative) User information template 119
Annex D (informative) Design verification 123
Annex E (informative) Rated diversity factor 125
Annex F (normative) Measurement of clearances and creepage distances 138
Annex G (normative) Correlation between the nominal voltage of the supply system and the rated impulse withstand voltage of the equipment 143
Annex H (informative) Operating current and power loss of copper ~~conductors~~ cables 145
Annex I (informative) Thermal equivalent of an intermittent current 149
~~Annex K (normative) Protection by electrical separation ..... ~~
~~Annex L (informative) Clearances and creepage distances for North American region ..... ~~
~~Annex M (informative) North American temperature rise limits ..... ~~
Annex J (normative) Electromagnetic compatibility (EMC) 150
Annex K (normative) Operating current and power loss of bare copper bars 163
Annex L (informative) Guidance on verification of temperature-rise 166

Annex M (normative) Verification of the short-circuit withstand strength of busbar structures by comparison with a ~~tested~~ reference design by calculation 173
Annex N (informative) List of notes concerning certain countries 178

Bibliography 184
Figure E.1 – Typical assembly 134
Figure E.2 – Example 1: Table E.1 – Functional unit loading for an assembly with a rated diversity factor of 0,68 136
Figure E.3 – Example 2: Table E.1 – Functional unit loading for an assembly with a rated diversity factor of 0,6 in Section B and 0,68 in Section C 137
Figure F.1 – Measurement of ~~ribs~~ clearance and creepage distances 142
Figure I.1 – Example of average heating effect calculation 149
Figure J.1 – Examples of ports 150
Figure L.1 – Verification of temperature-rise 172
Figure M.1 – Tested busbar structure (TS) 174
Figure M.2 – Non tested busbar structure (NTS) 175
Figure M.3 – Angular busbar configuration with supports at the corners 176

Table 1 – Minimum clearances in air (8.3.2) 107
Table 2 – Minimum creepage distances (8.3.3) 108
Table 3 – Cross-sectional area of a copper protective conductor (8.4.3.2.2) 109
Table 4 – Conductor selection and installation requirements (8.6.4) 109
Table 5 – Minimum terminal capacity for copper protective conductors (PE~~, PEN~~ (8.8) 110
Table 6 – Temperature-rise limits (9.2) 110
Table 7 – Values for the factor n^a (9.3.3) 111
Table 8 – Power-frequency withstand voltage for main circuits (10.9.2) 112
Table 9 – Power-frequency withstand voltage for auxiliary ~~and control~~ circuits (10.9.2) 112
Table 10 – Impulse withstand test voltages (10.9.3) 112
Table 11 – Copper test conductors for rated currents up to 400 A inclusive (10.10.2.3.2) 113
Table 12 – Copper test conductors for rated currents from 400 A to ~~4 000~~ 7 000 A (10.10.2.3.2) 114
Table 13 – Short-circuit verification by comparison with reference designs: checklist (10.5.3.3, 10.11.3 and 10.11.4) 115
Table 14 – Relationship between prospective fault current and diameter of copper wire 116
Table 15 – Climatic conditions 116
Table A.1 – Cross-section of copper ~~conductors~~ cables suitable for connection to terminals for external ~~conductors~~ cables 117
Table B.1 – Values of k for insulated protective conductors not incorporated in cables or bare protective conductors in contact with cable covering 118
Table C.1 – User information template 119
Table D.1 – List of design verifications to be performed 123
Table E.1 – Examples of loading for an assembly 135
Table F.1 – Minimum width of grooves 138
Table G.1 – Correspondence between the nominal voltage of the supply system and the equipment rated impulse withstand voltage 144

Table H.1 – Operating current and power loss of single-core copper cables with a permissible conductor temperature of 70 °C (ambient temperature inside the assembly: 55 °C) 145

Table H.2 – Reduction factor k_1 for cables with a permissible conductor temperature of 70 °C (extract from IEC 60364-5-52:2009, Table B.52.14) 146

Table J.1 – Tests for EMC immunity for environment A (see J.10.12.2) 154

Table J.2 – Tests for EMC immunity for environment B (see J.10.12.2) 155

Table J.3 – Acceptance criteria when electromagnetic disturbances are present 157

Table K.1 – Operating current and power loss of bare copper bars with rectangular cross-section, run horizontally and arranged with their largest face vertical, frequency 50 Hz to 60 Hz (ambient air temperature inside the assembly: 55 °C, temperature of the conductor 70 °C) 163

Table K.2 – Factor k_4 for different temperatures of the air inside the assembly and/or for the conductors 164

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

Part 1: General rules

FOREWORD

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

This redline version of the official IEC Standard is intended to provide the user with an indication of what changes have been made to the previous version. The IEC Central Office guarantees accuracy of its technical content.

This redline version provides you with a quick and easy way to compare all the changes between this standard and its previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 61439-1 has been prepared by subcommittee 121B: Low-voltage switchgear and controlgear assemblies, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low voltage.

This third edition cancels and replaces the second edition published in 2011. It constitutes a technical revision.

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

a) clarification that power electric converter systems, switch mode power supplies, uninterruptable power supplies and adjustable speed power drive systems are tested to their particular products standard, but when they are incorporated in assemblies the incorporation is in accordance with the IEC 61439 series of standards;
b) introduction of a group rated current for circuits within a loaded assembly and the refocusing of temperature-rise verification on this new characteristic;
c) addition of requirements in respect of DC;
d) introduction of the concept of class I and class II assemblies regarding protection against electric shock.

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

FDIS	Report on voting
121B/99/FDIS	121B/103/RVD

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

The reader’s attention is drawn to the fact that Annex N lists all the “in-some-countries” clauses on differing practices of a less permanent nature regarding this document.

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

A list of all parts of the IEC 61439 series, under the general title *Low-voltage switchgear and controlgear assemblies*, can be found on the IEC website.

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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The purpose of this document is to harmonize as far as practicable all rules and requirements of a general nature applicable to low-voltage switchgear and controlgear assemblies ~~(ASSEMBLIES)~~, in order to obtain uniformity of requirements and verification for assemblies and to avoid the need for verification in other standards. All those requirements for the various assembly standards which can be considered as general have therefore been gathered in this document together with specific subjects of wide interest and application, e.g. temperature-rise, dielectric properties, etc.

For each type of low-voltage switchgear and controlgear assembly, only two main standards are necessary to determine all requirements and the corresponding methods of verification:

– the basic standard, (this document) referred to as “IEC 61439-1” in the specific standards, covering the various types of low-voltage switchgear and controlgear assemblies;
– the specific assembly standard hereinafter also referred to as the relevant assembly standard.

For a general rule to apply to a specific assembly standard, it should be explicitly referred to by quoting this document followed by the relevant clause or subclause number e.g. “IEC 61439-1:2020, 9.1.3”.

A specific assembly standard may not require, and hence need not call up, a general rule where it is not applicable, or it ~~may~~ can add requirements if the general rule is deemed inadequate in the particular case, but it may not deviate from it unless there is substantial technical justification detailed in the specific assembly standard.

Where, in this document, a cross-reference is made to another clause, the reference is to be taken to apply to that clause as amended by the specific assembly standard, where applicable.

Requirements in this document that are subject to agreement between the assembly manufacturer and the user are summarized in Annex C (informative). This schedule also facilitates the supply of information on basic conditions and additional user specifications to enable proper design, application and utilization of the assembly.

For the ~~new re-structured~~ IEC 61439 series, the following parts are ~~envisaged~~ published:

a) IEC 61439-1: General rules
b) IEC 61439-2: Power switchgear and controlgear assemblies (PSC-assemblies)[1]
c) IEC 61439-3: Distribution boards ~~(to supersede IEC 60439-3)~~ intended to be operated by ordinary persons (DBO)
d) IEC 61439-4: ~~ASSEMBLIES for construction sites (to supersede IEC 60439-4)~~ Particular requirements for assemblies for construction sites (ACS)
e) IEC 61439-5: Assemblies for power distribution ~~(to supersede IEC 60439-5)~~ in public networks
f) IEC 61439-6: Busbar trunking systems ~~(to supersede IEC 60439-2)~~ (busways)
f) IEC 61439-7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations
g) IEC TR 61439-0: Guidance to specifying assemblies.

This list is not exhaustive; additional parts ~~may~~ can be developed as the need arises.

---

[1] IEC 61439-2 includes requirements for assemblies for use in photovoltaic installations.

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

Part 1: General rules

1 Scope

~~NOTE 1 Throughout this standard, the term ASSEMBLY (see 3.1.1) is used for a low-voltage switchgear and controlgear assembly.~~

This part of IEC 61439 lays down the general definitions and ~~states the~~ service conditions, construction requirements, technical characteristics and verification requirements for low-voltage switchgear and controlgear assemblies.

~~This standard cannot be used alone to specify an ASSEMBLY or used for a purpose of determining conformity. ASSEMBLIES shall comply with the relevant part of the IEC 61439 series, Parts 2 onwards.~~

NOTE Throughout this document, the term assembly(s) (see 3.1.1) is used for a low-voltage switchgear and controlgear assembly(s).

For the purpose of determining assembly conformity, the requirements of the relevant part of the IEC 61439 series, Part 2 onwards, apply together with the cited requirements of this document. For assemblies not covered by Part 3 onward, Part 2 applies.

This document applies to ~~low-voltage switchgear and controlgear~~ assemblies ~~(ASSEMBLIES)~~ only when required by the relevant assembly standard as follows:

– assemblies for which the rated voltage does not exceed 1 000 V ~~in case of~~ AC or 1 500 V ~~in case of~~ DC;

– assemblies designed for a nominal frequency of the incoming supply or supplies not exceeding 1 000 Hz;

– assemblies intended for indoor and outdoor applications;

– stationary or movable assemblies with or without an enclosure;

– assemblies intended for use in connection with the generation, transmission, distribution and conversion of electric energy, and for the control of electrical energy consuming equipment.

~~– ASSEMBLIES designed for use under special service conditions, for example in ships and in rail vehicles provided that the other relevant specific requirements are complied with;~~

~~NOTE 2 Supplementary requirements for ASSEMBLIES in ships are covered by IEC 60092-302.~~

~~– ASSEMBLIES designed for electrical equipment of machines provided that the other relevant specific requirements are complied with.~~

~~NOTE 3 Supplementary requirements for ASSEMBLIES forming part of a machine are covered by the IEC 60204 series.~~

~~This standard applies to all ASSEMBLIES whether they are designed, manufactured and verified on a one-off basis or fully standardised and manufactured in quantity.~~

~~The manufacture and/or assembly may be carried out other than by the original manufacturer (see 3.10.1).~~

This document does not apply to individual devices and self-contained components such as motor starters, fuse switches, power electronic converter systems and equipment (PECS), switch mode power supplies (SMPS), uninterruptable power supplies (UPS), basic drive

modules (BDM), complete drive modules (CDM), adjustable speed power drives systems (PDS), and other electronic equipment~~, etc.~~ which ~~will~~ comply with their relevant product standards. This document describes the integration of devices and self-contained components into an assembly or into an empty enclosure forming an assembly.

For some applications involving, for example, explosive atmospheres, functional safety, there can be a need to comply with the requirements of other standards or legislation in addition to those specified in the IEC 61439 series.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 60068-2-11:1981*, Basic environmental testing procedures – Part 2-11: Tests – Test Ka: Salt mist*

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

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

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

~~IEC 60216 (all parts), *Electrical insulating materials – Properties of thermal endurance*~~

~~IEC 60227-3:1993, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 3: Non-sheathed cables for fixed wiring*~~

~~IEC 60245-3:1994, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 3: Heat resistant silicone insulated cables*~~

~~IEC 60245-4:1994, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 4: Cords and flexible cables*~~

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

IEC 60364-5-51:2005, *Electrical installations of buildings – Part 5-51: Selection and erection of electrical equipment – Common rules*

IEC 60364-5-52:2009, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

~~IEC 60364-5-53:2001, *Electrical installations of buildings – Part 5-53: Selection and erection of electrical equipment – Isolation, switching and control*~~

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

IEC 60439 (all parts), *Low-voltage switchgear and controlgear assemblies*[2]

IEC 60445:~~2010~~2017, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors*

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

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*[~~3~~4]
IEC 60529:1989/AMD1:1999
IEC 60529:1989/AMD2:2013

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

IEC 60695-2-10:~~2000~~2013, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC 60695-2-11:~~2000~~2014, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

~~IEC 60695-11-5:2004, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*~~

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

IEC 60865-1:~~1993~~2011, *Short-circuit currents – Calculation of effects – Part 1: Definitions and calculation methods*

IEC TR 60890:~~1987~~2014, *A method of temperature-rise~~ assessment by extrapolation for partially type-tested assemblies (PTTA)~~ verification of low-voltage switchgear and controlgear assemblies by calculation*

~~IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*~~

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

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

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio frequency, electromagnetic field immunity test* [~~5~~6]

_____

2 Withdrawn. The IEC 60439 series has been cancelled and replaced by the IEC 61439 series.

~~3 There is a consolidated edition 1.1 (2001) that includes IEC 60529 (1989) and its amendment 1 (1999).~~

4 There is a consolidated document edition 2.2 (2013) that includes IEC 60529 (1989) and its Amendment 1 (1999) and Amendment 2 (2013).

IEC 61000-4-3:2006/AMD1:2007
IEC 61000-4-3:2006/AMD2:2010

IEC 61000-4-4:~~2004~~2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:~~2005~~2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*[7]
IEC 61000-4-5:2014/AMD1:2017

IEC 61000-4-6:~~2008~~2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*
IEC 61000-4-11:2004/AMD1:2017

~~IEC 61000-4-13:2002, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and measurement techniques – Harmonics and interharmonics including mains signalling at a.c. power port, low-frequency immunity tests*[8]~~

IEC 61000-6-3:2006, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*
IEC 61000-6-3:2006/AMD1:2010

IEC 61000-6-4:~~2006~~2018, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards –Emission standard for industrial environments*[9]

IEC 61082-1:2014, *Preparation of documents used in electrotechnology – Part 1: Rules*

IEC 61180~~ (all parts)~~:2016, *High-voltage test techniques for low-voltage equipment – Definitions, test and procedure requirements, test equipment*

~~IEC/TS 61201:2007, *Use of conventional touch voltage limits – Application guide*~~

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

IEC 61921:2017, *Power capacitors – Low-voltage power factor correction banks*

IEC 62208:2011, *Empty enclosures for low-voltage switchgear and controlgear assemblies – General requirements*

~~5 There is a consolidated edition 3.2 (2010) that includes IEC 61000-4-3 (2006) and amendment 1 (2007) and amendment 2 (2010).~~

6 There is a consolidated edition 3.2 (2010) that includes IEC 61000-4-3 (2006) and Amendment 1 (2007) and Amendment 2 (2010).

7 There is consolidated edition 3.1 (2017) that includes IEC 61000-4-5 (2014) and its Amendment 1 (2017).

~~8 There is a consolidated edition 1.1 (2009) that includes IEC 61000-4-13 (2002) and its amendment 1 (2009).~~

~~9 There is a consolidated edition 2.1 (2011) that includes IEC 61000-6-4 (2006) and its amendment 1 (2010).~~

~~IEC 62262:2002, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*~~

IEC 81346-1:2009, *Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 1: Basic rules*

IEC 81346-2:2019, *Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 2: Classification of objects and codes for classes*

CISPR 11:~~2009~~2015, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*~~10~~
CISPR 11:2015/AMD1:2016
CISPR 11:2015/AMD2:2019

~~CISPR 22, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*~~

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*
CISPR 32:2015/AMD1:2019

ISO 178:~~2001~~2010, *Plastics – Determination of flexural properties*
ISO 178:2010/AMD1:2013

~~ISO 179 (all parts) *Plastics – Determination of Charpy impact strength*~~

ISO 179-1:2010, *Plastics – Determination of Charpy impact properties – Part 1: Non-instrumented impact test*

ISO 179-2:1997, *Plastics – Determination of Charpy impact properties – Part 2: Instrumented impact test*
ISO 179-2:1997/AMD1:2011

ISO 2409:~~2007~~2013, *Paints and varnishes – Cross-cut test*

ISO 4628-3:~~2003~~2016, *Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 3: Assessment of degree of rusting*

ISO 4892-2:~~2006~~2013, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 7010, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

IEC 61439-1

Edition 3.0 2020-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Ensembles d'appareillage à basse tension – Partie 1: Règles générales



IEC 61439-1:2020-05(en-fr)

CONTENTS

FOREWORD 8
INTRODUCTION 10
1 Scope 11
2 Normative references 11
3 Terms and definitions 14
3.1 General terms 14
3.2 Constructional units of assemblies 16
3.3 External design of assemblies 18
3.4 Structural parts of assemblies 19
3.5 Conditions of installation of assemblies 20
3.6 Insulation characteristics 20
3.7 Protection against electric shock 23
3.8 Characteristics 27
3.9 Verification 31
3.10 Manufacturer 32
3.11 User 32
4 Symbols and abbreviations 32
5 Interface characteristics 33
5.1 General 33
5.2 Voltage ratings 33
5.2.1 Rated voltage (U_n) (of the assembly) 33
5.2.2 Rated operational voltage (U_e) (of a circuit of an assembly) 34
5.2.3 Rated insulation voltage (U_i) (of a circuit of an assembly) 34
5.2.4 Rated impulse withstand voltage (U_{imp}) (of the assembly) 34
5.3 Current ratings 34
5.3.1 Rated current of an assembly (I_{nA}) 34
5.3.2 Rated current of a main outgoing circuit (I_{nc}) 34
5.3.3 Group rated current of a main circuit (I_{ng}) 35
5.3.4 Rated peak withstand current (I_{pk}) 35
5.3.5 Rated short-time withstand current (I_{cw}) (of a main circuit of an assembly) 36
5.3.6 Rated conditional short-circuit current (I_{cc}) (of an assembly or a circuit of an assembly) 36
5.4 Rated diversity factor (RDF) 36
5.5 Rated frequency (f_n) 36
5.6 Other characteristics 37
6 Information 37
6.1 Assembly designation marking 37
6.2 Documentation 37
6.2.1 Information relating to the assembly 37
6.2.2 Instructions for handling, installation, operation and maintenance 38
6.3 Device and/or component identification 38
7 Service conditions 38
7.1 Normal service conditions 38
7.1.1 Climatic conditions 38
7.1.2 Pollution degree 39

7.2 Special service conditions 39
7.3 Conditions during transport, storage and installation 40
8 Constructional requirements 40
8.1 Strength of materials and parts 40
8.1.1 General 40
8.1.2 Protection against corrosion 41
8.1.3 Properties of insulating materials 41
8.1.4 Resistance to ultra-violet (UV) radiation 41
8.1.5 Mechanical strength 41
8.1.6 Lifting provision 42
8.2 Degree of protection provided by an assembly enclosure 42
8.2.1 Protection against mechanical impact (IK code) 42
8.2.2 Protection against contact with live parts, ingress of solid foreign bodies and water (IP code) 42
8.2.3 Assembly with removable parts 43
8.3 Clearances and creepage distances 43
8.3.1 General 43
8.3.2 Clearances 43
8.3.3 Creepage distances 44
8.4 Protection against electric shock 44
8.4.1 General 44
8.4.2 Basic protection 44
8.4.3 Fault protection 45
8.4.4 Additional requirements for class II assemblies 48
8.4.5 Limitation of steady-state touch currents and charge 49
8.4.6 Operating and servicing conditions 49
8.5 Incorporation of switching devices and components 50
8.5.1 Fixed parts 50
8.5.2 Removable parts 51
8.5.3 Selection of switching devices and components 51
8.5.4 Installation of switching devices and components 51
8.5.5 Accessibility 52
8.5.6 Barriers 52
8.5.7 Direction of operation and indication of switching positions 52
8.5.8 Indicator lights and push-buttons 52
8.5.9 Power factor correction banks 52
8.6 Internal electrical circuits and connections 52
8.6.1 Main circuits 52
8.6.2 Auxiliary circuits 53
8.6.3 Bare and insulated conductors 53
8.6.4 Selection and installation of non-protected live conductors to reduce the possibility of short-circuits 55
8.6.5 Identification of the conductors of main and auxiliary circuits 55
8.6.6 Identification of the protective conductor (PE, PEL, PEM, PEN) and of the neutral conductor (N) and the mid-point conductor (M) of the main circuits 55
8.6.7 Conductors in AC circuits passing through ferromagnetic enclosures or plates 55
8.7 Cooling 55
8.8 Terminals for external cables 55

9 Performance requirements 57
9.1 Dielectric properties 57
9.1.1 General 57
9.1.2 Power-frequency withstand voltage 57
9.1.3 Impulse withstand voltage 57
9.1.4 Protection of surge protective devices 58
9.2 Temperature-rise limits 58
9.2.1 General 58
9.2.2 Adjustment of rated currents for alternative ambient air temperatures 58
9.3 Short-circuit protection and short-circuit withstand strength 59
9.3.1 General 59
9.3.2 Information concerning short-circuit withstand strength 59
9.3.3 Relationship between peak current and short-time current 60
9.3.4 Coordination of protective devices 60
9.4 Electromagnetic compatibility (EMC) 60
10 Design verification 60
10.1 General 60
10.2 Strength of materials and parts 62
10.2.1 General 62
10.2.2 Resistance to corrosion 62
10.2.3 Properties of insulating materials 64
10.2.4 Resistance to ultraviolet (UV) radiation 65
10.2.5 Lifting 66
10.2.6 Verification of protection against mechanical impact (IK code) 67
10.2.7 Marking 67
10.2.8 Mechanical operation 67
10.3 Degree of protection of assemblies (IP Code) 68
10.4 Clearances and creepage distances 69
10.5 Protection against electric shock and integrity of protective circuits 69
10.5.1 General 69
10.5.2 Effective earth continuity between the exposed-conductive-parts of the class I assembly and the protective circuit 69
10.5.3 Short-circuit withstand strength of the protective circuit 69
10.6 Incorporation of switching devices and components 70
10.6.1 General 70
10.6.2 Electromagnetic compatibility 70
10.7 Internal electrical circuits and connections 70
10.8 Terminals for external conductors 70
10.9 Dielectric properties 71
10.9.1 General 71
10.9.2 Power-frequency withstand voltage 71
10.9.3 Impulse withstand voltage 72
10.9.4 Testing of enclosures made of insulating material 74
10.9.5 External door or cover mounted operating handles of insulating material 74
10.9.6 Testing of conductors and hazardous live parts covered by insulating material to provide protection against electric shock 74
10.10 Temperature-rise 74
10.10.1 General 74
10.10.2 Verification by testing 75

10.10.3 Verification by comparison 81
10.10.4 Verification assessment 84
10.11 Short-circuit withstand strength 86
10.11.1 General 86
10.11.2 Circuits of assemblies which are exempted from the verification of the short-circuit withstand strength 86
10.11.3 Verification by comparison with a reference design – Using a checklist 87
10.11.4 Verification by comparison with a reference design(s) – Using calculation 87
10.11.5 Verification by test 87
10.12 Electromagnetic compatibility (EMC) 93
11 Routine verification 93
11.1 General 93
11.2 Degree of protection against contact with hazardous live parts, ingress of solid foreign bodies and water of enclosures 94
11.3 Clearances and creepage distances 94
11.4 Protection against electric shock and integrity of protective circuits 94
11.5 Incorporation of built-in components 95
11.6 Internal electrical circuits and connections 95
11.7 Terminals for external conductors 95
11.8 Mechanical operation 95
11.9 Dielectric properties 95
11.10 Wiring, operational performance and function 95
Annex A (normative) Minimum and maximum cross-section of copper cables suitable for connection to terminals for external cables (see 8.8) 105
Annex B (normative) Method of calculating the cross-sectional area of protective conductors with regard to thermal stresses due to currents of short duration 106
Annex C (informative) User information template 107
Annex D (informative) Design verification 111
Annex E (informative) Rated diversity factor 112
E.1 General 112
E.2 Rated diversity factor for outgoing circuits within an assembly 112
E.2.1 General 112
E.2.2 Example of an assembly with an RDF of 0,68 115
E.2.3 Example of an assembly with RDF declared for each section 116
Annex F (normative) Measurement of clearances and creepage distances 117
F.1 Basic principles 117
F.2 Use of ribs 117
Annex G (normative) Correlation between the nominal voltage of the supply system and the rated impulse withstand voltage of the equipment 122
Annex H (informative) Operating current and power loss of copper cables 124
Annex I (informative) Thermal equivalent of an intermittent current 126
Annex J (normative) Electromagnetic compatibility (EMC) 127
J.1 General 127
Annex K (normative) Operating current and power loss of bare copper bars 134
Annex L (informative) Guidance on verification of temperature-rise 137
L.1 General 137
L.1.1 Principles 137

L.1.2 Current ratings of assemblies 137
L.2 Temperature-rise limits 138
L.3 Test 139
L.3.1 General 139
L.3.2 Method a) – Verification of the complete assembly (10.10.2.3.5) 139
L.3.3 Method b) – Verification considering individual functional units separately and the complete assembly (10.10.2.3.6) 139
L.3.4 Method c) – Verification considering individual functional units and the main and distribution busbars separately as well as the complete assembly (10.10.2.3.7) 140
L.4 Verification assessment 140
L.4.1 General 140
L.4.2 Single compartment assembly with a rated current (I_{nA}) not exceeding 630 A 140
L.4.3 Assembly with rated currents (I_{nA}) not exceeding 1 600 A 140
L.5 Verification by comparison with a reference design 140
Annex M (normative) Verification of the short-circuit withstand strength of busbar structures by comparison with a reference design by calculation 142
M.1 General 142
M.2 Terms and definitions 142
M.3 Method of verification 143
M.4 Conditions for application 144
M.4.1 General 144
M.4.2 Peak short-circuit current 144
M.4.3 Thermal short-circuit strength 144
M.4.4 Busbar supports 144
M.4.5 Busbar connections, equipment connections 144
M.4.6 Angular busbar configurations 144
M.4.7 Calculations with special regard to conductor oscillation 145
Annex N (informative) List of notes concerning certain countries 146
Bibliography 152

Figure E.1 – Typical assembly 113
Figure E.2 – Example 1: Table E.1 – Functional unit loading for an assembly with a rated diversity factor of 0,68 115
Figure E.3 – Example 2: Table E.1 – Functional unit loading for an assembly with a rated diversity factor of 0,6 in Section B and 0,68 in Section C 116
Figure F.1 – Measurement of clearance and creepage distances 121
Figure I.1 – Example of average heating effect calculation 126
Figure J.1 – Examples of ports 127
Figure L.1 – Verification of temperature-rise 141
Figure M.1 – Tested busbar structure (TS) 142
Figure M.2 – Non tested busbar structure (NTS) 143
Figure M.3 – Angular busbar configuration with supports at the corners 144

Table 1 – Minimum clearances in air (8.3.2) 96
Table 2 – Minimum creepage distances (8.3.3) 97
Table 3 – Cross-sectional area of a copper protective conductor (8.4.3.2.2) 98

Table 4 – Conductor selection and installation requirements (8.6.4) 98
Table 5 – Minimum terminal capacity for copper protective conductors (PE) (8.8) 98
Table 6 – Temperature-rise limits (9.2) 99
Table 7 – Values for the factor n (9.3.3) 100
Table 8 – Power-frequency withstand voltage for main circuits (10.9.2) 100
Table 9 – Power-frequency withstand voltage for auxiliary circuits (10.9.2) 100
Table 10 – Impulse withstand test voltages (10.9.3) 100
Table 11 – Copper test conductors for rated currents up to 400 A inclusive (10.10.2.3.2) 101
Table 12 – Copper test conductors for rated currents from 400 A to 7 000 A (10.10.2.3.2) 102
Table 13 – Short-circuit verification by comparison with reference designs: checklist (10.5.3.3, 10.11.3 and 10.11.4) 103
Table 14 – Relationship between prospective fault current and diameter of copper wire 104
Table 15 – Climatic conditions 104
Table A.1 – Cross-section of copper cables suitable for connection to terminals for external cables 105
Table B.1 – Values of k for insulated protective conductors not incorporated in cables or bare protective conductors in contact with cable covering 106
Table C.1 – User information template 107
Table D.1 – List of design verifications to be performed 111
Table E.1 – Examples of loading for an assembly 114
Table F.1 – Minimum width of grooves 117
Table G.1 – Correspondence between the nominal voltage of the supply system and the equipment rated impulse withstand voltage 123
Table H.1 – Operating current and power loss of single-core copper cables with a permissible conductor temperature of 70 °C (ambient temperature inside the assembly: 55 °C) 124
Table H.2 – Reduction factor k_1 for cables with a permissible conductor temperature of 70 °C (extract from IEC 60364-5-52:2009, Table B.52.14) 125
Table J.1 – Tests for EMC immunity for environment A (see J.10.12.2) 131
Table J.2 – Tests for EMC immunity for environment B (see J.10.12.2) 132
Table J.3 – Acceptance criteria when electromagnetic disturbances are present 133
Table K.1 – Operating current and power loss of bare copper bars with rectangular cross-section, run horizontally and arranged with their largest face vertical, frequency 50 Hz to 60 Hz (ambient air temperature inside the assembly: 55 °C, temperature of the conductor 70 °C) 134
Table K.2 – Factor k_4 for different temperatures of the air inside the assembly and/or for the conductors 135

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

Part 1: General rules

FOREWORD

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

International Standard IEC 61439-1 has been prepared by subcommittee 121B: Low-voltage switchgear and controlgear assemblies, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low voltage.

This third edition cancels and replaces the second edition published in 2011. It constitutes a technical revision.

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

a) clarification that power electric converter systems, switch mode power supplies, uninterruptable power supplies and adjustable speed power drive systems are tested to their particular products standard, but when they are incorporated in assemblies the incorporation is in accordance with the IEC 61439 series of standards;
b) introduction of a group rated current for circuits within a loaded assembly and the refocusing of temperature-rise verification on this new characteristic;

c) addition of requirements in respect of DC;

d) introduction of the concept of class I and class II assemblies regarding protection against electric shock.

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

FDIS	Report on voting
121B/99/FDIS	121B/103/RVD

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

The reader's attention is drawn to the fact that Annex N lists all the "in-some-countries" clauses on differing practices of a less permanent nature regarding this document.

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

A list of all parts of the IEC 61439 series, under the general title *Low-voltage switchgear and controlgear assemblies*, can be found on the IEC website.

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

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

INTRODUCTION

The purpose of this document is to harmonize as far as practicable all rules and requirements of a general nature applicable to low-voltage switchgear and controlgear assemblies, in order to obtain uniformity of requirements and verification for assemblies and to avoid the need for verification in other standards. All those requirements for the various assembly standards which can be considered as general have therefore been gathered in this document together with specific subjects of wide interest and application, e.g. temperature-rise, dielectric properties, etc.

For each type of low-voltage switchgear and controlgear assembly, only two main standards are necessary to determine all requirements and the corresponding methods of verification:

– the basic standard, (this document) referred to as “IEC 61439-1” in the specific standards, covering the various types of low-voltage switchgear and controlgear assemblies;
– the specific assembly standard hereinafter also referred to as the relevant assembly standard.

For a general rule to apply to a specific assembly standard, it should be explicitly referred to by quoting this document followed by the relevant clause or subclause number e.g. “IEC 61439-1:2020, 9.1.3”.

A specific assembly standard may not require, and hence need not call up, a general rule where it is not applicable, or it can add requirements if the general rule is deemed inadequate in the particular case, but it may not deviate from it unless there is substantial technical justification detailed in the specific assembly standard.

Where, in this document, a cross-reference is made to another clause, the reference is to be taken to apply to that clause as amended by the specific assembly standard, where applicable.

Requirements in this document that are subject to agreement between the assembly manufacturer and the user are summarized in Annex C (informative). This schedule also facilitates the supply of information on basic conditions and additional user specifications to enable proper design, application and utilization of the assembly.

For the IEC 61439 series, the following parts are published:

a) IEC 61439-1: General rules
b) IEC 61439-2: Power switchgear and controlgear assemblies (PSC-assemblies)[1]
c) IEC 61439-3: Distribution boards intended to be operated by ordinary persons (DBO)
d) IEC 61439-4: Particular requirements for assemblies for construction sites (ACS)
e) IEC 61439-5: Assemblies for power distribution in public networks
f) IEC 61439-6: Busbar trunking systems (busways)
g) IEC 61439-7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations
h) IEC TR 61439-0: Guidance to specifying assemblies.

This list is not exhaustive; additional parts can be developed as the need arises.

[1] IEC 61439-2 includes requirements for assemblies for use in photovoltaic installations.

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

Part 1: General rules

1 Scope

This part of IEC 61439 lays down the general definitions and service conditions, construction requirements, technical characteristics and verification requirements for low-voltage switchgear and controlgear assemblies.

NOTE Throughout this document, the term assembly(s) (see 3.1.1) is used for a low-voltage switchgear and controlgear assembly(s).

For the purpose of determining assembly conformity, the requirements of the relevant part of the IEC 61439 series, Part 2 onwards, apply together with the cited requirements of this document. For assemblies not covered by Part 3 onward, Part 2 applies.

This document applies to assemblies only when required by the relevant assembly standard as follows:

– assemblies for which the rated voltage does not exceed 1 000 V AC or 1 500 V DC;
– assemblies designed for a nominal frequency of the incoming supply or supplies not exceeding 1 000 Hz;
– assemblies intended for indoor and outdoor applications;
– stationary or movable assemblies with or without an enclosure;
– assemblies intended for use in connection with the generation, transmission, distribution and conversion of electric energy, and for the control of electrical energy consuming equipment.

This document does not apply to individual devices and self-contained components such as motor starters, fuse switches, power electronic converter systems and equipment (PECS), switch mode power supplies (SMPS), uninterruptable power supplies (UPS), basic drive modules (BDM), complete drive modules (CDM), adjustable speed power drives systems (PDS), and other electronic equipment which comply with their relevant product standards. This document describes the integration of devices and self-contained components into an assembly or into an empty enclosure forming an assembly.

For some applications involving, for example, explosive atmospheres, functional safety, there can be a need to comply with the requirements of other standards or legislation in addition to those specified in the IEC 61439 series.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 60068-2-11:1981*, Basic environmental testing procedures – Part 2-11: Tests – Test Ka: Salt mist*

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

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

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

IEC 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 60364-5-51:2005, *Electrical installations of buildings – Part 5-51: Selection and erection of electrical equipment – Common rules*

IEC 60364-5-52:2009, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60439 (all parts), *Low-voltage switchgear and controlgear assemblies*[2]

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

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

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*[3]
IEC 60529:1989/AMD1:1999
IEC 60529:1989/AMD2:2013

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

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

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

IEC 60865-1:2011, *Short-circuit currents – Calculation of effects – Part 1: Definitions and calculation methods*

IEC TR 60890:2014, *A method of temperature-rise verification of low-voltage switchgear and controlgear assemblies by calculation*

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

---

2 Withdrawn. The IEC 60439 series has been cancelled and replaced by the IEC 61439 series.

3 There is a consolidated document edition 2.2 (2013) that includes IEC 60529 (1989) and its Amendment 1 (1999) and Amendment 2 (2013).

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

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio frequency, electromagnetic field immunity test*[4]
IEC 61000-4-3:2006/AMD1:2007
IEC 61000-4-3:2006/AMD2:2010

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*[5]
IEC 61000-4-5:2014/AMD1:2017

IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*
IEC 61000-4-11:2004/AMD1:2017

IEC 61000-6-3:2006, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*
IEC 61000-6-3:2006/AMD1:2010

IEC 61000-6-4:2018, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*

IEC 61082-1:2014, *Preparation of documents used in electrotechnology – Part 1: Rule*s

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

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

IEC 61921:2017, *Power capacitors – Low-voltage power factor correction banks*

IEC 62208:2011, *Empty enclosures for low-voltage switchgear and controlgear assemblies – General requirements*

IEC 81346-1:2009*, Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 1: Basic rules*

IEC 81346-2:2019, *Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 2: Classification of objects and codes for classes*

_____

4 There is a consolidated edition 3.2 (2010) that includes IEC 61000-4-3 (2006) and Amendment 1 (2007) and Amendment 2 (2010).

5 There is consolidated edition 3.1 (2017) that includes IEC 61000-4-5 (2014) and its Amendment 1 (2017).

CISPR 11:2015, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*
CISPR 11:2015/AMD1:2016
CISPR 11:2015/AMD2:2019

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*
CISPR 32:2015/AMD1:2019

ISO 178:2010, *Plastics – Determination of flexural properties*
ISO 178:2010/AMD1:2013

ISO 179-1:2010, *Plastics – Determination of Charpy impact properties – Part 1: Non-instrumented impact test*

ISO 179-2:1997, *Plastics – Determination of Charpy impact properties – Part 2: Instrumented impact test*
ISO 179-2:1997/AMD1:2011

ISO 2409:2013, *Paints and varnishes – Cross-cut test*

ISO 4628-3:2016, *Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 3: Assessment of degree of rusting*

ISO 4892-2:2013, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 7010, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

SOMMAIRE

AVANT-PROPOS 162
INTRODUCTION 164
1 Domaine d'application 166
2 Références normatives 166
3 Termes et définitions 169
3.1 Termes généraux 170
3.2 Unités de construction des ensembles 172
3.3 Présentation extérieure des ensembles 173
3.4 Eléments de structure des ensembles 174
3.5 Conditions d'installation des ensembles 175
3.6 Caractéristiques d'isolement 176
3.7 Protection contre les chocs électriques 179
3.8 Caractéristiques 183
3.9 Vérification 187
3.10 Constructeur 188
3.11 Utilisateur 188
4 Symboles et abréviations 188
5 Caractéristiques d'interface 190
5.1 Généralités 190
5.2 Caractéristiques assignées de tension 190
5.2.1 Tension assignée (U_n) (de l'ensemble) 190
5.2.2 Tension assignée d'emploi (U_e) (d'un circuit d'un ensemble) 190
5.2.3 Tension assignée d'isolement (U_i) (d'un circuit d'un ensemble) 190
5.2.4 Tension assignée de tenue aux chocs (U_{imp}) (de l'ensemble) 190
5.3 Caractéristiques assignées de courant 190
5.3.1 Courant assigné d'un ensemble (I_{nA}) 190
5.3.2 Courant assigné d'un circuit principal de départ (I_{nc}) 191
5.3.3 Courant assigné de groupe d'un circuit principal (I_{ng}) 191
5.3.4 Courant assigné de crête admissible (I_{pk}) 192
5.3.5 Courant assigné de courte durée admissible (I_{cw}) (d'un circuit principal d'un ensemble) 192
5.3.6 Courant conditionnel de court-circuit assigné (I_{cc}) (d'un ensemble ou d'un circuit d'un ensemble) 192
5.4 Facteur de diversité assigné (RDF) 192
5.5 Fréquence assignée (f_n) 193
5.6 Autres caractéristiques 193
6 Informations 194
6.1 Marquage pour l'identification des ensembles 194
6.2 Documentation 194
6.2.1 Renseignements concernant l'ensemble 194
6.2.2 Instructions de manutention, d'installation, d'exploitation et de maintenance 194
6.3 Identification des appareils et/ou des composants 195
7 Conditions d'emploi 195
7.1 Conditions normales d'emploi 195
7.1.1 Conditions climatiques 195

7.1.2 Degré de pollution 195
7.2 Conditions spéciales d'emploi 196
7.3 Conditions au cours du transport, du stockage et de l'installation 196
8 Exigences de construction 197
8.1 Résistance des matériaux et des parties 197
8.1.1 Généralités 197
8.1.2 Protection contre la corrosion 197
8.1.3 Propriétés des matériaux isolants 197
8.1.4 Résistance aux rayonnements ultraviolets (UV) 198
8.1.5 Résistance mécanique 198
8.1.6 Dispositifs de levage 198
8.2 Degré de protection procuré par l'enveloppe d'un ensemble 198
8.2.1 Protection contre les impacts mécaniques (code IK) 199
8.2.2 Protection contre les contacts avec des parties actives, contre la pénétration de corps étrangers solides et d'eau (code IP) 199
8.2.3 Ensemble avec parties amovibles 199
8.3 Distances d'isolement et lignes de fuite 200
8.3.1 Généralités 200
8.3.2 Distances d'isolement 200
8.3.3 Lignes de fuite 200
8.4 Protection contre les chocs électriques 201
8.4.1 Généralités 201
8.4.2 Protection principale 201
8.4.3 Protection en cas de défaut 202
8.4.4 Exigences supplémentaires pour les ensembles de classe II 205
8.4.5 Limitation du courant permanent et de la charge 206
8.4.6 Conditions d'exploitation et d'entretien 207
8.5 Intégration des appareils de connexion et des composants 208
8.5.1 Parties fixes 208
8.5.2 Parties amovibles 208
8.5.3 Choix des appareils de connexion et des composants 209
8.5.4 Installation des appareils de connexion et des composants 209
8.5.5 Accessibilité 209
8.5.6 Barrières 210
8.5.7 Sens de manœuvre et indication des positions de commande 210
8.5.8 Voyants lumineux et boutons-poussoirs 210
8.5.9 Batteries de compensation du facteur de puissance 210
8.6 Circuits électriques internes et connexions 210
8.6.1 Circuits principaux 210
8.6.2 Circuits auxiliaires 211
8.6.3 Conducteurs nus et isolés 211
8.6.4 Choix et installation de conducteurs actifs non protégés pour réduire la possibilité de courts-circuits 213
8.6.5 Identification des conducteurs des circuits principaux et auxiliaires 213
8.6.6 Identification du conducteur de protection (PE, PEL, PEM, PEN), du conducteur neutre (N) et du conducteur de point milieu (M) des circuits principaux 213
8.6.7 Conducteurs dans des circuits à courant alternatif traversant des enveloppes ou des plaques ferromagnétiques 213
8.7 Refroidissement 213

8.8 Bornes pour câbles externes 214
9 Exigences relatives aux performances 215
9.1 Propriétés diélectriques 215
9.1.1 Généralités 215
9.1.2 Tension de tenue à fréquence industrielle 216
9.1.3 Tension de tenue aux chocs 216
9.1.4 Protection des parafoudres 216
9.2 Limites d'échauffement 216
9.2.1 Généralités 216
9.2.2 Ajustement des courants assignés pour d'autres températures de l'air ambiant 217
9.3 Protection contre les courts-circuits et tenue aux courts-circuits 217
9.3.1 Généralités 217
9.3.2 Indications concernant la tenue aux courts-circuits 218
9.3.3 Relation entre le courant de crête et le courant de courte durée 218
9.3.4 Coordination des dispositifs de protection 218
9.4 Compatibilité électromagnétique (CEM) 219
10 Vérification de la conception 219
10.1 Généralités 219
10.2 Résistance des matériaux et des parties 220
10.2.1 Généralités 220
10.2.2 Tenue à la corrosion 221
10.2.3 Propriétés des matériaux isolants 222
10.2.4 Résistance aux rayonnements ultraviolets (UV) 224
10.2.5 Levage 225
10.2.6 Vérification de la protection contre les impacts mécaniques (code IK) 226
10.2.7 Marquage 226
10.2.8 Fonctionnement mécanique 226
10.3 Degré de protection des ensembles (code IP) 227
10.4 Distances d'isolement et lignes de fuite 228
10.5 Protection contre les chocs électriques et intégrité des circuits de protection 228
10.5.1 Généralités 228
10.5.2 Continuité du circuit de terre entre les masses de l'ensemble de classe I et le circuit de protection 228
10.5.3 Tenue aux courts-circuits du circuit de protection 228
10.6 Intégration des appareils de connexion et des composants 229
10.6.1 Généralités 229
10.6.2 Compatibilité électromagnétique 229
10.7 Circuits électriques internes et connexions 229
10.8 Bornes pour conducteurs externes 229
10.9 Propriétés diélectriques 230
10.9.1 Généralités 230
10.9.2 Tension de tenue à fréquence industrielle 230
10.9.3 Tension de tenue aux chocs 231
10.9.4 Essais des enveloppes en matériau isolant 233
10.9.5 Les poignées de manœuvre externes en matériau isolant montées sur portes ou panneaux 233
10.9.6 Essais des conducteurs et des parties actives dangereuses recouverts de matériau isolant pour offrir une protection contre les chocs électriques 234

10.10 Echauffement 234
10.10.1 Généralités 234
10.10.2 Vérification par des essais 234
10.10.3 Vérification par comparaison 241
10.10.4 Evaluation de vérification 244
10.11 Tenue aux courts-circuits 247
10.11.1 Généralités 247
10.11.2 Circuits des ensembles exemptés de la vérification de la tenue aux courts-circuits 247
10.11.3 Vérification par comparaison avec une conception de référence – Utilisation d'une liste de contrôle 248
10.11.4 Vérification par comparaison avec une ou plusieurs conceptions de référence – Utilisation de calculs 248
10.11.5 Vérification par essai 248
10.12 Compatibilité électromagnétique (CEM) 255
11 Vérification individuelle de série 255
11.1 Généralités 255
11.2 Degré de protection des enveloppes contre les contacts avec des parties actives dangereuses, contre la pénétration de corps étrangers solides et d'eau 256
11.3 Distances d'isolement et lignes de fuite 256
11.4 Protection contre les chocs électriques et intégrité des circuits de protection 256
11.5 Intégration de composants incorporés 256
11.6 Circuits électriques internes et connexions 256
11.7 Bornes pour conducteurs externes 257
11.8 Fonctionnement mécanique 257
11.9 Propriétés diélectriques 257
11.10 Câblage, fonctionnement électrique et fonction 257
Annexe A (normative) Sections minimale et maximale des câbles de cuivre convenant au raccordement aux bornes pour câbles externes (voir 8.8) 268
Annexe B (normative) Méthode de calcul de la section des conducteurs de protection par rapport aux contraintes thermiques occasionnées par les courants de courte durée 269
Annexe C (informative) Modèle d'information de l'utilisateur 270
Annexe D (informative) Vérification de la conception 274
Annexe E (informative) Facteur de diversité assigné 276
E.1 Généralités 276
E.2 Facteur de diversité assigné pour circuits de départ à l'intérieur d'un ensemble 276
E.2.1 Généralités 276
E.2.2 Exemple d'un ensemble avec un RDF de 0,68 279
E.2.3 Exemple d'un ensemble avec un RDF déclaré pour chaque colonne 280
Annexe F (normative) Mesure des distances d'isolement et des lignes de fuite 281
F.1 Principes de base 281
F.2 Emploi des nervures 281
Annexe G (normative) Correspondance entre la tension nominale du réseau d'alimentation et la tension assignée de tenue aux chocs du matériel 286
Annexe H (informative) Courant admissible et puissance dissipée des câbles en cuivre 288
Annexe I (informative) Equivalent thermique d'un courant intermittent 290
Annexe J (normative) Compatibilité électromagnétique (CEM) 291

J.1 Généralités 291
Annexe K (normative) Courant admissible et puissance dissipée des barres en cuivre nues 299
Annexe L (informative) Recommandations concernant la vérification de l'échauffement 302
L.1 Généralités 302
L.1.1 Principes 302
L.1.2 Caractéristiques assignées de courant des ensembles 302
L.2 Limites d'échauffement 303
L.3 Essai 304
L.3.1 Généralités 304
L.3.2 Méthode a) – Vérification de l'ensemble complet (10.10.2.3.5) 304
L.3.3 Méthode b) – Vérification séparée de chaque unité fonctionnelle et de l'ensemble complet (10.10.2.3.6) 305
L.3.4 Méthode c) – Vérification individuelle de chaque unité fonctionnelle, des jeux de barres principaux, des jeux de barres de distribution et de l'ensemble complet (10.10.2.3.7) 305
L.4 Evaluation de vérification 305
L.4.1 Généralités 305
L.4.2 Ensemble à un seul compartiment avec courant assigné, I_{nA}, ne dépassant pas 630 A 305
L.4.3 Ensemble avec courants assignés, I_{nA}, ne dépassant pas 1 600 A 305
L.5 Vérification par comparaison avec une conception de référence 306
Annexe M (normative) Vérification de la tenue aux courts-circuits des structures de jeux de barres par comparaison avec une conception de référence par calcul 308
M.1 Généralités 308
M.2 Termes et définitions 308
M.3 Méthode de vérification 309
M.4 Conditions d'application 310
M.4.1 Généralités 310
M.4.2 Valeur de crête du courant de court-circuit 310
M.4.3 Contrainte thermique en court-circuit 310
M.4.4 Supports des jeux de barres 310
M.4.5 Raccordements des jeux de barres, raccordements des matériels 310
M.4.6 Configurations des jeux de barres coudées 310
M.4.7 Calculs avec considération spéciale de l'oscillation des conducteurs 311
Annexe N (informative) Liste de notes concernant certains pays 312
Bibliographie 318

Figure E.1 – Ensemble type 277
Figure E.2 – Exemple 1: Tableau E.1 – Charge d'une unité fonctionnelle pour un ensemble avec un facteur de diversité assigné de 0,68 279
Figure E.3 – Exemple 2: Tableau E.1 – Charge d'une unité fonctionnelle pour un ensemble avec un facteur de diversité assigné de 0,6 dans la colonne B et 0,68 dans la colonne C 280
Figure F.1 – Mesure des distances d'isolement et des lignes de fuite 285
Figure I.1 – Exemple de calcul d'effet thermique moyen 290
Figure J.1 – Exemples d'accès 291
Figure L.1 – Vérification de l'échauffement 307
Figure M.1 – Structure de jeu de barres éprouvée par essai (SS) 308
Figure M.2 – Structure de jeu de barres qui n'a pas été éprouvée par essai (NSS) 309

Figure M.3 – Configuration de jeux de barres coudées avec supports aux coins 310

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

_____

ENSEMBLES D'APPAREILLAGE À BASSE TENSION –

Partie 1: Règles générales

AVANT-PROPOS

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

La Norme internationale IEC 61439-1 a été établie par le sous-comité 121B: Ensembles d'appareillages à basse tension, du comité d'études 121 de l'IEC: Appareillages et ensembles d'appareillages basse tension.

Cette troisième édition annule et remplace la deuxième édition parue en 2011. Elle constitue une révision technique.

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

a) clarification du fait que les systèmes et matériels électroniques de conversion de puissance, les alimentations à découpage, les alimentations sans interruption et les systèmes d'entraînements électriques de puissance à vitesse variable sont soumis à essai

conformément à leur propre norme de produit, mais que lorsqu'ils sont incorporés dans des ensembles, l'incorporation est conforme à la série de normes IEC 61439;

b) introduction d'un courant assigné de groupe pour les circuits au sein d'un ensemble chargé et recentrage de la vérification de l'échauffement sur cette nouvelle caractéristique;

c) ajout d'exigences relatives au courant continu;

d) introduction du concept d'ensembles de classe I et de classe II en matière de protection contre les chocs électriques.

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

FDIS	Rapport de vote
121B/99/FDIS	121B/103/RVD

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

L'attention du lecteur est attirée sur le fait que l'Annexe N énumère tous les articles traitant des différences à caractère moins permanent inhérentes à certains pays, relatifs au présent document.

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

Une liste de toutes les parties de la série IEC 61439, publiées sous le titre général *Ensembles d'appareillage à basse tension*, peut être consultée sur le site web de l'IEC.

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

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

INTRODUCTION

Le but du présent document est d'harmoniser, autant que possible, l'ensemble des règles et des exigences de nature générale qui sont applicables aux ensembles d'appareillage à basse tension afin d'obtenir l'uniformité des exigences et de la vérification pour les ensembles et pour éviter toute vérification nécessaire selon d'autres normes. Toutes ces exigences relatives aux différentes normes applicables aux ensembles qui peuvent être considérées comme d'ordre général ont ainsi été rassemblées dans le présent document avec des aspects spécifiques présentant une portée et une application étendues, par exemple l'échauffement, les propriétés diélectriques, etc.

Pour chaque type d'ensemble d'appareillage à basse tension, seules deux normes principales sont nécessaires pour déterminer toutes les exigences et toutes les méthodes correspondantes de vérification:

– la norme de base (le présent document) désignée sous l'appellation "IEC 61439-1" dans les normes particulières couvrant les différents types d'ensembles d'appareillage à basse tension;
– la norme particulière applicable à un ensemble désignée ci-après également sous l'appellation norme d'ensemble applicable.

Pour qu'une règle générale s'applique à une norme d'ensemble, il convient de citer celle-ci explicitement en indiquant le présent document suivi du numéro de l'article ou du paragraphe correspondant, par exemple "IEC 61439-1:2020, 9.1.3".

Une norme d'ensemble particulière peut ne pas exiger et donc ne pas renvoyer à une règle générale lorsque cette règle n'est pas applicable, ou elle peut ajouter des exigences si la règle générale est considérée comme inappropriée dans le cas particulier traité, mais elle ne peut pas introduire de divergences sauf si une justification technique importante est donnée dans la norme d'ensemble particulière.

Lorsque, dans le présent document, des références de mise en correspondance sont faites à un autre article, la référence doit s'appliquer à l'article considéré tel que modifié par la norme d'ensemble particulière, le cas échéant.

Les exigences du présent document qui sont sujettes à un accord entre le constructeur d'ensembles et l'utilisateur sont rassemblées à l'Annexe C (informative). Cette liste facilite également la fourniture des informations sur les conditions de base et les spécifications supplémentaires de l'utilisateur afin de permettre la conception, la mise en œuvre et l'utilisation correctes de l'ensemble.

Pour la série IEC 61439, les parties suivantes sont publiées:

a) IEC 61439-1: Règles générales;
b) IEC 61439-2: Ensembles d'appareillage de puissance (ensembles EAP) [1];
c) IEC 61439-3: Tableaux de répartition destinés à être utilisés par des personnes ordinaires (DBO);
d) IEC 61439-4: Exigences particulières pour ensembles de chantiers (EC);
e) IEC 61439-5: Ensembles pour réseaux de distribution publique;
f) IEC 61439-6: Systèmes de canalisation préfabriquée;
g) IEC 61439-7: Ensembles pour installations publiques particulières telles que les marinas, les terrains de camping, les marchés et les emplacements analogues, et pour les bornes de charge de véhicules électriques;

[1] L'IEC 61439-2 comprend les exigences pour les ensembles destinés aux installations photovoltaïques.

h) IEC TR 61439-0: Guidance to specifying assemblies (disponible en anglais seulement).

Cette liste n’est pas exhaustive; des parties supplémentaires peuvent être élaborées en fonction des besoins.

ENSEMBLES D'APPAREILLAGE À BASSE TENSION –

Partie 1: Règles générales

1 Domaine d'application

La présente partie de l'IEC 61439 formule les définitions générales et les conditions d'emploi, les exigences de construction, les caractéristiques techniques et les exigences de vérification pour les ensembles d'appareillage à basse tension.

NOTE Dans le présent document, le terme ensemble(s) (voir 3.1.1) est utilisé pour désigner un ou des ensembles d'appareillage à basse tension.

Dans le but de déterminer la conformité de l'ensemble, les exigences de la partie applicable de la série IEC 61439 (à partir de la Partie 2), s'appliquent, de même que les exigences citées dans le présent document. Pour les ensembles non couverts par les parties à partir de la Partie 3, la Partie 2 s'applique.

Le présent document s'applique, uniquement lorsque la norme d'ensemble applicable l'exige, aux ensembles tels que décrits ci-après:

– les ensembles dont la tension assignée ne dépasse pas 1 000 V en courant alternatif ou 1 500 V en courant continu;
– les ensembles conçus pour une fréquence nominale de l'alimentation ou des alimentations d'entrée ne dépassant pas 1 000 Hz;
– les ensembles conçus pour des applications d'intérieur ou d'extérieur;
– les ensembles fixes ou mobiles, avec ou sans enveloppe;
– les ensembles destinés à être utilisés avec des équipements conçus pour la production, le transport, la distribution et la conversion de l'énergie électrique et la commande des matériels consommant de l'énergie électrique.

Le présent document ne s'applique pas aux appareils considérés individuellement et aux composants indépendants, tels que démarreurs de moteur, fusibles-interrupteurs, systèmes et appareils électroniques de conversion de puissance (SECP), alimentations à découpage (SMPS, *Switch Mode Power Supplies*), alimentations sans interruption (ASI), modules d'entraînement principaux (MEP), modules d'entraînement complets (MEC), entraînements électriques de puissance (PDS, *Power Drive System*) à vitesse variable et autres matériels électroniques qui sont conformes aux normes de produit les concernant. Le présent document décrit l'intégration d'appareils et de constituants indépendants dans un ensemble ou dans une enveloppe vide formant un ensemble.

Pour certaines applications impliquant, par exemple, des atmosphères explosives ou la sécurité fonctionnelle, il peut être nécessaire de satisfaire aux exigences d'autres normes ou d'une autre législation, en plus de celles spécifiées dans la série IEC 61439.

2 Références normatives

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

IEC 60068-2-2:2007, *Essais d'environnement – Partie 2-2: Essais – Essai B: Chaleur sèche*

IEC 60068-2-11:1981, *Essais fondamentaux climatiques et de robustesse mécanique – Partie 2-11: Essais – Essai Ka: Brouillard salin*

IEC 60068-2-30:2005*, Essais d'environnement – Partie 2-30: Essais – Essai Db: Essai cyclique de chaleur humide (cycle de 12 h + 12 h)*

IEC 60073:2002, *Principes fondamentaux et de sécurité pour l'interface homme-machine, le marquage et l'identification – Principes de codage pour les indicateurs et les organes de commande*

IEC 60085:2007*, Isolation électrique – Evaluation et désignation thermiques*

IEC 60364 (toutes les parties), *Installations électriques à basse tension*

IEC 60364-4-41:2005, *Installations électriques à basse tension – Partie 4-41: Protection pour assurer la sécurité – Protection contre les chocs électriques*
IEC 60364-4-41:2005/AMD1:2017

IEC 60364-5-51:2005, *Installations électriques des bâtiments – Partie 5-51: Choix et mise en œuvre des matériels électriques – Règles communes*

IEC 60364-5-52:2009*, Installations électriques à basse tension – Partie 5-52: Choix et mise en œuvre des matériels électriques – Canalisations*

IEC 60439 (toutes les parties), *Ensembles d'appareillage à basse tension* [2]

IEC 60445:2017, *Principes fondamentaux et de sécurité pour les interfaces homme-machines, le marquage et l'identification – Identification des bornes de matériels, des extrémités de conducteurs et des conducteurs*

IEC 60447:2004, *Principes fondamentaux et de sécurité pour l'interface homme-machine, le marquage et l'identification – Principes de manœuvre*

IEC 60529:1989, *Degrés de protection procurés par les enveloppes (Code IP*) [3]
IEC 60529:1989/AMD1:1999
IEC 60529:1989/AMD2:2013

IEC 60695-2-10:2013, *Essais relatifs aux risques du feu – Partie 2-10: Essais au fil incandescent/chauffant – Appareillage et méthode commune d'essai*

IEC 60695-2-11:2014, *Essais relatifs aux risques du feu – Partie 2-11: Essais au fil incandescent/chauffant – Méthode d'essai d'inflammabilité pour produits finis (GWEPT)*

IEC 60695-2-12, *Essais relatifs aux risques du feu – Partie 2-12: Essais au fil incandescent/chauffant – Méthode d'essai d'indice d'inflammabilité au fil incandescent (GWFI) pour matériaux*

IEC 60865-1:2011, *Courants de court-circuit – Calcul des effets – Partie 1: Définitions et méthodes de calcul*

---

2 Supprimée. La série IEC 60439 a été annulée et remplacée par la série IEC 61439.

3 Il existe une édition 2.2 consolidée (2013) de ce document, qui comprend l'IEC 60529 (1989), son Amendement 1 (1999) et son Amendement 2 (2013).

IEC TR 60890:2014, *Méthode de vérification par calcul des échauffements pour les ensembles d'appareillage à basse tension*

IEC 60947-4:1:2018, *Appareillage à basse tension – Partie 4-1: Contacteurs et démarreurs de moteurs – Contacteurs et démarreurs électromécaniques*

IEC 61000-4-2:2008*, Compatibilité électromagnétique (CEM) – Partie 4-2: Techniques d'essai et de mesure – Essai d'immunité aux décharges électrostatiques*

IEC 61000-4-3:2006, *Compatibilité électromagnétique (CEM) – Partie 4-3: Techniques d'essai et de mesure – Essai d'immunité aux champs électromagnétiques rayonnés aux fréquences radioélectriques* [4]
IEC 61000-4-3:2006/AMD1:2007
IEC 61000-4-3:2006/AMD2:2010

IEC 61000-4-4:2012, *Compatibilité électromagnétique (CEM) – Partie 4-4: Techniques d'essai et de mesure – Essais d'immunité aux transitoires électriques rapides en salves*

IEC 61000-4-5:2014, *Compatibilité électromagnétique (CEM) – Partie 4-5: Techniques d'essai et de mesure – Essai d'immunité aux ondes de choc* [5]
IEC 61000-4-5:2014/AMD1:2017

IEC 61000-4-6:2013, *Compatibilité électromagnétique (CEM) – Partie 4-6: Techniques d'essai et de mesure – Immunité aux perturbations conduites, induites par les champs radioélectrique*s

IEC 61000-4-8:2009, *Compatibilité électromagnétique (CEM) – Partie 4-8: Techniques d'essai et de mesure – Essai d'immunité au champ magnétique à la fréquence du réseau*

IEC 61000-4-11:2004, *Compatibilité électromagnétique (CEM) – Partie 4-11: Techniques d'essai et de mesure – Essais d'immunité aux creux de tension, coupures brèves et variations de tension*
IEC 61000-4-11:2004/AMD1:2017

IEC 61000-6-3:2006, *Compatibilité électromagnétique (CEM) – Partie 6-3: Normes génériques – Norme sur l'émission pour les environnements résidentiels, commerciaux et de l'industrie légère*
IEC 61000-6-3:2006/AMD1:2010

IEC 61000-6-4:2018, *Compatibilité électromagnétique (CEM) – Partie 6-4: Normes génériques – Norme sur l'émission pour les environnements industriels*

IEC 61082-1:2014, *Etablissement des documents utilisés en électrotechnique – Partie 1: Règles*

IEC 61180:2016, *Techniques des essais à haute tension pour matériel à basse tension – Définitions, exigences relatives aux essais, matériel d'essai*

IEC 61439 (toutes les parties*), Ensembles d'appareillage à basse tension*

_____

4 Il existe une édition 3.2 consolidée (2010) qui comprend l'IEC 61000-4-3 (2006), l'Amendement 1 (2007) et l'Amendement 2 (2010).

5 Il existe une édition 3.1 consolidée (2017) qui comprend l'IEC 61000-4-5 (2014) et son Amendement 1 (2017).

IEC 61921:2017, *Condensateurs de puissance – Batteries de compensation du facteur de puissance basse tension*

IEC 62208:2011, *Enveloppes vides destinées aux ensembles d'appareillage à basse tension – Règles générales*

IEC 81346-1:2009, *Systèmes industriels, installations et appareils, et produits industriels – Principes de structuration et désignations de référence – Partie 1: Règles de base*

IEC 81346-2:2019, *Systèmes industriels, installations et appareils, et produits industriels – Principes de structuration et désignations de référence – Partie 2: Classification des objets et codes pour les classes*

CISPR 11:2015, *Appareils industriels, scientifiques et médicaux – Caractéristiques de perturbations radioélectriques – Limites et méthodes de mesure*
CISPR 11:2015/AMD1:2016
CISPR 11:2015/AMD2:2019

CISPR 32:2015, *Compatibilité électromagnétique des équipements multimédia – Exigences d'émission*
CISPR 32:2015/AMD1:2019

ISO 178:2010, *Plastiques – Détermination des propriétés en flexion*
ISO 178:2010/AMD1:2013

ISO 179-1:2010, *Plastiques – Détermination des caractéristiques au choc Charpy – Partie 1: Essai de choc non instrumenté*

ISO 179-2:1997, *Plastiques – Détermination des caractéristiques au choc Charpy – Partie 2: Essai de choc instrumenté*
ISO 179-2:1997/AMD1:2011

ISO 2409:2013, *Peintures et vernis – Essai de quadrillage*

ISO 4628-3:2016, *Peintures et vernis – Evaluation de la dégradation des revêtements – Désignation de la quantité et de la dimension des défauts, et de l'intensité des changements uniformes d'aspect – Partie 3: Evaluation du degré d'enrouillement*

ISO 4892-2:2013, *Plastiques – Méthodes d'exposition à des sources lumineuses de laboratoire – Partie 2: Lampes à arc au xénon*

ISO 7010*, Symboles graphiques – Couleurs de sécurité et signaux de sécurité – Signaux de sécurité enregistrés*