IEC 60947-4-1

Edition 5.0 2023-11

Corrected version
2026-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Low-voltage switchgear and controlgear –
Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters

Appareillage à basse tension –
Partie 4-1: Contacteurs et démarreurs de moteurs – Contacteurs et démarreurs électromécaniques



IEC 60947-4-1:2023-11(en-fr)



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 29.120.99, 29.130.20

ISBN 978-2-8322-7773-7

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters

FOREWORD

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IEC 60947-4-1 has been prepared by subcommittee 121A: Low-voltage switchgear and controlgear, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low voltage. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2018. This edition constitutes a technical revision.

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

a) objective in the scope;
b) instantaneous only motor protective switching device IMPSD (3.5.33);
c) kinds of equipment (5.2.1);

d) methods of overload protection of motors (5.2.6);
e) adoption of the AC-7d from IEC 61095:2023 (in 5.4.2);
f) separately mounted overload relay of a starter (in 5.7.3 b));
g) starter and contactor suitable for use downstream to basic drive module (6.1.2 w));
h) reference to IEC TS 63058 for environmental aspects (in 6.4);
i) wiring subject to movement (in 8.1.3);
j) use of voltage transient limiting device (8.1.18);
k) accessible parts subject to temperature limits (in 8.2.2.3);
l) reference to Annex X of IEC 60947-1:2020 for the co-ordination of MPSD with SCPD (8.2.5.4);
m) reference to IEC TR 63216 with different EMC environments (8.3.1);
n) reference to IEC TR 63201 for the embedded software design (8.4);
o) reference to IEC TS 63208 for cybersecurity aspects (8.5);
p) update and completion of the measurement method of the power consumption of the electromagnet (9.3.3.2.1.2);
q) update of Annex C including rational about AC-3e;
r) determination of the critical load current for photovoltaic applications (M.8.7).

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

Draft	Report on voting
121A/571/FDIS	121A/580/RVD

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

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

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

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

This document shall be read in conjunction with IEC 60947-1:2020, *Low voltage switchgear and controlgear – Part 1: General rules*. The provisions of the general rules are applicable to this document, where specifically called for.

The provisions of the general rules dealt with IEC 60947-1 are applicable to this part of IEC 60947 series where specifically called for. Clauses and subclauses, tables, figures and annexes of the general rules thus applicable are identified by reference to IEC 60947-1:2020. For example, 5.3.4.1 of IEC 60947-1:2020, Table 4 of IEC 60947-1:2020, or Annex A of IEC 60947-1:2020.

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters

1 Scope

This part of IEC 60947 is applicable to the following equipment:

– electromechanical contactors and starters including motor protective switching devices (MPSD and IMPSD);

– actuators of contactor relays;

– contacts dedicated exclusively to the coil circuit of the contactor or the contactor relay;

– dedicated accessories (e.g. dedicated wiring, dedicated latch accessory);

intended to be connected to distribution circuits, motors circuits and other load circuits, the rated voltage of which does not exceed 1 000 V AC or 1 500 V DC.

This document does not apply to:

– starters for DC motors;

– auxiliary contacts of contactors and contacts of contactor relays. These are covered by IEC 60947-5-1;

– the short-circuit protective device integrated within starters, other than MPSDs. This is covered by IEC 60947-2 and IEC 60947-3;

– motor overload protection function performed by control units for built-in thermal protection (PTC). They are covered by IEC 60947-8;

– the use of the equipment with additional measures within explosive atmospheres. These are given in IEC 60079 series;

The objective of this document is to state:

- the characteristics and composition of the equipment (Clause 5);
- the conditions applicable to the equipment with reference to:
  - its operation (5.2.5) and protection functions (5.2.6, 5.7, 5.8),
  - its intended environments (6.5, 8.3.1) and applications (5.4, Annex C, Annex D, Annex G, Annex H, Annex I, Annex M, Annex O) including safety applications (Annex F, Annex K, Annex L),
  - its construction and performance (Clause 8) including requirements to reduce risks of electric shock, thermal hazard, energy hazard, fire hazard and mechanical hazard, reasonably foreseeable misuse, electromagnetic compatibility (EMC) issues, software errors and security issues;
- the tests intended for confirming that these conditions have been met, and the methods to be adopted for these tests (Clause 9);
- the information to be included with the equipment or in the product documentation (Clause 6).

2 Normative references

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

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

IEC 60034-12:2016, *Rotating electrical machines – Part 12: Starting performance of single-speed three-phase cage induction motors*

IEC 60034-30-1:2014, *Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors (IE code)*

IEC 60068-2-14:2023, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60079-14, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*

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

IEC 60364-1:2005, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60715:2017, *Dimensions of low-voltage switchgear and controlgear – Standardized mounting on rails for mechanical support of switchgear, controlgear and accessories*

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

IEC 60947-1:2020, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 60947-2:2016, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*

IEC 60947-5-1:2016, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 61051-2, *Varistors for use in electronic equipment – Part 2: Sectional specification for surge suppression varistors*

IEC 61095:2023, *Electromechanical contactors for household and similar purposes*

IEC 61140:2016, *Protection against electric shock – Common aspects for installation and equipment*

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

IEC 61643-331, *Components for low-voltage surge protection – Part 331: Performance requirements and test methods for metal oxide varistors (MOV)*

IEC 61800-5-1:2022, *Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy*

IEC 61810-1, *Electromechanical elementary relays – Part 1: General and safety requirements*

IEC TS 63058, *Switchgear and controlgear and their assemblies for low voltage – Environmental aspects*

IEC TS 63208, *Low-voltage switchgear and controlgear – Security aspects*

IEC TR 63216:2019, *Low-voltage switchgear and controlgear – Electromagnetic compatibility assessment for switchgear and controlgear and their assemblies*

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

ISO 2859-1:1999, *Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 3864-2, *Graphical symbols – Safety colours and safety signs – Part 2: Design principles for product safety labels*

3 Terms, definitions, symbols and abbreviated terms

3.1 General

For the purposes of this document, the terms and definitions of Clause 3 of IEC 60947-1:2020, as well as the following terms, definitions, symbols and abbreviated terms apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.2 Alphabetical index of terms

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3.3 Terms and definitions concerning contactors

3.3.1
mechanical contactor
contactor
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

Note 1 to entry: Mechanical contactors can be designated according to the method by which the force for closing the main contacts is provided.

Note 2 to entry: The term "operated otherwise than by hand" means that the device is intended to be controlled and kept in working position from one or more external supplies.

Note 3 to entry: In French, a contactor the main contacts of which are closed in the position of rest is usually called a "rupteur". The word "rupteur" has no equivalent in the English language.

Note 4 to entry: A contactor is usually intended to operate frequently.

Note 5 to entry: A mechanical contactor can provide a galvanic opening (3.6.13) but is not suitable for isolation unless the additional requirements defined under 8.1.7 are fulfilled. In this case the equipment can be marked in accordance with IEC 60417-6169-1 "Disconnector; isolator" (2012-08).

[SOURCE: IEC 60050-441:1984, 441-14-33, modified – Term“contactor” added as synonymous; "may" replaced by "can" in Note 1 to entry; Notes to entry 2 to 5 have been added.]

3.3.2
electromagnetic contactor
contactor in which the force for closing the normally open main contacts or opening the normally closed main contacts is provided by an electromagnet

Note 1 to entry: The electromagnet can be electronically controlled.

3.3.3
pneumatic contactor
contactor in which the force for closing the normally open main contacts or opening the normally closed main contacts is provided by a device using compressed air, without the use of electrical means

3.3.4
electro-pneumatic contactor
contactor in which the force for closing the normally open main contacts or opening the normally closed main contacts is provided by a device using compressed air under the control of electrically operated valves

3.3.5
latched contactor
contactor, the moving elements of which are prevented by means of a latching arrangement from returning to the position of rest when the operating means are de-energized

Note 1 to entry: The latching, and the release of the latching, can be mechanical, electromagnetic, pneumatic, etc.

Note 2 to entry: Because of the latching, the latched contactor actually acquires a second position of rest and, according to the definition of a contactor, it is not, strictly speaking, a contactor. However, since the latched contactor in both its utilization and its design is more closely related to contactors in general than to any other classification of switching device, it is considered proper to require that it complies with the specifications for contactors wherever they are appropriate.

[SOURCE: IEC 60050-441:1984, 441-14-34, modified – "may" replaced by "can" in Note 1 to entry.]

3.3.6
vacuum contactor
contactor in which the main contacts open and close within a highly evacuated envelope

3.3.7
position of rest
<contactor> position which the moving elements of the contactor take up when its electromagnet or its compressed-air device is not energized

[SOURCE: IEC 60050-441:1984, 441-16-24]

3.3.8
electronically controlled electromagnet
electromagnet in which the coil is controlled by a circuit with active electronic elements

3.3.9
holding power
<contactor> power needed to maintain the operation of the electromagnet

3.3.10
pick-up power
<contactor> power needed to operate the contactor from the de-energized state to the energized state

3.4 Terms and definitions of the functions of starters

3.4.1
switching
<motor starter> capability to make and break the current of a motor in normal operation according to the appropriate motor load utilization category

3.4.2
overload protection
<motor starter> detection of the overload condition of a motor intended to control mechanically or electrically the opening of the switching function of the starter

3.4.3
electromechanical overload protection
protection of a rotating electrical machine in case of excessive temperatures resulting from certain conditions of overload by means of thermo mechanical detection that initiate the interruption of the motor load circuit

Note 1 to entry: Electromechanical overload protection is typically provided by thermal overload relays or motor protective switching devices (MPSD).

3.4.4
isolating
<motor starter> ability to provide in an indicated open position adequate isolation between the motor circuits and the supply circuits

3.4.5
electronic overload relay with control functions
multipole electronic relay with motor control operations through its inputs and outputs

Note 1 to entry: Example of control functions: reversing control, two speed control, star-delta control, etc.

3.4.6
electronic overload relay with under-voltage restarting function
electronic relay which operates when the voltage applied to the main circuit or control circuit is reduced below a predetermined value and automatically resets (with or without time delay) when the voltage is recovered

3.4.7
electronic overload relay with main circuit undervoltage restarting function
electronic overload relay with under-voltage restarting function monitoring only the main circuit

3.4.8
electronic overload relay with control circuit undervoltage restarting function
electronic overload relay with under-voltage restarting function monitoring only the control circuit

Note 1 to entry: The automatic restarting function can be de-activated.

3.5 Terms and definitions concerning starters

3.5.1
motor starter
starter
combination of all the switching means necessary to start and stop a motor in combination with suitable overload protection

[SOURCE: IEC 60050-441:1984, 441-14-38, modified – "motor starter" added as the first term and Note 1 to entry has been deleted.]

3.5.2
direct-on-line starter
starter which connects the line voltage across the motor terminals in one step

[SOURCE: IEC 60050-441:1984, 441-14-40]

3.5.3
reversing starter
starter intended to cause the motor to reverse the direction of rotation by reversing the motor primary connections when the motor is not running

Note 1 to entry: An application where reversing the motor primary connections while the motor is running is called plugging (see 3.5.25).

3.5.4
reduced voltage starter
starter which connects the line voltage across the motor terminals in more than one step or by gradually increasing the voltage applied to the terminals

3.5.4.1
star-delta starter
starter for a three-phase induction motor such that in the starting position the stator windings are connected in star and in the final running position they are connected in delta

[SOURCE: IEC 60050-441:1984, 441-14-44]

3.5.4.2
auto-transformer starter
starter for an induction motor which uses for starting one or more reduced voltages derived from an auto-transformer

[SOURCE: IEC 60050-441:1984, 441-14-45]

3.5.4.3
auto-transformer
transformer in which at least two windings have a common part

[SOURCE: IEC 60050-421:1990, 421-01-11]

3.5.5
rheostatic starter
starter utilizing one or several resistors for obtaining, during starting, stated motor torque characteristics and for limiting the current

Note 1 to entry: A rheostatic starter generally consists of three basic parts which can be supplied either as a composite unit or as separate units to be connected at the place of utilization:

– the mechanical switching devices for supplying the stator (generally associated with an overload protective device);
– the resistor(s) inserted in the stator or rotor circuit;
– the mechanical switching devices for cutting out the resistor(s) successively.

Note 2 to entry: It applies also to starters for two directions of rotation when reversal of connections is made with the motor stopped.

[SOURCE: IEC 60050-441:1984, 441-14-42, modified – Notes to entry have been added]

3.5.5.1
rheostatic stator starter
rheostatic starter for a squirrel cage motor which, during the starting period, cuts out successively one or several resistors previously provided in the stator circuit

3.5.5.2
rheostatic rotor starter
rheostatic starter for an asynchronous wound-rotor motor which, during the starting period, cuts out successively one or several resistors previously provided in the rotor circuit

[SOURCE: IEC 60050-441:1984, 441-14-43]

3.5.6
protected starter
equipment consisting of a starter, a manually-operated switching device and a short-circuit protective device, rated as a unit by the manufacturer

Note 1 to entry: The protected starter can be enclosed.

Note 2 to entry: In the context of this document, the term "manufacturer" means any person, company or organization with ultimate responsibility as follows:

– to verify compliance with the appropriate standard;
– to provide the equipment information according to Clause 6.

Note 3 to entry: A manually protected starter as one unit can be a MPSD.

3.5.7
combination starter
equipment consisting of a protected starter incorporating an isolating function

Note 1 to entry: Also called "combination motor controller".

Note 2 to entry: See Figure C.7.

3.5.8
manual starter
starter in which the force for closing the main contacts is provided exclusively by manual energy

[SOURCE: IEC 60050-441:1984, 441-14-39]

3.5.9
electromagnetic starter
starter in which the force for closing the main contacts is provided by an electromagnet

3.5.10
motor-operated starter
starter in which the force for closing the main contacts is provided by an electric motor

3.5.11
pneumatic starter
starter in which the force for closing the main contacts is provided by using compressed air, without the use of electrical means

3.5.12
electro-pneumatic starter
starter in which the force for closing the main contacts is provided by using compressed air under the control of electrically operated valves

3.5.13
single-step starter
starter in which there is no intermediate accelerating position between the OFF and ON positions

Note 1 to entry: This starter is a direct-on-line starter.

3.5.14
two-step starter
starter in which there is only one intermediate accelerating position between the OFF and ON positions

EXAMPLE A star-delta starter is a two-step starter.

3.5.15
***n*-step starter**
starter in which there are (n-1) intermediate accelerating positions between the OFF and full ON positions

EXAMPLE A three-step rheostatic starter has two sections of resistors used for starting.

[SOURCE: IEC 60050-441:1984, 441-14-41, modified – "OFF" and "ON" in capital; Example added]

3.5.16
vacuum starter
starter in which the main contacts open and close within a highly evacuated envelope

3.5.17
separately mounted overload relay
overload relays not exclusively dedicated to a switching device

3.5.18
phase loss sensitive overload relay
phase loss sensitive overload release
multipole overload relay or release which operates in the case of overload and also in case of loss of phase in accordance with specified requirements

3.5.19
under-current relay
under-current relay release
measuring relay or release which operates automatically when the current through it is reduced below a predetermined value

3.5.20
starting time
<rheostatic starter> period of time during which the starting resistors or parts of them carry current

Note 1 to entry: The starting time of a starter is shorter than the total starting time of the motor which also takes into account the last period of acceleration following the switching operation to the ON position.

3.5.21
starting time
<auto-transformer starter> period of time during which the auto-transformer carries current

Note 1 to entry: The starting time of a starter is shorter than the total starting time of the motor which also takes into account the last period of acceleration following the switching operation to the ON position.

3.5.22
open transition
<with an auto-transformer starter or star-delta starter> circuit arrangement such that the supply to the motor is interrupted and reconnected when changing over from one step to another

Note 1 to entry: The transition stage is not considered as an additional step.

3.5.23
closed transition
<with an auto-transformer starter or star-delta starter> circuit arrangement such that the supply to the motor is not interrupted (even momentarily) when changing over from one step to another

Note 1 to entry: The transition stage is not considered as an additional step.

3.5.24
inching
jogging
energizing a motor or solenoid repeatedly for short periods to obtain small movements of the driven mechanism

3.5.25
plugging
stopping or reversing a motor rapidly by reversing the motor primary connections while the motor is running

3.5.26
protected switching device
equipment (for non-motor loads) consisting of a contactor or a semiconductor controller, overload protection, a manually operated switching device and a short-circuit protective device, rated as a unit by the manufacturer

Note 1 to entry: The protected switching device can be enclosed.

Note 2 to entry: In the context of this document, the term "manufacturer" means any person, company or organization with ultimate responsibility as follows:

– to verify compliance with the appropriate standard;

– to provide the equipment information according to Clause 6.

Note 3 to entry: The manually operated switching device and the short-circuit protective device can be just one device and can incorporate the overload protection as well.

3.5.27
combination switching device
equipment consisting of a protected switching device incorporating an isolating function

3.5.28
stall relay
stall release
electronic overload relay or release which operates when the current has not decreased below a predetermined value for a specific period of time during start-up or when the relay or the release receives the input indicating there is no rotation of the motor after a predetermined time in accordance with specified requirements

Note 1 to entry: Explanation of stall: rotor locked during start.

Note 2 to entry: With appropriate adjustment of the current and starting time settings, such relay or release can be used to detect starts requiring longer than specified times.

3.5.29
jam relay
jam release
electronic overload relay or release which operates in the case of overload and also when the current has increased above a predetermined value for a specific period of time during operation, in accordance with specified requirements

Note 1 to entry: A jam is a high overload occurring after the completion of starting which causes the current to reach the locked rotor current value of the motor being controlled.

3.5.30
inhibit time
time-delay period during which the tripping function of the relay is inhibited

3.5.31
motor management starter
starter including extended functions with communication ability

Note 1 to entry: Interoperable device profiles for motor management starter are defined by IEC 61915-2:2011.

3.5.32
motor protective switching device
MPSD
manually operated motor starter additionally providing resettable short-circuit protection to the motor and the circuit

Note 1 to entry: A MPSD can also be used as a manual starter, a protected starter or a combination starter.

Note 2 to entry: A MPSD can be used as a SCPD within the motor branch.

Note 3 to entry: In North America, this device can be qualified as a manual motor controller suitable for tap conductor protection.

3.5.33
instantaneous only motor protective switching device
IMPSD
motor protective switching device (MPSD) without overload protection function

Note 1 to entry: This type of device is typically used in a 3 components starter where the overload protection function is within a separately mounted overload relay.

3.5.34
dedicated wiring accessory
prefabricated connection wiring system specifically intended for identified switchgear or controlgear

Note 1 to entry: A dedicated wiring accessory can be integrated in the switchgear or controlgear or delivered separately.

Note 2 to entry: A typical dedicated wiring accessory is for example a connection link.

3.5.35
latch accessory
mechanical device attached to a contactor, the moving elements of which are prevented from returning to the position of rest when the operating means are de-energized

Note 1 to entry: The latching, and the release of the latching, can be mechanical, electromagnetic, pneumatic, etc.

[SOURCE: IEC 60050-441:1984, 441-14-34, modified – Adapted to accessories, and Note 2 to entry deleted]

3.5.36
basic drive module
BDM
electronic power converter and related control, connected between an electric supply and a motor

Note 1 to entry: The BDM is capable of transmitting power from the electric supply to the motor and may be capable of transmitting power from the motor to the electric supply.

Note 2 to entry: The BDM controls some or all of the following aspects of power transmitted to the motor and motor output: current, frequency, voltage, speed, torque, force.

[SOURCE: IEC 61800-5-1:2022, 3.6]

3.6 Terms and definitions concerning characteristic quantities

3.6.1
product documentation
manufacturer's installation and operations' literature which accompanies the product, the product information contained in the manufacturer's catalogue and other product marketing material-information and, the description, definitions, product literature and usage as presented in electronic format on the manufacturer's (or supplier's) website on the World Wide Web/Internet

[SOURCE: ISO/IEC 14762:2009, 3.1.13, modified ─ Replacement of two ";" by "," and "and,".]

3.6.2
transient recovery voltage
TRV
recovery voltage during the time in which it has a significant transient character

Note 1 to entry: In a vacuum contactor or vacuum starter, the highest transient recovery voltage can occur on another pole than the first pole to clear.

[SOURCE: IEC 60947-1:2020, 3.7.34, modified – Note 1 to entry has been modified and Note 2 to entry was deleted.]

3.6.3
CO operation
breaking of the circuit by the SCPD resulting from closing the circuit by the equipment under test

3.6.4
O operation
breaking of the circuit by the SCPD resulting from closing the circuit on the equipment under test which is in the closed position

Note 1 to entry: The SCPD is normally in the closed position prior closing the circuit; in some cases, the SCPD closes the circuit (see 9.3.4.2.2, item b)).

3.6.5
I_{cd} current
current representing a fault current equal to or higher than the current corresponding to the crossover point of the mean value of the published curves representing the time-current characteristics of the overload relay and the SCPD respectively

3.6.6
crossover current
I_{co}
current corresponding to the crossover point of the mean or published curves representing the time-current characteristics of the overload relay and the SCPD respectively

Note 1 to entry: The mean curves are the curves corresponding to the average values calculated from the tolerances on the time-current characteristics of the overload relay.

3.6.7
time-current withstand characteristic capability of contactors or starters
locus of the currents a contactor or starter can withstand as a function of time

3.6.8
resetting time
time elapsed between a circuit-breaker tripping due to an overcurrent and subsequently reaching a condition where it can be reclosed

[SOURCE: IEC 60947-2:2016, 2.19, modified – Insertion of "or a starter" in definition.]

3.6.9
conventional prospective current "r"
specified value of prospective short-circuit current for which the switching device is tested under specified conditions

3.6.10
I^2t characteristic
<circuit-breaker or MPSD> information (usually a curve) giving the maximum values of I^2t related to break time as a function of prospective current (RMS symmetrical for AC) up to the maximum prospective current corresponding to the rated service short-circuit breaking capacity and associated voltage

[SOURCE: IEC 60947-2:2016, 2.18, modified – "or MPSD" inserted in context, “service” inserted in definition.]

3.6.11
rated instantaneous short-circuit current setting
I_i
rated value of the current causing the operation of a release without any intentional time-delay

[SOURCE: IEC 60947-2:2016, 2.20]

3.6.12
overload current setting
I_r
current setting of an adjustable overload release

[SOURCE: IEC 60947-2:2016, 2.21, modified – Note 1 to entry has been deleted]

3.6.13
galvanic opening
<circuit> prevention of electric conduction within an electric circuit intended to provide power and/or signals

Note 1 to entry: Galvanic opening can be provided e.g. by a switch or a contactor.

3.6.14
galvanic separation
prevention of electric conduction between two electric circuits intended to exchange power and/or signals

Note 1 to entry: Galvanic separation can be provided e.g. by an isolating transformer or an opto-coupler.

[SOURCE: IEC 60050-151:2001, 151-12-26]

3.6.15
recurring peak voltage
maximum peak value of periodic excursions of the voltage waveform resulting from distortions of an AC voltage or from AC components superimposed on a DC voltage

Note 1 to entry: Random overvoltages, for example due to occasional switching, are not considered to be recurring peak voltages.

[SOURCE: IEC 60050-442:2014, 442-09-15]

3.6.16
rated voltage pulse slope
dV/dt
maximum admissible value of the voltage slope dV/dt of a pulse, at the ambient air temperature at such a repetition frequency that no significant increase of temperature occurs

[SOURCE: IEC 60384-17:2019, 1.5.3.5, modified — Replacement of dU/dT with dV/dt, and replacement of “rated” with “ambient air”.]

3.6.17
critical load current
I_{crit}
value of breaking current, within the range of service conditions, at which the arcing time is significantly extended

Note 1 to entry: This phenomenon, crucial for PV applications, is due to the low magnetic field coming from the arc current, creating a slow moving arc.

[SOURCE: IEC 60947-1:2020, 3.7.16, modified — In Note 1 to entry, replacement of “crucial for direct currents (e.g. photovoltaïc (PV) applications)” with “crucial for PV applications”.]

3.6.18
rated conventional switching current
$\boldsymbol{I_{scl}}$
rated current assigned to a contactor for switching the current controlled to a low level by a semiconductor, taking into the account the rated operational voltage, the rated frequency and the rated duty

Note 1 to entry: This current is typically lower than I_e.

3.7 Terms and definitions concerning safety aspects

3.7.1
abnormal operating condition
temporary operating condition that is not a normal operating condition and is not a single fault condition of the equipment itself

Note 1 to entry: An abnormal operating condition is a temporary condition which can be introduced by the equipment or by a person and can result in a failure of a component, a device or a safeguard.

Note 2 to entry: This definition is used in the context of component failure risk analysis.

3.7.2
accessible part
part which can be touched by means of the standard test finger

[SOURCE: IEC 60050-442:1998, 442-01-15]

3.7.3
live-part
conductive part intended to be energized in normal conditions, including a neutral conductor or mid-point conductor, but by convention not a PEN conductor or PEM conductor or PEL conductor

Note 1 to entry: This concept does not necessarily imply a risk of electric shock.

[SOURCE: IEC 60050-195:2021, 195-02-19, modified – Addition of a Note 1 to entry.]

3.7.4
hazardous-live-part
live part which, under certain conditions, can give a harmful electric shock

[SOURCE: IEC 60050-195:2021, 195-06-05 modified – Note 1 to entry deleted.]

3.7.5
limited energy source
source that is designed and protected that, under both normal operating conditions and single fault conditions, the current that can be delivered is not hazardous with respect to fire hazard

3.7.6
protective impedance
impedance connected between hazardous-live-parts and accessible conductive parts, of such value that the current, in normal use and under likely fault conditions, is limited to a safe value, and which is so constructed that its ability is maintained throughout the life of the equipment

[SOURCE: IEC 62477-1:2022, 3.60, modified – Replacement of “the PECS” with “the equipment”.]

3.7.7
reasonably foreseeable misuse
use of a product or system in a way not intended by the supplier, but which can result from readily predictable human behaviour

[SOURCE: ISO/IEC Guide 51:2014, 3.7, modified – Notes to entry have been removed.]

3.7.8
single fault condition
condition in which there is a fault of a single protection (but not a reinforced protection) or of a single component or a device

Note 1 to entry: If a single fault condition results in one or more other fault conditions, all are considered as one single fault condition.

[SOURCE: IEC Guide 104:2019, 3.8, modified – Deletion of Note 2 to entry.]

3.7.9
touch current
electric current passing through a human body or through an animal body when it touches one or more accessible parts of an electrical installation or electrical equipment

[SOURCE: IEC 60050-826:2022, 826-11-12, modified ─ Replacement of “livestock” with “animal body”, and addition of “electrical” (2 occurrences)]

3.7.10
hot functional surface
surface that is intentionally heated by an internal heat source and that has to be hot to carry out the function for which the equipment is intended to be used

[SOURCE: IEC Guide 117:2010, 3.5, modified – NOTE 1 and NOTE 2 have been deleted.]

3.7.11
mirror contact
normally closed auxiliary contact which cannot be in closed position simultaneously with the normally open main contact under conditions defined in Clause F.7

Note 1 to entry: One contactor can have more than one mirror contact.

3.7.12
safe state
state of the safety device which leads to a safe condition of the EUC

Note 1 to entry: In this annex, the safe state is the condition of the interruption of the motor load circuit.

3.7.13
hardware fault tolerance
HFT
ability of a safety device to continue to perform a required function in the presence of faults

3.7.14
SIL-capability
characteristic of functional units that comply with the requirements of IEC 61508-2 and IEC 61508-3 suitable for use in functions which are allocated a SIL 1, 2 or 3 respectively

[SOURCE: IEC 60079-29-3:2014, 3.15]

3.7.15
systematic failure
failure, related in a deterministic way to a certain cause, which can only be eliminated by a modification of the design or of the manufacturing process, operational procedures, documentation or other relevant factors

Note 1 to entry: Corrective maintenance without modification will usually not eliminate the failure cause.

Note 2 to entry: A systematic failure can be induced by simulating the failure cause.

Note 3 to entry: Examples of causes of systematic failures include human error in:

– the safety requirements specification;
– the design, manufacture, installation, operation of the hardware.

[SOURCE: IEC 61508-4:2010, 3.6.6, modified – Third example of Note 3 and Note 4 deleted]

3.7.16
safety integrity level
SIL
discrete level (one out of a possible four), corresponding to a range of safety integrity values, where safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest

[SOURCE: IEC 61508-4:2010, 3.5.8, modified – Notes to entry deleted]

3.7.17
risk priority number
RPN
one of the methods of quantitative determination of criticality

[SOURCE: derived from IEC 60812:2018, Annex B]

3.8 Terms and definitions concerning electric motor characteristics

3.8.1
inrush current
first maximum value of current peak during motor start (positive or negative)

3.8.2
locked-rotor current
I_{LRC}
greatest steady state rms current taken from the line with the motor held at rest, over all angular positions of its rotor, at rated voltage and frequency

Note 1 to entry: In the USA, ILRC DOL current is called LRA (Locked Rotor Amps).

Note 2 to entry: IEC 60034-1 provides a tolerance of 20 % of locked rotor direct-on-line current.

3.8.3
kappa factor
K
ratio of the root-mean-square value of the inrush current to the direct on-line current

Note 1 to entry: A typical value for high efficiency motors is 1,8.

3.8.4
motor rated current
rated current from the motor name plate

Note 1 to entry: In the USA, motor rated current is called FLA (Full Load Amps).

3.9 Symbols and abbreviated terms

AQL	Acceptable quality level
EMC	Electromagnetic compatibility
EUC	Equipment under control
FMEA	Failure mode effect analysis
FRU	Field replaceable unit
FTA	Fault tree analysis
HFT	Hardware Fault Tolerance
MPSD	Motor protective switching device
RPN	Risk priority number
SCPD	Short-circuit protective device
SIL	Safety integrity level
$\hat{I}$	Maximum peak value of the pick-up current of an electronically controlled electromagnet
I_c	Current made and broken (Table 7)
I_{cd}	Maximum crossover breaking current (B.4.5)
I_{cs}	Rated service short-circuit breaking capacity (5.3.6.2)