

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

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





THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2011 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

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

About IEC publications

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

- Catalogue of IEC publications: www.iec.ch/searchpub

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 It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch

Tel.: +41 22 919 02 11

Fax: +41 22 919 03 00

A propos de la CEI

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

A propos des publications CEI

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

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,...). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:

Email: csc@iec.ch

Tél.: +41 22 919 02 11

Fax: +41 22 919 03 00

This is a preview. Click here to purchase the full publication.



IEC 61439-1

Edition 2.0 2011-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX XG

ICS 29.130.20

ISBN 978-2-88912-634-7

® Registered trademark of
Marque déposée de la C

This is a preview. Click here to purchase the full publication.

CONTENTS

FOREWORD	8
INTRODUCTION	11
1 Scope	12
2 Normative references	12
3 Terms and definitions	15
3.1 General terms	15
3.2 Constructional units of ASSEMBLIES	17
3.3 External design of ASSEMBLIES	18
3.4 Structural parts of ASSEMBLIES	18
3.5 Conditions of installation of ASSEMBLIES	20
3.6 Insulation characteristics	20
3.7 Protection against electric shock	23
3.8 Characteristics	25
3.9 Verification	27
3.10 Manufacturer/user	28
4 Symbols and abbreviations	28
5 Interface characteristics	29
5.1 General	29
5.2 Voltage ratings	29
5.2.1 Rated voltage (U_n) (of the ASSEMBLY)	29
5.2.2 Rated operational voltage (U_e) (of a circuit of an ASSEMBLY)	29
5.2.3 Rated insulation voltage (U_i) (of a circuit of an ASSEMBLY)	29
5.2.4 Rated impulse withstand voltage (U_{imp}) (of the ASSEMBLY)	29
5.3 Current ratings	30
5.3.1 Rated current of the ASSEMBLY (I_{nA})	30
5.3.2 Rated current of a circuit (I_{nc})	30
5.3.3 Rated peak withstand current (I_{pk})	30
5.3.4 Rated short-time withstand current (I_{cw}) (of a circuit of an ASSEMBLY)	30
5.3.5 Rated conditional short-circuit current of an ASSEMBLY (I_{cc})	30
5.4 Rated diversity factor (RDF)	31
5.5 Rated frequency (f_n)	31
5.6 Other characteristics	31
6 Information	32
6.1 ASSEMBLY designation marking	32
6.2 Documentation	32
6.2.1 Information relating to the ASSEMBLY	32
6.2.2 Instructions for handling, installation, operation and maintenance	32
6.3 Device and/or component identification	33
7 Service conditions	33
7.1 Normal service conditions	33
7.1.1 Ambient air temperature	33
7.1.2 Humidity conditions	33
7.1.3 Pollution degree	33
7.1.4 Altitude	34
7.2 Special service conditions	34
7.3 Conditions during transport, storage and installation	35

8	Constructional requirements	35
8.1	Strength of materials and parts.....	35
8.1.1	General	35
8.1.2	Protection against corrosion	35
8.1.3	Properties of insulating materials.....	35
8.1.4	Resistance to ultra-violet radiation.....	36
8.1.5	Mechanical strength	36
8.1.6	Lifting provision	36
8.2	Degree of protection provided by an ASSEMBLY enclosure	36
8.2.1	Protection against mechanical impact.....	36
8.2.2	Protection against contact with live parts, ingress of solid foreign bodies and water	36
8.2.3	ASSEMBLY with removable parts	37
8.3	Clearances and creepage distances	37
8.3.1	General	37
8.3.2	Clearances	38
8.3.3	Creepage distances.....	38
8.4	Protection against electric shock	39
8.4.1	General	39
8.4.2	Basic protection.....	39
8.4.3	Fault protection	40
8.4.4	Protection by total insulation.....	42
8.4.5	Limitation of steady-state touch current and charge.....	43
8.4.6	Operating and servicing conditions	43
8.5	Incorporation of switching devices and components	45
8.5.1	Fixed parts	45
8.5.2	Removable parts	45
8.5.3	Selection of switching devices and components.....	46
8.5.4	Installation of switching devices and components	46
8.5.5	Accessibility	46
8.5.6	Barriers	47
8.5.7	Direction of operation and indication of switching positions.....	47
8.5.8	Indicator lights and push-buttons	47
8.6	Internal electrical circuits and connections	47
8.6.1	Main circuits	47
8.6.2	Auxiliary circuits	48
8.6.3	Bare and insulated conductors	48
8.6.4	Selection and installation of non-protected live conductors to reduce the possibility of short-circuits	49
8.6.5	Identification of the conductors of main and auxiliary circuits	49
8.6.6	Identification of the protective conductor (PE, PEN) and of the neutral conductor (N) of the main circuits	49
8.7	Cooling.....	49
8.8	Terminals for external conductors.....	49
9	Performance requirements	51
9.1	Dielectric properties	51
9.1.1	General	51
9.1.2	Power-frequency withstand voltage	51
9.1.3	Impulse withstand voltage	51

9.1.4 Protection of surge protective devices	51
9.2 Temperature rise limits	52
9.3 Short-circuit protection and short-circuit withstand strength	52
9.3.1 General	52
9.3.2 Information concerning short-circuit withstand strength	52
9.3.3 Relationship between peak current and short-time current	53
9.3.4 Co-ordination of protective devices	53
9.4 Electromagnetic compatibility (EMC)	53
10 Design verification	54
10.1 General	54
10.2 Strength of materials and parts	55
10.2.1 General	55
10.2.2 Resistance to corrosion	55
10.2.3 Properties of insulating materials	56
10.2.4 Resistance to ultra-violet (UV) radiation	58
10.2.5 Lifting	58
10.2.6 Mechanical impact	59
10.2.7 Marking	59
10.3 Degree of protection of ASSEMBLIES	59
10.4 Clearances and creepage distances	59
10.5 Protection against electric shock and integrity of protective circuits	60
10.5.1 Effectiveness of the protective circuit	60
10.5.2 Effective earth continuity between the exposed conductive parts of the ASSEMBLY and the protective circuit	60
10.5.3 Short-circuit withstand strength of the protective circuit	60
10.6 Incorporation of switching devices and components	61
10.6.1 General	61
10.6.2 Electromagnetic compatibility	61
10.7 Internal electrical circuits and connections	61
10.8 Terminals for external conductors	61
10.9 Dielectric properties	61
10.9.1 General	61
10.9.2 Power-frequency withstand voltage	61
10.9.3 Impulse withstand voltage	62
10.9.4 Testing of enclosures made of insulating material	64
10.9.5 External operating handles of insulating material	64
10.10 Verification of temperature rise	64
10.10.1 General	64
10.10.2 Verification by testing	64
10.10.3 Derivation of ratings for similar variants	70
10.10.4 Verification assessment	71
10.11 Short-circuit withstand strength	74
10.11.1 General	74
10.11.2 Circuits of ASSEMBLIES which are exempted from the verification of the short-circuit withstand strength	74
10.11.3 Verification by comparison with a reference design – Utilising a check list	75
10.11.4 Verification by comparison with a reference design – Utilising calculation	75
10.11.5 Verification by test	75

10.12 Electromagnetic compatibility (EMC)	80
10.13 Mechanical operation	80
11 Routine verification.....	80
11.1 General	80
11.2 Degree of protection of enclosures	81
11.3 Clearances and creepage distances	81
11.4 Protection against electric shock and integrity of protective circuits	81
11.5 Incorporation of built-in components.....	81
11.6 Internal electrical circuits and connections	81
11.7 Terminals for external conductors.....	81
11.8 Mechanical operation	82
11.9 Dielectric properties	82
11.10 Wiring, operational performance and function.....	82
Annex A (normative) Minimum and maximum cross-section of copper conductors suitable for connection to terminals for external conductors (see 8.8)	90
Annex B (normative) Method of calculating the cross-sectional area of protective conductors with regard to thermal stresses due to currents of short duration	91
Annex C (informative) User information template	92
Annex D (informative) Design verification	96
Annex E (informative) Rated diversity factor	97
Annex F (normative) Measurement of clearances and creepage distances	106
Annex G (normative) Correlation between the nominal voltage of the supply system and the rated impulse withstand voltage of the equipment	111
Annex H (informative) Operating current and power loss of copper conductors	113
Annex I (Void).....	115
Annex J (normative) Electromagnetic compatibility (EMC).....	116
Annex K (normative) Protection by electrical separation.....	123
Annex L (informative) Clearances and creepage distances for North American region	126
Annex M (informative) North American temperature rise limits	127
Annex N (normative) Operating current and power loss of bare copper bars	128
Annex O (informative) Guidance on temperature rise verification	130
Annex P (normative) Verification of the short-circuit withstand strength of busbar structures by comparison with a tested reference design by calculation	135
Bibliography.....	139
 Figure E.1 – Typical ASSEMBLY	98
Figure E.2 – Example 1: Table E.1 – Functional unit loading for an ASSEMBLY with a rated diversity factor of 0,8	100
Figure E.3 – Example 2: Table E.1 – Functional unit loading for an ASSEMBLY with a rated diversity factor of 0,8	101
Figure E.4 – Example 3: Table E.1 – Functional unit loading for an ASSEMBLY with a rated diversity factor of 0,8	102
Figure E.5 – Example 4: Table E.1 – Functional unit loading for an ASSEMBLY with a rated diversity factor of 0,8	103
Figure E.6 – Example of average heating effect calculation	104
Figure E.7 – Example graph for the relation between the equivalent RDF and the parameters at intermittent duty at $t_1 = 0,5$ s, $I_1 = 7 \cdot I_2$ at different cycle times	105

Figure E.8 – Example graph for the relation between the equivalent RDF and the parameters at intermittent duty at $I_1 = I_2$ (no starting overcurrent).....	105
Figure F.1 – Measurement of ribs	110
Figure J.1 – Examples of ports	116
Figure O.1 – Temperature rise verification methods	134
Figure P.1 – Tested busbar structure (TS)	135
Figure P.2 – Non tested busbar structure (NTS).....	136
Figure P.3 – Angular busbar configuration with supports at the corners	138
 Table 1 – Minimum clearances in air ^a (8.3.2).....	82
Table 2 – Minimum creepage distances (8.3.3)	83
Table 3 – Cross-sectional area of a copper protective conductor (8.4.3.2.2)	83
Table 4 – Conductor selection and installation requirements (8.6.4).....	84
Table 5 – Minimum terminal capacity for copper protective conductors (PE, PEN) (8.8)	84
Table 6 – Temperature-rise limits (9.2)	85
Table 7 – Values for the factor n ^a (9.3.3)	86
Table 8 – Power-frequency withstand voltage for main circuits (10.9.2)	86
Table 9 – Power-frequency withstand voltage for auxiliary and control circuits (10.9.2).....	86
Table 10 – Impulse withstand test voltages (10.9.3).....	87
Table 11 – Copper test conductors for rated currents up to 400 A inclusive (10.10.2.3.2)	87
Table 12 – Copper test conductors for rated currents from 400 A to 4 000 A (10.10.2.3.2)	88
Table 13 – Short-circuit verification by comparison with a reference design: check list (10.5.3.3, 10.11.3 and 10.11.4).....	88
Table 14 – Relationship between prospective fault current and diameter of copper wire	89
Table A.1 – Cross-section of copper conductors suitable for connection to terminals for external conductors	90
Table B.1 – Values of k for insulated protective conductors not incorporated in cables, or bare protective conductors in contact with cable covering.....	91
Table C.1 – Template	92
Table D.1 – List of design verifications to be performed	96
Table E.1 – Examples of loading for an ASSEMBLY with a rated diversity factor of 0,8	99
Table E.2 – Example of loading of a group of circuits (Section B – Figure E.1) with a rated diversity factor of 0,9	104
Table E.3 – Example of loading of a group of circuits (Sub-distribution board – Figure E.1) with a rated diversity factor of 0,9	104
Table F.1 – Minimum width of grooves	106
Table G.1 – Correspondence between the nominal voltage of the supply system and the equipment rated impulse withstand voltage	112
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)	113
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).....	114
Table J.1 – Tests for EMC immunity for environment A (see J.10.12.1).....	120
Table J.2 – Tests for EMC immunity for environment B (see J.10.12.1).....	121

Table J.3 – Acceptance criteria when electromagnetic disturbances are present.....	122
Table K.1 – Maximum disconnecting times for TN systems	125
Table L.1 – Minimum clearances in air	126
Table L.2 – Minimum creepage distances	126
Table M.1 – North American temperature rise limits	127
Table N.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 temperature inside the ASSEMBLY: 55 °C, temperature of the conductor 70 °C).....	128
Table N.2 – Factor k_4 for different temperatures of the air inside the ASSEMBLY and/or for the conductors	129

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 17D: Low-voltage switchgear and controlgear assemblies, of IEC technical committee 17: Switchgear and controlgear.

This second edition cancels and replaces the first edition published in 2009. It constitutes a technical revision.

This second edition includes the following significant technical changes with respect to the last edition of IEC 61439-1:

- revision of service conditions in Clause 7;
- numerous changes regarding verification methods in Clause 10;
- modification of routine verification in respect of clearances and creepage distances (see 11.3);

- adaption of the tables in Annex C and Annex D to the revised requirements and verification methods;
- revision of the EMC requirements in Annex J;
- shifting of tables from Annex H to new Annex N;
- new Annex O with guidance on temperature rise verification;
- new Annex P with a verification method for short-circuit withstand strength (integration of the content of IEC/TR 61117);
- update of normative references;
- general editorial review.

NOTE It should be noted that when a dated reference to IEC 60439-1 is made in another Part of the IEC 60439 series of assembly standards not yet transferred into the new IEC 61439 series, the superseded IEC 60439-1 still applies (see also the Introduction below).

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

FDIS	Report on voting
17D/441/FDIS	17D/446/RVD

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

In this standard, terms written in small capitals are defined in Clause 3.

The “in some countries” notes regarding differing national practices are contained in the following subclauses:

- 5.4
- 8.2.2
- 8.3.2
- 8.3.3
- 8.4.2.3
- 8.5.5
- 8.6.6
- 8.8
- 9.2
- 10.11.5.4
- 10.11.5.6.1
- Annex L
- Annex M

This publication 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.