UL 60947-1

STANDARD FOR SAFETY

Low-Voltage Switchgear and Controlgear – Part 1: General Rules

UL Standard for Safety for Low-Voltage Switchgear and Controlgear – Part 1: General Rules, UL 60947-1

Sixth Edition, Dated May 31, 2022

Summary of Topics

This sixth edition of ANSI/UL 60947-1 is a IEC-based standard covering general requirements for industrial control equipment. It is based on the edition 5.2 of IEC 60947-1.

Please note that the national difference document incorporates all of the national differences for UL 60947-1.

The requirements are substantially in accordance with Proposal(s) on this subject dated May 8, 2020 and September 10, 2021.

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NMX-J-515-ANCE
Third Edition

CSA Group
CSA C22.2 No. 60947-1:22
Third Edition
(IEC 60947-1:2007+A1:2010+A2:2014, MOD)

Underwriters Laboratories Inc.
UL 60947-1
Sixth Edition

Low-Voltage Switchgear and Controlgear – Part 1: General Rules

May 31, 2022

This standard is based on publication IEC 60947-1, Edition 5.2 (2014).

ANSI/UL 60947-1-2022

Commitment for Amendments

This standard is issued jointly by the Association of Standardization and Certification (ANCE), the Canadian Standards Association (operating as “CSA Group”), and Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to ANCE, CSA Group, or UL at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of ANCE, CSA Group, and UL. CSA Group and UL will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue. ANCE will incorporate the same revisions into a new edition of the standard bearing the same date of issue as the CSA Group and UL pages.

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This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. The technical content of IEC and ISO publications is kept under constant review by IEC and ISO. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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This ANSI/UL Standard for Safety consists of the Sixth Edition. The most recent designation of ANSI/UL 60947-1 as an American National Standard (ANSI) occurred on May 31, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

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Preface

This is the harmonized ANCE, CSA Group, and UL standard for Low-voltage switchgear and controlgear – Part 1: General rules. It is the third edition of NMX-J-515-ANCE, the third edition of CSA C22.2 No. 60947-1, and the sixth edition of UL 60947-1. This edition of CSA C22.2 No. 60947-1 supersedes the previous edition published in 2013 as CAN/CSA-C22.2 No. 60947-1.

This harmonized standard is based on IEC publication 60947-1, Edition 5.2, Low-voltage switchgear and controlgear – Part 1: General rules, issued September 2014. IEC 60947-1 is copyrighted by the IEC.

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), CSA Group, and Underwriters Laboratories Inc. (UL). The efforts and support of the Technical Harmonization Committee for Industrial Control Equipment, of the Council on the Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA), are gratefully acknowledged.

This Standard is considered suitable for use for conformity assessment within the stated scope of the Standard.

This Standard was reviewed by the CSA Integrated Committee on Industrial Control, under the jurisdiction of the CSA Technical Committee on Industrial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee. This Standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is considered a minimum quantity.

Note: Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

Level of harmonization

This standard adopts the IEC text with national differences.

This standard is published as an equivalent standard for ANCE, CSA Group, and UL.

An equivalent standard is a standard that is substantially the same in technical content, except as follows: Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

All national differences from the IEC text are included in the ANCE, CSA Group, and UL versions of the standard. While the technical content is the same in each organization's version, the format and presentation may differ

Reasons for differences from IEC

National differences from the IEC are being added in order to address safety and regulatory situations present in the US, Mexico, and Canada.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

IEC Copyright

For ANCE, the text, figures, and tables of International Electrotechnical Commission Publication 60947-1, Standard for Low-voltage switchgear and controlgear – Part 1: General rules, edition 5.2, copyright 2014, are used in this Standard according to the guidelines provided in the ISO/IEC/POCOSA.

For CSA Group, the text, figures, and tables of International Electrotechnical Commission Publication 60947-1, Low-voltage switchgear and controlgear – Part 1: General rules, copyright 2014, are used in this Standard with the consent of the International Electrotechnical Commission. The IEC Foreword is not a part of the requirements of this Standard but is included for information purposes only.

National Differences

National Differences from the text of International Electrotechnical Commission (IEC) Publication 60947-1, Low-voltage switchgear and controlgear – Part 1: General rules, copyright 2014, are indicated by notations (differences) and are presented in bold text. The national difference type is included in the body.

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

DR – These are National Differences based on the **national regulatory requirements**.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are National Differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.

Modification / Modify - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

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FOREWORD

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – Part 1: General rules

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.

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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 Consolidated version of IEC 60947-1 bears the edition number 5.2. It consists of the fifth edition (2007-06) [documents 17B/1550/FDIS and 17B/1563/RVD], its amendment 1 (2010-12) [documents 17B/1710/FDIS and 17B/1721/RVD] and its amendment 2 (2014-09) [documents 121A/15/FDIS and 121A/21/RVD]. The technical content is identical to the base edition and its amendments.

International Standard IEC 60947-1 has been prepared by subcommittee 17B: Low-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

The main changes with respect to the previous edition are as follows:

– modification and restructuration of 7.1;

– introduction of new figures concerning EMC tests;

– introduction of new Annexes Q, R and S.

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

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

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

• reconfirmed,

• withdrawn,

• replaced by a revised edition, or

• amended.

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

DV.1 DE *Modification of the IEC Foreword by adding the following:*

The numbering system in the standard uses a space instead of a comma to indicate thousands and uses a comma instead of a period to indicate a decimal point. For example, 1 000 means 1,000 and 1,01 means 1.01.

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – Part 1: General rules

1 General

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

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

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

1) this basic standard, referred to as "Part 1" in the specific standards covering the various types of low-voltage switchgear and controlgear;

2) the relevant equipment standard hereinafter referred to as the "relevant product standard" or "product standard".

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

A specific product standard may not require, and hence may omit, a general rule (as being not applicable), or it may add to it (if deemed inadequate in the particular case), but it may not deviate from it, unless there is a substantial technical justification.

NOTE The product standards forming the series of IEC standards covering low-voltage switchgear and controlgear are:

IEC 60947-2: Part 2: Circuit-breakers

IEC 60947-3: Part 3: Switches, disconnectors, switch-disconnectors and fuse combination units

IEC 60947-4: Part 4: Contactors and motor-starters

IEC 60947-5: Part 5: Control-circuit devices and switching elements

IEC 60947-6: Part 6: Multiple function equipment

IEC 60947-7: Part 7: Ancillary equipment

IEC 60947-8: Part 8: Control units for built-in thermal protection (PTC) for rotating electrical machines.

1DV.1 DE *Modification of Clause 1 by adding the following NOTE:*

NOTE 2DV: The Canadian, Mexican, and United States product standards based on the IEC 60947 series are part of the series of standards covering low-voltage switchgear and controlgear. See Annex DVA, Table DVA.2, for the Canadian, Mexican, and U.S. equivalent standards.

1DV.2 DE *Modification of Clause 1 by adding the following:*

1DV.2.1 The user of this standard should note that the term "switchgear" as used in IEC 60947-1 has a different definition than the North American definition. Refer to Clause 2.1.1 of this standard for the definition.

1DV.2.2 In Canada, general requirements applicable to this standard are given in CSA C22.2 No. 0. In Mexico and the United States, this requirement does not apply.

1.1 Scope and object

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

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

– definitions;

– characteristics;

– information supplied with the equipment;

– normal service, mounting and transport conditions;

– constructional and performance requirements;

– verification of characteristics and performance;

– environmental aspects.

This standard does not apply to low-voltage switchgear and controlgear assemblies which are dealt with in IEC 61439 series, as applicable.

1.1DV.1 D2 *Modification of 1.1 by adding the following*

1.1DV.1.1 This equipment is intended for installation in accordance with CSA C22.1, Canadian Electrical Code (CE Code, Part I); Mexican Official Standard, NOM-001-SEDE; and the US National Electrical Code (NEC), NFPA 70.

1.2 Normative references

The following referenced documents are indispensable for the application 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 60050(151):2001, *International Electrotechnical Vocabulary (IEV) – Chapter 151: Electrical and magnetic devices*

IEC 60050(441):1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*
Amendment 1 (2000)

IEC 60050(604):1987, *International Electrotechnical Vocabulary (IEV) – Chapter 604: Generation, transmission and distribution of electricity – Operation*
Amendment 1 (1998)

IEC 60050(826):2004, *International Electrotechnical Vocabulary (IEV) – Chapter 826: Electrical installations*

IEC 60060, *High-voltage test techniques*

IEC 60068-1:1988, *Environmental testing − Part 1: General and guidance*
Amendment 1 (1992)

IEC 60068-2-1:1990, *Environmental testing − Part 2-1: Tests − Tests A: Cold*
Amendment 1 (1993)
Amendment 2 (1994)

IEC 60068-2-2:1974, *Environmental testing − Part 2-2: Tests − Tests B: Dry heat*
Amendment 1 (1993)
Amendment 2 (1994)

IEC 60068-2-6:1995, *Environmental testing − Part 2-6: Tests − Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27:1987, *Environmental testing − Part 2-27: Tests − Test Ea and guidance: Shock*

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

IEC 60068-2-52:1996, *Environmental testing − Part 2-52: Tests − Test Kb: Salt mist, cyclic (sodium chloride solution)*

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

IEC 60071-1:1993, *Insulation co-ordination – Part 1: Definitions, principles and rules*

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

IEC 60085:2004, *Electrical insulation – Thermal classification*

IEC 60092-504:2001, *Electrical installations in ships – Part 504: Special features – Control and instrumentation*

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

IEC 60216, *Guide for the determination of thermal endurance properties of electrical insulating materials*

IEC 60228:2004, *Conductors of insulated cables*

IEC 60269-1:1998, *Low-voltage fuses – Part 1: General requirements*
Amendment 1 (2005)

IEC 60269-2:1986, *Low-voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)*
Amendment 1 (1995)
Amendment 2 (2001)

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

IEC 60344:1980, *Guide to the calculation of resistance of plain and coated copper conductors of low-frequency cables and wires*
Amendment 1 (1985)

IEC 60364-4-44:2001, *Electrical installations of buildings – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*
Amendment 1 (2003)

IEC 60417-DB:2002[1], *Graphical symbols for use on equipment*

[1] "DB" refers to the IEC on-line database.

IEC 60445:1999, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals and of terminations of certain designated conductors, including general rules of an alphanumeric system*

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)*
Amendment 1 (1999)

IEC 60617-DB:2001[1], *Graphical symbols for diagrams*

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

IEC 60664-3:2003, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution*

IEC 60664-5:2007, *Insulation coordination for equipment within low-voltage systems – Part 5: Comprehensive method for determining clearances and creepage distances equal to or less than 2 mm*

IEC 60695-2-2:1991, *Fire hazard testing – Part 2: Test methods – Section 2: Needle-flame test*
Amendment 1 (1994)

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

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

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

IEC 60695-11-10:1999, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*
Amendment 1 (2003)

IEC 60947-5-1:2003, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*
Amendment 1 (2009)

IEC 60947-8:2003, *Low-voltage switchgear and controlgear – Part 8: Control units for built-in thermal protection (PTC) for rotating electrical machines*
Amendment 1 (2006)

IEC 60981:2004, *Extra heavy-duty electrical rigid steel conduits*

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

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

IEC 61000-3-2:2005, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*
Amendment 1 (2008)
Amendment 2 (2009)

IEC 61000-3-3:2013, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems for equipment with rated current ≤ 16 A per phase and not subject to conditional connection*

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*
Amendment 1 (2007)
Amendment 2 (2010)

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

IEC 61000-4-5:2005, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

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 61000-4-13:2002, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and measurement techniques – Harmonics and inter-harmonics including mains signalling at a.c. power port, low-frequency immunity tests*
Amendment 1 (2009)

IEC 61000-6-2:2005, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61131-2:2003, *Programmable controllers – Part 2: Equipment requirements and tests*

IEC 61140:2001, *Protection against electric shock – Common aspects for installation and equipment*
Amendment 1(2004)

IEC 61180 (all parts), *High-voltage test techniques for low voltage equipment*

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

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

IEC 61649:2008, *Weibull analysis*

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

IEC 62430:2009, *Environmentally conscious design for electrical and electronic products*

IEC 62474:2012, *Material declaration for products of and for the electrotechnical industry*

CISPR 11:2009, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*
Amendment 1 (2010)

ISO 13849-1:2006, *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*

1.2DV D2 *Modification of 1.2 by adding the following:*

See Table DVA.2 for normative references and Table DVB.1 for component standards.

2 Definitions

NOTE 1 Most of the definitions listed in this clause are taken unchanged from the IEV (IEC 60050). When this is the case, the IEV reference is given in brackets with the title (the first group of 3 figures indicates the IEV chapter reference).

When an IEV definition is amended, the IEV reference is not indicated with the title, but in an explanatory note.

Alphabetical index of definitions

NOTE 2 The alphabetical list of ratings, characteristics and symbols is given in Clause 4.

2.1 General terms

2.1.1
switchgear and controlgear
general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equip¬ment with associated interconnections, accessories, enclosures and supporting structures

[441-11-01]

2.1.2
switchgear
general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for use in connection with generation, transmission, distribution and conversion of electric energy

[441-11-02]

2.1.3
controlgear
general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting struc¬tures, intended in principle for the control of electric energy consuming equipment

[441-11-03]

2.1.4
over-current
current exceeding the rated current

[441-11-06]

2.1.5
short circuit
accidental or intentional conductive path between two or more conductive parts forcing the electric potential differences between these conductive parts to be equal to or close to zero

[151-12-04]

2.1.6
short-circuit current
over-current resulting from a short circuit due to a fault or an incorrect connection in an electric circuit

[441-11-07]

2.1.7
overload
operating conditions in an electrically undamaged circuit which cause an over-current

[441-11-08]

2.1.8
overload current
over-current occurring in an electrically undamaged circuit

2.1.9
ambient air temperature
temperature, determined under prescribed conditions, of the air surrounding the complete switching device or fuse

[441-11-13]

NOTE For switching devices or fuses installed inside an enclosure, it is the temperature of the air outside the enclosure.

2.1.10
conductive part
part which is capable of conducting current although it may not necessarily be used for carrying service current

[441-11-09]

2.1.11
exposed conductive part
conductive part which can readily be touched and which is not normally alive, but which may become alive under fault conditions

[441-11-10]

NOTE Typical exposed conductive parts are walls of enclosures, operating handles, etc.

2.1.12
extraneous conductive part
conductive part not forming part of the electrical installation and liable to introduce a potential, generally the earth potential

[826-03-03]

2.1.13
live part
conductor or conductive part intended to be energized in normal use, including a neutral conductor but, by convention, not a PEN conductor

[826-03-01]

NOTE This term does not necessarily imply a risk of electric shock.

2.1.14
protective conductor (symbol PE)
conductor required by some measures for protection against electric shock for electrically connecting any of the following parts:

– exposed conductive parts,

– extraneous conductive parts,

– main earthing terminal,

– earth electrode,

– earthed point of the source or artificial neutral

[826-04-05]

2.1.14DV DR *Modification of 2.1.14 by adding the following:*

2.1.14DV.1 Segments of the "protective conductor" connecting various parts together are referenced by specific terms which identify their location in the grounding system and specific regulatory requirements for their installation.

2.1.14DV.2 In Mexico and the United States, the defined term "equipment grounding conductor" describes a conductor connecting non-current carrying parts of electrical equipment to the system grounded conductor. In Canada, this conductor is defined as a "bonding conductor".

2.1.14DV.3 In Canada, the defined term "grounding conductor" describes a conductor connecting service equipment or a system circuit conductor to the grounding electrode. In Mexico and the United States, this conductor is defined as a "grounding electrode conductor".

2.1.15
neutral conductor (symbol N)
conductor connected to the neutral point of a system and capable of contributing to the transmission of electrical energy

[826-01-03]

NOTE In some cases, the functions of the neutral conductor and the protective conductor may be combined under specified conditions in one and the same conductor referred to as the PEN conductor (Symbol PEN).

2.1.16
enclosure
part providing a specified degree of protection of equipment against certain external influences and a specified degree of protection against approach to or contact with live parts and moving parts

NOTE This definition is similar to IEV 441-13-01, which applies to assemblies.

2.1.17
integral enclosure
enclosure which forms an integral part of the equipment

2.1.18
utilization category (for a switching device or a fuse)
combination of specified requirements related to the conditions in which the switching device or the fuse fulfils its purpose, selected to represent a characteristic group of practical applications

[441-17-19]

NOTE The specified requirements may concern e.g. the values of making capacities (if applicable), breaking capacities and other characteristics, the associated circuits and the relevant conditions of use and behaviour.

2.1.19
isolation (isolating function)
function intended to cut off the supply from all or a discrete section of the installation by separating the installation or section from every source of electrical energy for reasons of safety

2.1.20
electric shock
pathophysiological effect resulting from an electric current passing through a human or animal body

[826-03-04]

2.1.21
manufacturer
for the purposes of this standard, any person, company or organisation with ultimate responsibility as follows:

− to verify compliance with the appropriate standard or standards

− to provide the product information according to Clause 5

NOTE For instance, in the case of “protected starters” assembled according to the instructions of the component providers, the manufacturer will be the entity that undertook the assembly.

2.1.22
solid insulation
solid insulating material interposed between two conductive parts

2.1.23
insulation coordination barrier
solid insulating material that is not an integral part, provided for the purpose of increasing either creepage distances or clearance distances or both

2.1.24DV D2 *Add the following definition:*

Bonding
A low impedance path obtained by permanently joining all non-current-carrying metal parts to assure electrical continuity and having the capacity to conduct safely any current likely to be imposed on it.

2.1.25DV D2 *Add the following definition:*

Ground
A conducting connection, whether intentional or accidental, between an electric circuit or equipment and the earth or to some conducting body that serves in place of the earth.

2.1.26DV D2 *Add the following definition:*

Grounding
Means to limit the voltage to ground on exposed metal parts of enclosures for electrical conductors and equipment by connection to a permanent or continuous conductive path to the earth.

2.1.27DV D2 *Add the following definition:*

Grounding conductor
A conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes.

2.1.28DV D2 *Add the following definition:*

Grounding electrode conductor
The conductor used to connect the grounding electrode(s) to the equipment grounding conductor, to the grounded conductor, or to both, at the service, at each building or structure where supplied from a common service, or at the source of a separately derived system.

2.1.29DV D2 ***Add the following definition:***

Insulation system
The classification of insulation materials for the purpose of establishing temperature limits.

2.1.30DV D2 ***Add the following definition:***

Field wiring
Conductors installed for connections to external circuits.

2.2 Switching devices

2.2.1
switching device
device designed to make or break the current in one or more electric circuits

[441-14-01]

NOTE A switching device may perform one or both of these operations.

2.2.2
mechanical switching device
switching device designed to close and open one or more electric circuits by means of separable contacts

[441-14-02]

NOTE Any mechanical switching device may be designated according to the medium in which its contacts open and close, e.g.: air, SF_6, oil.

2.2.3
semiconductor switching device
switching device designed to make and/or break the current in an electric circuit by means of the controlled conductivity of a semiconductor

NOTE This definition differs from IEV 441-14-03 since a semiconductor switching device is also designed for breaking the current.

2.2.4
fuse
device that, by the fusing of one or more of its specifically designed and proportioned components, opens the circuit in which it is inserted by breaking the current when this exceeds a given value for a sufficient time. The fuse comprises all the parts that form the complete device

[441-18-01]

2.2.5
fuse-linkpart of a fuse (including the fuse-element(s)) intended to be replaced after the fuse has operated

[441-18-09]

2.2.6
fuse-element
part of the fuse-link designed to melt under the action of current exceeding some definite value for a definite period of time

[441-18-08]

2.2.7
fuse-combination unit
combination of a mechanical switching device and one or more fuses in a composite unit, assembled by the manufacturer or in accordance with his instructions

[441-14-04]

2.2.8
disconnector
mechanical switching device which, in the open position, complies with the requirements specified for the isolating function

NOTE This definition differs from IEV 441-14-05 because the requirements for the isolating function are not based only on an isolating distance.

2.2.9
switch (mechanical)
mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions which may include specified operating overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions such as those of short circuit

[441-14-10]

NOTE A switch may be capable of making but not breaking short-circuit currents.

2.2.10
switch-disconnector
switch which, in the open position, satisfies the isolating requirements specified for a disconnector

[441-14-12]

2.2.11
circuit-breaker
mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal circuit conditions such as those of short circuit

[441-14-20]

2.2.12
contactor (mechanical)
mechanical switching device having only one position of rest, operated otherwise than by hand, capable of making, carrying and breaking currents under normal circuit conditions including operating overload conditions

[441-14-33]

NOTE Contactors may be designated according to the method by which the force for closing the main contacts is provided.

2.2.13
semiconductor contactor (solid-state contactor)
device which performs the function of a contactor by utilizing a semiconductor switching device

NOTE A semiconductor contactor may also contain mechanical switching devices.

2.2.14
contactor relay
contactor used as a control switch

[441-14-35]

2.2.15
starter
combination of all the switching means necessary to start and stop a motor, in combination with suitable overload protection

[441-14-38]

NOTE Starters may be designated according to the method by which the force for closing the main contacts is provided.

2.2.16
control circuit device
electrical device, intended for the controlling, signalling, interlocking, etc. of switchgear and controlgear

NOTE Control circuit devices may include associated devices dealt with in other standards, such as instruments, potentiometers, relays, in so far as such associated devices are used for the purposes specified.

2.2.17
control switch (for control and auxiliary circuits)
mechanical switching device which serves the purpose of controlling the operation of switchgear or controlgear, including signalling, electrical interlocking, etc.

[441-14-46]

NOTE A control switch consists of one or more contact elements with a common actuating system.

2.2.18
pilot switch
non-manual control switch actuated in response to specified conditions of an actuating quantity

[441-14-48]

NOTE The actuating quantity may be pressure, temperature, velocity, liquid level, elapsed time, etc.

2.2.19
push-button
control switch having an actuator intended to be operated by force exerted by a part of the human body, usually the finger or palm of the hand, and having stored energy (spring) return

[441-14-53]

2.2.20
terminal block
insulating part carrying one or more mutually insulated terminal assemblies and intended to be fixed to a support

2.2.21
short-circuit protective device (SCPD)
device intended to protect a circuit or parts of a circuit against short-circuit currents by interrupting them

2.2.22
surge arrester
device designed to protect the electrical apparatus from high transient overvoltages and to limit the duration and frequently the amplitude of the follow-on current

[604-03-51]

2.2.23
individual enclosure
enclosure designed and dimensioned to contain one equipment only

2.3 Parts of switching devices

2.3.1
pole of a switching device
portion of a switching device associated exclusively with one electrically separated conducting path of its main circuit and excluding those portions which provide a means for mounting and operating all poles together

[441-15-01]

NOTE A switching device is called single-pole if it has only one pole. If it has more than one pole, it may be called multipole (two-pole, three-pole, etc.) provided the poles are or can be coupled in such a manner as to operate together.

2.3.2
main circuit (of a switching device)
all the conductive parts of a switching device included in the circuit which it is designed to close or open

[441-15-02]

2.3.3
control circuit (of a switching device)
all the conductive parts (other than the main circuit) of a switching device which are included in a circuit used for the closing operation or opening operation, or both, of the device

[441-15-03]

2.3.4
auxiliary circuit (of a switching device)
all the conductive parts of a switching device which are intended to be included in a circuit other than the main circuit and the control circuits of the device

[441-15-04]

NOTE Some auxiliary circuits fulfil supplementary functions such as signalling, interlocking, etc., and, as such, they may be part of the control circuit of another switching device.

2.3.5
contact (of a mechanical switching device)
conductive parts designed to establish circuit continuity when they touch and which, due to their relative motion during an operation, open or close a circuit or, in the case of hinged or sliding contacts, maintain circuit continuity

[441-15-05]

2.3.6
contact piece
one of the conductive parts forming a contact

[441-15-06]

2.3.7
main contact
contact included in the main circuit of a mechanical switching device, intended to carry, in the closed position, the current of the main circuit

[441-15-07]

2.3.8
arcing contact
arc contact on which the arc is intended to be established

[441-15-08]

NOTE An arcing contact may serve as a main contact; it may be a separate contact so designed that it opens after and closes before another contact which it is intended to protect from deterioration.

2.3.9
control contact
contact included in a control circuit of a mechanical switching device and mechanically operated by this device

[441-15-09]

2.3.10
auxiliary contact
contact included in an auxiliary circuit and mechanically operated by the switching device

[441-15-10]

2.3.11
auxiliary switch (of a mechanical switching device)
switch containing one or more control and/or auxiliary contacts mechanically operated by a switching device

[441-15-11]

2.3.12
"a" contact – make contact
control or auxiliary contact which is closed when the main contacts of the mechanical switching device are closed and open when they are open

[441-15-12]

2.3.13
"b" contact – break contact
control or auxiliary contact which is open when the main contacts of the mechanical switching device are closed and closed when they are open

[441-15-13]

2.3.14
relay (electrical)
device designed to produce sudden, predetermined changes in one or more electrical output circuits when certain conditions are fulfilled in the electrical input circuits controlling the device

[446-11-01]

2.3.15
release (of a mechanical switching device)
device, mechanically connected to a mechanical switching device, which releases the holding means and permits the opening or the closing of the switching device

[441-15-17]

NOTE A release can have instantaneous, time-delay, etc., operation. The various types of releases are defined in 2.4.24 to 2.4.35.

2.3.16
actuating system (of a mechanical switching device)
whole of the operating means of a mechanical switching device which transmit the actuating force to the contact pieces

NOTE The operating means of an actuating system may be mechanical, electromagnetic, hydraulic, pneumatic, thermal, etc.

2.3.17
actuator
part of the actuating system to which an external actuating force is applied

[441-15-22]

NOTE The actuator may take the form of a handle, knob, push-button, roller, plunger, etc.

2.3.18
position indicating device
part of a mechanical switching device which indicates whether it is in the open, closed, or, where appropriate, earthed position

[441-15-25]

2.3.19
indicator light
light signal giving information either by lighting or extinguishing

2.3.20
anti-pumping device
device which prevents reclosing after a close-open operation as long as the device initiating closing is maintained in the position for closing

[441-16-48]

2.3.21
interlocking device
device which makes the operation of a switching device dependent upon the position of operation of one or more other pieces of equipment

[441-16-49]

2.3.22
connecting device
a device for the electrical connection of one (or more) conductor(s), comprising one (or more) terminal(s), either fixed to a base or forming an integral part of the equipment

[IEC 60999-1:1999, 3.3]

2.3.23
terminal
conductive part of one pole of a device for electrical connection to external circuit, composed of one or more clamping unit(s) and insulation if necessary

[IEC 60999-1:1999, 3.2, modified]

2.3.23DV DE *Modification of 2.3.23 by adding the following:*

The term "field wiring terminal" is equivalent.

2.3.24
screw-type terminal
terminal intended for the connection and disconnection of conductors or for the inter-connection of two or more conductors, the connection being made, directly or indirectly, by means of screws or nuts of any kind

NOTE Examples are given in Annex D.

2.3.25
screwless-type terminal
terminal intended for the connection and disconnection of conductors or for the interconnection on two or more conductors, the connection being made, directly or indirectly, by means of springs, wedges, eccentrics or cones, etc.

NOTE Examples are given in Annex D.

2.3.25.1
universal terminal
terminal for the connection and disconnection of all types of conductors (rigid and flexible)

[IEC 60998-2-2:2002, 3.101.1]

2.3.25.2
non-universal terminal
terminal for the connection and disconnection of a certain kind of conductor only (for example, solid conductors only or rigid [solid and stranded] conductors only)

[IEC 60998-2-2:2002, 3.101.2]

2.3.25.3
push-wire terminal
non-universal terminal in which the connection is made by pushing in rigid (solid or stranded) conductors

[IEC 60998-2-2:2002, 3.101.3]

2.3.26
clamping unit
the part(s) of the terminal necessary for the mechanical clamping and the electrical connection of the conductor(s), including the parts which are necessary to ensure the correct contact pressure

[IEC 60999-1:1999, 3.1]

2.3.26.1
universal clamping unit
clamping unit intended for all types of conductors

2.3.26.2
non-universal clamping unit
clamping unit intended for certain types of conductors only, for example:

– push-wire clamping unit for solid conductors only

– push-wire clamping unit for rigid (solid and stranded) conductors only

NOTE On push-wire clamping unit the connection is made by simple insertion of rigid conductors. (see 7.1.8.1)

2.3.27
unprepared conductor
conductor which has been cut and the insulation of which has been removed for insertion into a terminal

NOTE A conductor the shape of which is arranged for introduction into a terminal or the strands of which are twisted to consolidate the end is considered to be an unprepared conductor.

2.3.28
prepared conductor
conductor, the strands of which are soldered or the end of which is fitted with a cable lug, eyelet, etc.

2.3.29
solid conductor
conductor consisting of a single wire

NOTE 1 The solid conductor may be circular or shaped.

NOTE 2 Solid conductor is defined as class 1 conductor in IEC 60228, or by IEC 60344, or equivalent AWG/kcmil.

[461-01-06, modified]

2.3.30
stranded conductor
conductor consisting of a number of wires, all or some of which are wound in a helix

NOTE Stranded conductor is defined as class 2 conductor in IEC 60228, or by IEC 60344, or equivalent AWG/kcmil.

[151-12-36, modified]

2.3.31
rigid conductor
solid or stranded conductor having wires of such diameters, or so assembled, that the conductor is not suitable for use in a flexible cable

2.3.32
flexible conductor
stranded conductor having wires of diameters small enough and so assembled that the conductor is suitable for use in a flexible cable

NOTE Flexible conductor is defined as class 5 or class 6 conductor in IEC 60228, or by IEC 60344, or equivalent AWG/kcmil.

[461-01-11, modified]

2.3.33
multiple tip contact system
contact system comprising more than one contact gap per pole, which can be switched, in series and/or in parallel

2.3.34
minimum cross-section
value of the smallest connectable conductor cross-section stated by the manufacturer as suitable for the terminal

NOTE The manufacturer may declare several minimum cross-sections depending on the type of conductor, for example rigid, stranded, flexible, with or without ferrule.

2.3.35
maximum cross-section
value of the largest connectable conductor cross-section stated by the manufacturer as suitable for the terminal

NOTE 1 The manufacturer may declare several maximum cross-sections depending on the type of conductor, for example rigid, stranded, flexible, with or without ferrule.

NOTE 2 The term “rated cross-section” used in IEC 60947-7-1 and IEC 60999-2 and the term “rated connecting capacity” of a clamping unit used in IEC 60999-1 are considered equivalent when referring to certain thermal, mechanical and electrical requirements, as stated by the manufacturer and as specified in their relevant product standard.

2.3.36
electronically controlled electromagnet
electromagnet in which the coil is controlled by a circuit with active electronic elements

2.4 Operation of switching devices

2.4.1
operation (of a mechanical switching device)
transfer of the moving contact(s) from one position to an adjacent position

[441-16-01]

NOTE 1 For example, for a circuit-breaker, this may be a closing operation or an opening operation.

NOTE 2 If distinction is necessary, an operation in the electrical sense, e.g., make or break, is referred to as a switching operation, and an operation in the mechanical sense, e.g., close or open, is referred to as a mechanical operation.

2.4.2
operating cycle (of a mechanical switching device)
succession of operations from one position to another and back to the first position through all other positions, if any

[441-16-02]

2.4.3
operating sequence (of a mechanical switching device)
succession of specified operations with specified time intervals

[441-16-03]

2.4.4
manual control
control of an operation by human intervention

[441-16-04]

2.4.5
automatic control
control of an operation without human intervention, in response to the occurrence of predetermined conditions

[441-16-05]

2.4.6
local control
control of an operation at a point on or adjacent to the controlled switching device

[441-16-06]

2.4.7
remote control
control of an operation at a point distant from the controlled switching device

[441-16-07]

2.4.8
closing operation (of a mechanical switching device)
operation by which the device is brought from the open position to the closed position

[441-16-08]

2.4.9
opening operation (of a mechanical switching device)
operation by which the device is brought from the closed position to the open position

[441-16-09]

2.4.10
positive opening operation (of a mechanical switching device)
opening operation which, in accordance with specified requirements, ensures that all the main contacts are in the open position when the actuator is in the position corresponding to the open position of the device

[441-16-11]

2.4.11
positively driven operation
operation which, in accordance with specified requirements, is designed to ensure that auxiliary contacts of a mechanical switching device are in the respective positions corres-ponding to the open or closed position of the main contacts

[441-16-12]

2.4.12
dependent manual operation (of a mechanical switching device)
operation solely by means of directly applied manual energy such that the speed and force of the operation are dependent upon the action of the operator

[441-16-13]

2.4.13
dependent power operation (of a mechanical switching device)
operation by means of energy other than manual, where the completion of the operation is dependent upon the continuity of the power supply (to solenoids, electric or pneumatic motors, etc.)

[441-16-14]

2.4.14
stored energy operation (of a mechanical switching device)
operation by means of energy stored in the mechanism itself prior to the completion of the operation and sufficient to complete it under predetermined conditions

[441-16-15]

NOTE This kind of operation may be subdivided according to:

1 the manner of storing the energy (spring, weight, etc.);

2 the origin of the energy (manual, electric, etc.);

3 the manner of releasing the energy (manual, electric, etc.).

2.4.15
independent manual operation (of a mechanical switching device)
stored energy operation where the energy originates from manual power, stored and released in one continuous operation, such that the speed and force of the operation are independent of the action of the operator

[441-16-16]

2.4.16
independent power operation (of a mechanical switching device)
stored energy operation where the stored energy originates from an external power source and is released in one continuous operation, such that the speed and force of the operation are independent of the action of the operator

2.4.17
actuating force (moment)
force (moment) applied to an actuator necessary to complete the intended operation

[441-16-17]

2.4.18
restoring force (moment)
force (moment) provided to restore an actuator or a contact element to its initial position

[441-16-19]

2.4.19
travel (of a mechanical switching device or a part thereof)
displacement (translation or rotation) of a point on a moving element

[441-16-21]

NOTE Distinction may be made between pre-travel, over-travel, etc.

2.4.20
closed position (of a mechanical switching device)
position in which the predetermined continuity of the main circuit of the device is secured

[441-16-22]

2.4.21
open position (of a mechanical switching device)
position in which the predetermined dielectric withstand voltage requirements are satisfied between open contacts in the main circuit of the device

NOTE This definition differs from IEV 441-16-23 to meet the requirements of dielectric properties.

2.4.22
tripping (operation)
opening operation of a mechanical switching device initiated by a relay or release

2.4.23
trip-free mechanical switching device
mechanical switching device, the moving contacts of which return to and remain in the open position when the opening (i.e. tripping) operation is initiated after the initiation of the closing operation, even if the closing command is maintained

NOTE 1 To ensure proper breaking of the current which may have been established, it may be necessary that the contacts momentarily reach the closed position.

NOTE 2 The wording of IEV 441-16-31 has been completed by adding "(i.e. tripping)" since the opening operation of a trip-free mechanical switching device is automatically controlled.

2.4.24
instantaneous relay or release
relay or release which operates without any intentional time-delay

2.4.25
over-current relay or release
relay or release which causes a mechanical switching device to open with or without time-delay when the current in the relay or release exceeds a predetermined value

NOTE This value can in some cases depend upon the rate-of-rise of current.

2.4.26
definite time-delay over-current relay or release
over-current relay or release which operates with a definite time-delay which may be adjustable, but is independent of the value of the over-current

2.4.27
inverse time-delay over-current relay or release
over-current relay or release which operates after a time-delay inversely dependent upon the value of the over-current

NOTE Such a relay or release may be designed so that the time-delay approaches a definite minimum value for high values of over-current.

2.4.28
direct over-current relay or release
over-current relay or release directly energized by the current in the main circuit of a switching device

2.4.29
indirect over-current relay or release
over-current relay or release energized by the current in the main circuit of a switching device through a current transformer or a shunt

2.4.30
overload relay or release
over-current relay or release intended for protection against overloads

2.4.31
thermal overload relay or release
inverse time-delay overload relay or release depending for its operation (including its time-delay) on the thermal action of the current flowing in the relay or release

2.4.32
magnetic overload relay or release

overload relay or release depending for its operation on the force exerted by the current in the main circuit exciting the coil of an electromagnet

NOTE Such a relay or release usually has an inverse time-delay/current characteristic.

2.4.33
shunt release
release energized by a source of voltage

[441-16-41]

NOTE The source of voltage may be independent of the voltage of the main circuit.

2.4.34
under-voltage relay or release
relay or release which permits a mechanical switching device to open or close, with or without time-delay, when the voltage across the terminals of the relay or release falls below a predetermined value

2.4.35
reverse current relay or release (d.c. only)
relay or release which permits a mechanical switching device to open, with or without time-delay, when the current flows in the reverse direction and exceeds a predetermined value

2.4.36
operating current (of an over-current relay or release)
value of current at and above which the relay or release will operate

2.4.37
current-setting (of an over-current or overload relay or release)
value of current of the main circuit to which the operating characteristics of the relay or release are referred and for which the relay or release is set

NOTE A relay or release may have more than one current setting, provided by an adjustment dial, interchangeable heaters, etc.

2.4.38
current setting range (of an over-current or overload relay or release)
range between the minimum and maximum values over which the current setting of the relay or release can be adjusted

2.5 Characteristic quantities

2.5.1
nominal value
value of a quantity used to designate and identify a component, device, equipment, or system

[151-16-09]

NOTE The nominal value is generally a rounded value.

2.5.2
limiting value
in a specification of a component, device, equipment, or system, the greatest or smallest admissible value of a quantity

[151-16-10]

2.5.3
rated value
value of a quantity used for specification purposes, established for a specified set of operating conditions of a component, device, equipment, or system

[151-16-08]

2.5.4
rating
set of rated values and operating conditions

[151-16-11]

2.5.5
prospective current (of a circuit and with respect to a switching device or a fuse)
current that would flow in the circuit if each pole of the switching device or the fuse were replaced by a conductor of negligible impedance

[441-17-01]

NOTE The method to be used to evaluate and to express the prospective current is to be specified in the relevant product standard.

2.5.6
prospective peak current
peak value of a prospective current during the transient period following initiation

[441-17-02]

NOTE The definition assumes that the current is made by an ideal switching device, i.e. with instantaneous transition from infinite to zero impedance. For circuits where the current can follow several different paths, e.g. polyphase circuits, it further assumes that the current is made simultaneously in all poles, even if only the current in one pole is considered.

2.5.7
prospective symmetrical current (of an a.c. circuit)
prospective current when it is initiated at such an instant that no transient phenomenon follows the initiation

[441-17-03]

NOTE 1 For polyphase circuits the condition of non-transient period can only be satisfied for the current in one pole at a time.

NOTE 2 The prospective symmetrical current is expressed by its r.m.s. value.

2.5.8
maximum prospective peak current (of an a.c. circuit)
prospective peak current when initiation of the current takes place at the instant which leads to the highest possible value

[441-17-04]

NOTE For a multipole device in a polyphase circuit, the maximum prospective peak current refers to one pole only.

2.5.9
prospective making current (for a pole of a switching device)
prospective current when initiated under specified conditions

[441-17-05]

NOTE The specified conditions may relate to the method of initiation, e.g. by an ideal switching device, or to the instant of initiation, e.g., leading to the maximum prospective peak current in an a.c. circuit, or to the highest rate of rise. The specification of these conditions is given in the relevant product standard.

2.5.10
prospective breaking current (for a pole of a switching device or a fuse)
prospective current evaluated at a time corresponding to the instant of the initiation of the breaking process

[441-17-06]

NOTE Specifications concerning the instant of the initiation of the breaking process are given in the relevant product standard. For mechanical switching devices or fuses, it is usually defined as the moment of initiation of the arc during the breaking process.

2.5.11
breaking current (of a switching device or a fuse)
current in a pole of a switching device or in a fuse at the instant of initiation of the arc during a breaking process

[441-17-07]

NOTE For a.c., the current is expressed as the symmetrical r.m.s. value of the a.c. component.

2.5.12
breaking capacity (of a switching device or a fuse)
value of prospective breaking current that a switching device or a fuse is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

[441-17-08]

NOTE 1 The voltage to be stated and the conditions to be prescribed are dealt with in the relevant product standard.

NOTE 2 For a.c., the current is expressed as the symmetrical r.m.s. value of the a.c. component.

NOTE 3 For short-circuit breaking capacity, see 2.5.14.

2.5.13
making capacity (of a switching device)
value of prospective making current that a switching device is capable of making at a stated voltage under prescribed conditions of use and behaviour

[441-17-09]

NOTE 1 The voltage to be stated and the conditions to be prescribed are dealt with in the relevant product standard.

NOTE 2 For short-circuit making capacity, see 2.5.15.

2.5.14
short-circuit breaking capacity
breaking capacity for which prescribed conditions include a short circuit at the terminals of the switching device

[441-17-11]

2.5.15
short-circuit making capacity
making capacity for which prescribed conditions include a short circuit at the terminals of the switching device

[441-17-10]

2.5.16
critical load current
value of breaking current, within the range of service conditions, at which the arcing time is significantly extended

2.5.17
critical short-circuit current
value of breaking current, less than the rated short-circuit breaking capacity, at which the arc energy is significantly higher than at the rated short-circuit breaking capacity

2.5.18
Joule integral (I^2t)
integral of the square of the current over a given time interval

[441-18-23]

$$I^2t = \int_{t_0}^{t_1} i^2 \, dt$$

2.5.19
cut-off current – let-through current
maximum instantaneous value of current attained during the breaking operation of a switching device or a fuse

[441-17-12]

NOTE This concept is of particular importance when the switching device or the fuse operates in such a manner that the prospective peak current of the circuit is not reached.

2.5.20
time-current characteristic
curve giving the time, e.g. pre-arcing time or operating time, as a function of the prospective current, under stated conditions of operation

[441-17-13]

2.5.21
cut-off (current) characteristic – let-through (current) characteristic
curve giving the cut-off current as a function of the prospective current, under stated conditions of operation

[441-17-14]

NOTE In the case of a.c., the values of the cut-off currents are the maximum values which can be reached whatever the degree of asymmetry. In the case of d.c., the values of the cut-off currents are the maximum values reached related to the time constant as specified.

2.5.22
over-current protective co-ordination of over-current protective devices
co-ordination of two or more over-current protective devices in series to ensure overcurrent discrimination (selectivity) and/or back-up protection

2.5.23
over-current selectivity
co-ordination of the operating characteristics of two or more over-current protective devices such that, on the incidence of over-currents within stated limits, the device intended to operate within these limits does so, while the other(s) does (do) not

NOTE Distinction is made between series discrimination involving different over-current protective devices passing substantially the same over-current and network selectivity involving identical protective devices passing different proportions of the over-current.

2.5.24
back-up protection
over-current co-ordination of two over-current protective devices in series where the protective device, generally but not necessarily on the supply side, effects the over-current protection with or without the assistance of the other protective device and prevents any excessive stress on the latter

2.5.25
take-over current
current co-ordinate of the intersection between the time-current characteristics of two over-current protective devices

[441-17-16]

2.5.26
short-time delay
any intentional delay in operation within the limits of the rated short-time withstand current

2.5.27
short-time withstand current
current that a circuit or a switching device in the closed position can carry during a specified short time under prescribed conditions of use and behaviour

[441-17-17]

2.5.28
peak withstand current
value of peak current that a circuit or a switching device in the closed position can withstand under prescribed conditions of use and behaviour

[441-17-18]

2.5.29
conditional short-circuit current (of a circuit or a switching device)
prospective current that a circuit or a switching device, protected by a specified short-circuit protective device, can satisfactorily withstand for the total operating time of that device under specified conditions of use and behaviour

NOTE 1 For the purpose of this standard, the short-circuit protective device is generally a circuit-breaker or a fuse.

NOTE 2 This definition differs from IEV 441-17-20 by broadening the concept of current limiting device into a short-circuit protective device, the function of which is not only to limit the current.

2.5.30
conventional non-tripping current (of an over-current relay or release)
specified value of current which the relay or release can carry for a specified time (conventional time) without operating

2.5.31
conventional tripping current (of an over-current relay or release)
specified value of current which causes the relay or release to operate within a specified time (conventional time)

2.5.32
applied voltage (for a switching device)
voltage which exists across the terminals of a pole of a switching device just before the making of the current

[441-17-24]

NOTE This definition applies to a single-pole device. For a multipole device it is the phase-to-phase voltage across the supply terminals of the device.

2.5.33
recovery voltage
voltage which appears across the terminals of a pole of a switching device or a fuse after the breaking of the current

[441-17-25]

NOTE 1 This voltage may be considered in two successive intervals of time, one during which a transient voltage exists, followed by a second one during which the power-frequency voltage or the steady-state recovery voltage alone exists.

NOTE 2 This definition applies to a single-pole device. For a multipole device it is the phase-to-phase voltage across the supply terminals of the device.

2.5.34
transient recovery voltage (abbreviation TRV)
recovery voltage during the time in which it has a significant transient character

[441-17-26]

NOTE The transient voltage may be oscillatory or non-oscillatory or a combination of these depending on the characteristics of the circuit, the switching device or the fuse. It includes the voltage shift of the neutral of a polyphase circuit.

2.5.35
power-frequency recovery voltage
recovery voltage after the transient voltage phenomena have subsided

[441-17-27]

2.5.36
d.c. steady-state recovery voltage
recovery voltage in a d.c. circuit after the transient voltage phenomena have subsided, expressed by the mean value where ripple is present

[441-17-28]

2.5.37
prospective transient recovery voltage (of a circuit)
transient recovery voltage following the breaking of the prospective symmetrical current by an ideal switching device

[441-17-29]

NOTE The definition assumes that the switching device or the fuse, for which the prospective transient recovery voltage is sought, is replaced by an ideal switching device, i.e. having instantaneous transition from zero to infinite impedance at the very instant of zero current, i.e. at the "natural" zero. For circuits where the current can follow several different paths, e.g. a polyphase circuit, the definition further assumes that the breaking of the current by the ideal switching device takes place only in the pole considered.

2.5.38
peak arc voltage (of a mechanical switching device)
maximum instantaneous value of voltage which, under prescribed conditions, appears across the terminals of a pole of a switching device during the arcing time

[441-17-30]

2.5.39
opening time (of a mechanical switching device)
interval of time between the specified instant of initiation of the opening operation and the instant when the arcing contacts have separated in all poles

[441-17-36]

NOTE The instant of initiation of the opening operation, i.e. the application of the opening command (e.g. energizing the release), is given in the relevant product standard.

2.5.40
arcing time (of a pole or a fuse)
interval of time between the instant of the initiation of the arc in a pole or a fuse and the instant of final arc extinction in that pole or that fuse

[441-17-37]

2.5.41
arcing time (of a multipole switching device)
interval of time between the instant of the first initiation of an arc and the instant of final arc extinction in all poles

[441-17-38]

2.5.42
break time
interval of time between the beginning of the opening time of a mechanical switching device (or the pre-arcing time of a fuse) and the end of the arcing time

[441-17-39]

2.5.43
make time
interval of time between the initiation of the closing operation and the instant when the current begins to flow in the main circuit

[441-17-40]

2.5.44
closing time
interval of time between the initiation of the closing operation and the instant when the contacts touch in all poles

[441-17-41]

2.5.45
make-break time
interval of time between the instant when the current begins to flow in a pole and the instant of final arc extinction in all poles, with the opening release energized at the instant when current begins to flow in the main circuit

[441-17-43]

2.5.46
clearance
distance between two conductive parts, along a string stretched the shortest way between these conductive parts

[441-17-31]

2.5.47
clearance between poles
clearance between any conductive parts of adjacent poles

[441-17-32]

2.5.48
clearance to earth
clearance between any conductive parts and any parts which are earthed or intended to be earthed

[441-17-33]

2.5.49
clearance between open contacts (gap)
total clearance between the contacts, or any conductive parts connected thereto, of a pole of a mechanical switching device in the open position

[441-17-34]

2.5.50
isolating distance (of a pole of a mechanical switching device)
clearance between open contacts meeting the safety requirements specified for disconnectors

[441-17-35]

2.5.51
creepage distance
shortest distance along the surface of an insulating material between two conductive parts

NOTE A joint between two pieces of insulating material is considered part of the surface.

2.5.52
working voltage
highest r.m.s. value of the a.c. or d.c. voltage across any particular insulation which can occur when the equipment is supplied at rated voltage

NOTE 1 Transients are disregarded.

NOTE 2 Both open-circuit conditions and normal operating conditions are taken into account.

2.5.53
temporary overvoltage
phase-to-earth, phase-to-neutral or phase-to-phase overvoltage at a given location and of relatively long duration (several seconds)

2.5.54
transient overvoltages
transient overvoltages in the sense of this standard are the following:

2.5.54.1
switching overvoltage
transient overvoltage at a given location on a system due to a specific switching operation or a fault

2.5.54.2
lightning overvoltage
transient overvoltage at a given location on a system due to a specific lightning discharge

[see also IEC 60060 and IEC 60071-1]

2.5.54.3
functional overvoltage
deliberately imposed overvoltage necessary for the functioning of a device

2.5.55
impulse withstand voltage
highest peak value of an impulse voltage, of prescribed form and polarity, which does not cause breakdown under specified conditions of test

2.5.56
power-frequency withstand voltage
r.m.s. value of a power-frequency sinusoidal voltage which does not cause breakdown under specified conditions of test

2.5.57
pollution
any condition of foreign matter, solid, liquid or gaseous (ionized gases), that may affect dielectric strength or surface resistivity

2.5.58
pollution degree (of environmental conditions)
conventional number based on the amount of conductive or hygroscopic dust, ionized gas or salt and on the relative humidity and its frequency of occurrence, resulting in hygroscopic absorption or condensation of moisture leading to reduction in dielectric strength and/or surface resistivity

NOTE 1 The pollution degree to which equipment is exposed may be different from that of the macro-environment where the equipment is located because of protection offered by means such as an enclosure or internal heating to prevent absorption or condensation of moisture.

NOTE 2 For the purpose of this standard, the pollution degree is that of the micro-environment.

2.5.59
micro-environment (of a clearance or creepage distance)
ambient conditions which surround the clearance or creepage distance under consideration

NOTE The micro-environment of the creepage distance or clearance and not the environment of the equipment determines the effect on the insulation. The micro-environment might be better or worse than the environment of the equipment. It includes all factors influencing the insulation, such as climatic and electromagnetic conditions, generation of pollution, etc.

2.5.60
overvoltage category (of a circuit or within an electrical system)
conventional number based on limiting (or controlling) the values of prospective transient overvoltages occurring in a circuit (or within an electrical system having different nominal voltages) and depending upon the means employed to influence the overvoltages

NOTE In an electrical system, the transition from one overvoltage category to another of lower category is obtained through appropriate means complying with interface requirements, such as an overvoltage protective device or a series-shunt impedance arrangement capable of dissipating, absorbing, or diverting the energy in the associated surge current, to lower the transient overvoltage value to that of the desired lower overvoltage category.

2.5.61
co-ordination of insulation
correlation of insulating characteristics of electrical equipment with the expected overvoltages and the characteristics of overvoltage protective devices on the one hand, and with the expected micro-environment and the pollution protective means on the other hand

2.5.62
homogeneous (uniform) field
electric field which has an essentially constant voltage gradient between electrodes, such as that between two spheres where the radius of each sphere is greater than the distance between them

2.5.63
inhomogeneous (non-uniform) field
electric field which has not an essentially constant voltage gradient between electrodes

2.5.64
tracking
progressive formation of conducting paths which are produced on the surface of a solid insulating material, due to the combined effects of electric stress and electrolytic contamination on this surface

2.5.65
comparative tracking index (CTI)
numerical value of the maximum voltage in volts at which a material withstands 50 drops of a test solution without tracking

NOTE 1 The value of each test voltage and the CTI should be divisible by 25.

NOTE 2 This definition reproduces 2.3 of IEC 60112.

2.5.66
rated control circuit voltage
U_c
rated voltage which is controlling the input signal of the control device

2.5.67
rated control circuit supply voltage
U_s
rated voltage applied to energize the power supply terminals of the control circuit

2.6 Tests

2.6.1
type test
test of one or more devices made to a certain design to show that the design meets certain specifications

2.6.2
routine test
test to which each individual device is subjected during and/or after manufacture to ascertain whether it complies with certain criteria

2.6.3
sampling test
test on a number of devices taken at random from a batch

2.6.4
special test
test, additional to type tests and routine tests, made either at the discretion of the manufacturer or according to an agreement between manufacturer and user

2.7 Ports

2.7.1
port
particular interface of the specified apparatus with the external electromagnetic environment (see Figure 17)

2.7.2
enclosure port
physical boundary of the apparatus which electromagnetic fields may radiate through or impinge on

2.7.3
cable port
port at which a conductor or cable is connected to the apparatus

NOTE Examples are signal ports used for the transfer of data.

2.7.4
functional earth port
cable port other than main, signal or power port, intended for connection to earth for purposes other than electrical safety

2.7.5
signal port
port at which a conductor or cable carrying information for transferring data is connected to the apparatus

NOTE Examples are data buses, communication networks, control networks.

2.7.6
power port (control supply port)
port at which a conductor or cable carrying the primary electrical power needed for the operation (functioning) of an apparatus or associated apparatus is connected to the apparatus

2.7.7
main port
port at which a conductor or cable is connected to a pole of the main circuit of the equipment

NOTE 1 Examples are main circuit terminals of a contactor.

NOTE 2 In some equipment a main port is also a power port.

3 Classification

This clause is intended to list the characteristics of an equipment on which information may be given by the manufacturer and which may not necessarily have to be verified by testing.

This clause is not mandatory in product standards which should, however, leave space for it in order to list, where necessary, classification criteria.

4 Characteristics

Alphabetical list of characteristics (whether rated or not) and symbols

Characteristic	Symbol	Subclause
Conventional enclosed thermal current	I_{the}	4.3.2.2
Conventional free air thermal current	I_{th}	4.3.2.1
Eight-hour duty	–	4.3.4.1
Intermittent duty	–	4.3.4.3
Periodic duty	–	4.3.4.5
Pole impedance of the switching device	Z	4.3.7
Rated breaking capacity	–	4.3.5.3
Rated conditional short-circuit current	I_q	4.3.6.4
Rated control circuit voltage	U_c	4.5.1
Rated control circuit supply voltage	U_s	4.5.1
Rated current	I_n	a
Rated frequency	–	4.3.3
Rated impulse withstand voltage	U_{imp}	4.3.1.3
Rated insulation voltage	U_i	4.3.1.2
Rated making capacity	–	4.3.5.2
Rated operational current	I_e	4.3.2.3
Rated operational power	–	4.3.2.3
Rated operational voltage	U_e	4.3.1.1
Rated rotor insulation voltage	U_{ir}	a
Rated rotor operational current	I_{er}	a
Rated rotor operational voltage	U_{er}	a
Rated service short-circuit breaking capacity	I_{cs}	a
Rated short-circuit breaking capacity	I_{cn}	4.3.6.3
Rated short-circuit making capacity	I_{cm}	4.3.6.2
Rated short-time withstand current	I_{cw}	4.3.6.1
Rated starting voltage of an autotransformer starter	–	a
Rated stator insulation voltage	U_{is}	a
Rated stator operational current	I_{es}	a
Rated stator operational voltage	U_{es}	a
Rated ultimate short-circuit breaking capacity	I_{cu}	a
Rated uninterrupted current	I_u	4.3.2.4
Rotor thermal current	I_{thr}	a
Selectivity limit current	I_s	a
Stator thermal current	I_{ths}	a

Characteristic	Symbol	Subclause
Take-over current	I_B	2.5.25
Temporary duty	–	4.3.4.4
Uninterrupted duty	–	4.3.4.2
Utilization category	–	4.4
[a] This rating is defined in the relevant product standard.		

NOTE – The above list is not exhaustive.

4.1 General

The characteristics of an equipment shall be stated in the relevant product standard in respect of the following, where applicable:

– type of equipment (4.2);

– rated and limiting values for the main circuit (4.3);

– utilization category (4.4);

– control circuits (4.5);

– auxiliary circuits (4.6);

– relay and releases (4.7);

– co-ordination with short-circuit protective devices (4.8);

– switching overvoltages (4.9).

4.2 Type of equipment

The product standard shall state the following, where applicable:

– kind of equipment: e.g. contactor, circuit-breaker, etc.;

– number of poles;

– kind of current;

– interrupting medium;

– operating conditions (method of operation, method of control, etc.).

NOTE The above list is not exhaustive.

4.3 Rated and limiting values for the main circuit

Ratings are assigned by the manufacturer. They shall be stated in accordance with 4.3.1 to 4.3.6 as required by the relevant product standard, but it is not necessary to establish all the ratings listed.

4.3.1 Rated voltages

An equipment is defined by the following rated voltages:

NOTE Certain types of equipment may have more than one rated voltage or may have a rated voltage range.

4.3.1.1 Rated operational voltage (U_e)

A rated operational voltage of an equipment is a value of voltage which, combined with a rated operational current, determines the application of the equipment and to which the relevant tests and the utilization categories are referred.

For single-pole equipment, the rated operational voltage is generally stated as the voltage across the pole.

For multipole equipment, it is generally stated as the voltage between phases.

NOTE 1 For certain devices and particular applications a different method of stating U_e, may apply: this should be stated in the relevant product standard.

NOTE 2 For multipole equipment for use on polyphase circuits a distinction may be made between

a) equipment for use on systems where a single fault to earth will not cause the full phase-to-phase voltage to appear across a pole;

– neutral earthed systems;

– unearthed and impedance earthed systems.

b) equipment for use on systems where a single fault to earth will cause the full phase-to-phase voltage to appear across a pole (i.e. phase earthed systems).

NOTE 3 An equipment may be assigned a number of combinations of rated operational voltages and rated operational currents or powers for different duties and utilization categories.

NOTE 4 An equipment may be assigned a number of rated operational voltages and associated making and breaking capacities for different duties and utilization categories.

NOTE 5 Attention is drawn to the fact that the operational voltage may differ from the working voltage (see 2.5.52) within an equipment.

4.3.1.2 Rated insulation voltage (U_i)

The rated insulation voltage of an equipment is the value of voltage to which dielectric tests and creepage distances are referred.

In no case shall the maximum value of the rated operational voltage exceed that of the rated insulation voltage.

NOTE For equipment not having a specified rated insulation voltage, the highest value of the rated operational voltage is considered to be the rated insulation voltage.

4.3.1.3 Rated impulse withstand voltage (U_{imp})

The peak value of an impulse voltage of prescribed form and polarity which the equipment is capable of withstanding without failure under specified conditions of test and to which the values of the clearances are referred.

The rated impulse withstand voltage of an equipment shall be equal to or higher than the values stated for the transient overvoltages occurring in the circuit in which the equipment is fitted.

NOTE Preferred values of rated impulse withstand voltage are given in Table 12.

4.3.2 Currents

An equipment is defined by the following currents:

4.3.2.1 Conventional free air thermal current (I_{th})

The conventional free air thermal current is the maximum value of test current to be used for temperature-rise tests of unenclosed equipment in free air (see 8.3.3.3).

The value of the conventional free air thermal current shall be at least equal to the maximum value of the rated operational current (see 4.3.2.3) of the unenclosed equipment in eight-hour duty (see 4.3.4.1).

Free air is understood to be air under normal indoor conditions reasonably free from draughts and external radiation.

NOTE 1 This current is not a rating and is not mandatorily marked on the equipment.

NOTE 2 An unenclosed equipment is an equipment supplied by the manufacturer without an enclosure or an equipment supplied by the manufacturer with an integral enclosure which is not normally intended to be the sole equipment protective enclosure.

4.3.2.2 Conventional enclosed thermal current (I_{the})

The conventional enclosed thermal current is the value of current stated by the manufacturer to be used for the temperature-rise tests of the equipment when mounted in a specified enclosure. Such tests shall be in accordance with 8.3.3.3 and are mandatory if the equipment is described as enclosed equipment in the manufacturer's catalogues and normally intended for use with one or more enclosures of specified type and size (see Note 3).

The value of the conventional enclosed thermal current shall be at least equal to the maximum value of the rated operational current (see 4.3.2.3) of the enclosed equipment in eight-hour duty (see 4.3.4.1).

If the equipment is normally intended for use in unspecified enclosures, the test is not mandatory if the test for conventional free air thermal current (I_{th}) has been made. In this case, the manufacturer shall be prepared to give guidance on the value of enclosed thermal current or the derating factor (see Note 1).

NOTE 1 Guidance may be in the form of a publication of the maximum rated current at a specified local ambient (surrounding, in the immediate vicinity of the device) air temperature (example 1: AC-1 I_e = 45 A at 40 °C local ambient air, AC-1 I_e = 40 A at 60 °C local ambient air − example 2: I_{th} = 200 A at 40 °C local ambient air, I_{th} = 150 A at 60 °C local ambient air). By publishing such values, the manufacturer informs the user of the limits of application of the product independently of the size or the type of the enclosure.

NOTE 2 This current is not a rating and is not mandatorily marked on the equipment.

NOTE 3 The conventional enclosed thermal current value may be for unventilated equipment, in which case the enclosure used for the test should be of the size stated by the manufacturer, being the smallest that is applicable in service. Alternatively, the value may be for a ventilated equipment according to the manufacturer's data.

NOTE 4 An enclosed equipment is an equipment normally intended for use with a specified type and size of enclosure or intended for use with more than one type of enclosure.

4.3.2.3 Rated operational current (I_e) or rated operational power

A rated operational current of an equipment is stated by the manufacturer and takes into account the rated operational voltage (see 4.3.1.1), the rated frequency (see 4.3.3), the rated duty (see 4.3.4), the utilization category (see 4.4) and the type of protective enclosure, if appropriate.

In the case of equipment for direct switching of individual motors, the indication of a rated operational current may be replaced or supplemented by an indication of the maximum rated power output, at the rated operational voltage considered, of the motor for which the equipment is intended. The manufacturer shall be prepared to state the relationship assumed between the operational current and the operational power, if any.

4.3.2.4 Rated uninterrupted current (I_u)

The rated uninterrupted current of an equipment is a value of current, stated by the manufacturer, which the equipment can carry in uninterrupted duty (see 4.3.4.2).

4.3.3 Rated frequency

The supply frequency for which an equipment is designed and to which the other characteristic values correspond.

NOTE The same equipment may be assigned a number or a range of rated frequencies or be rated for both a.c. and d.c.

4.3.4 Rated duties

The rated duties considered as normal are:

4.3.4.1 Eight-hour duty

A duty in which the main contacts of an equipment remain closed, whilst carrying a steady current long enough for the equipment to reach thermal equilibrium but not for more than eight hours without interruption.

NOTE 1 This is the basic duty on which the conventional thermal currents I_{th} and I_{the} of the equipment are determined.

NOTE 2 Interruption means breaking of the current by operation of the equipment.

4.3.4.2 Uninterrupted duty

A duty without any off-load period in which the main contacts of an equipment remain closed, whilst carrying a steady current without interruption for periods of more than eight hours (weeks, months, or even years).

NOTE This kind of service is set apart from the eight-hour duty because oxides and dirt can accumulate on the contacts and lead to progressive heating. Uninterrupted duty can be taken account of either by a derating factor, or by special design considerations (e.g. silver contacts).

4.3.4.3 Intermittent periodic duty or intermittent duty

A duty with on-load periods, in which the main contacts of an equipment remain closed, having a definite relation to off-load periods, both periods being too short to allow the equipment to reach thermal equilibrium.

Intermittent duty is characterized by the value of the current, the duration of the current flow and by the on-load factor which is the ratio of the in-service period to the entire period, often expressed as a percentage.

Standardized values of the on-load factor are 15 %, 25 %, 40 % and 60 %.

According to the number of operating cycles which they shall be capable of carrying out per hour, equipments are divided into the following classes:

– class 1: 1 operating cycle per hour;

– class 3: 3 operating cycles per hour;

– class 12: 12 operating cycles per hour;

– class 30: 30 operating cycles per hour;

– class 120: 120 operating cycles per hour;

– class 300: 300 operating cycles per hour;

– class 1 200: 1 200 operating cycles per hour;

– class 3 000: 3 000 operating cycles per hour;

– class 12 000: 12 000 operating cycles per hour;

– class 30 000: 30 000 operating cycles per hour;

– class 120 000: 120 000 operating cycles per hour;

– class 300 000: 300 000 operating cycles per hour.

For intermittent duty with a large number of operating cycles per hour, the manufacturer shall indicate, either in terms of the true cycle if this is known, or in terms of conventional cycles designated by him, the values of the rated operational currents which shall be such that:

$$\int_o^T i^2 \mathrm{d}t \leq I_{\mathrm{th}}^2 \times T \quad \text{or} \quad I_{\mathrm{the}}^2 \times T$$

whichever is applicable

where T is the total operating cycle time.

NOTE The above formula does not take account of the switching arc energy.

A switching device intended for intermittent duty may be designated by the characteristics of the intermittent duty.

Example: An intermittent duty comprising a current flow of 100 A for 2 min in every 5 min may be stated as 100 A, class 12, 40 %.