



High-voltage switchgear and controlgear

Part 106: Alternating current
contactors, contactor-based
controllers and motor-starters

National foreword

This British Standard is the UK implementation of EN 62271-106:2011. It is identical to IEC 62271-106:2011, incorporating corrigendum February 2014. It supersedes BS EN 60470:2001, which is withdrawn.

The start and finish of text introduced or altered by corrigendum is indicated in the text by tags. Text altered by IEC corrigendum February 2014 is indicated in the text by AC1 AC1.

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A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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English version

**High-voltage switchgear and controlgear -
Part 106: Alternating current contactors, contactor-based controllers and
motor-starters
(IEC 62271-106:2011)**

Appareillage à haute tension -
Partie 106: Contacteurs, combinés de
démarrage à contacteurs et démarreurs
de moteurs, pour courant alternatif
(CEI 62271-106:2011)

Hochspannungs-Schaltgeräte und -
Schaltanlagen -
Teil 106: Wechselstrom-Schütze,
Kombinationsstarter und Motorstarter mit
Schützen
(IEC 62271-106:2011)

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CENELEC

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Foreword

The text of document 17A/971/FDIS, future edition 1 of IEC 62271-106, prepared by SC 17A, "High-voltage switchgear and controlgear", of IEC TC 17, "Switchgear and controlgear" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62271-106:2011.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2012-06-23
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2014-09-23

This document supersedes EN 60470:2000 + corrigendum June 2000.

EN 62271-106:2011 includes the following significant technical changes with respect to EN 60470:2000:

- Scope and object: The voltage range covered by the standard was expanded from 12 Kv to 24 kV. Overload relay calibration and testing is not covered by this standard.
- 3 Terms and definitions: Added definitions for capacitor switching classes.
- 4.1 Rated voltage: Added 15, 17,5 and 24 kV as standard voltage values.
- 4.109.2 Starting duty of reduced-voltage starters: Added ratings for autotransformer and reactor starters (was in the testing section).
- 4.112 Rated capacitive switching currents: Added capacitor switching current ratings.
- 5.101 Protective relays: Removed the requirements for overload relays. This section is obsolete since there are only a few MV starters fitted with thermal overload relays and electronic relays have their own standards.
- 6.2.5 Application of the test voltage and test conditions (former 6.2.2 b)): Changed wording of requirement for impulse across the open gap of vacuum contactors.
- 6.4.2 Auxiliary circuits: The requirement for resistance checks of auxiliary circuits was deleted.
- 6.5.5.104 Temperature rise of the auto-transformer or reactor for two-step auto-transformer or reactor starters: Reworded to transfer ratings to subclause 4.109.2.
- 6.102.9 Condition following making and breaking tests: Gave specific direction as to what the tolerance should be based on where the resistance was to be checked.
- 6.104 Short-circuit current making and breaking tests: Clarified test conditions for shortcircuit testing.
- 6.109 Capacitive current switching tests: Added capacitive current switching tests.
- Annex B: Added Table B.1 – Tolerances on test quantities for type test.

This standard is to be read in conjunction with EN 62271-1:2008, to which it refers and which is applicable unless otherwise specified in this standard. In order to simplify the indication of corresponding requirements, the same numbering of clauses and subclauses is used as in EN 62271-1. Amendments to these clauses and subclauses are given under the same references whilst additional subclauses are numbered from 101.

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

Endorsement notice

The text of the International Standard IEC 62271-106:2011 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60034-11	NOTE	Harmonized as EN 60034-11.
IEC 60060 series	NOTE	Harmonized in EN 60060 series.
IEC 60060-1	NOTE	Harmonized as EN 60060-1.
IEC 60060-2	NOTE	Harmonized as EN 60060-2.
IEC 60076-11:2004	NOTE	Harmonized as EN 60076-11:2004 (not modified).
IEC 60076-2	NOTE	Harmonized as EN 60076-2.
IEC 60255-8	NOTE	Harmonized as EN 60255-8.
IEC 60947-5-1	NOTE	Harmonized as EN 60947-5-1.
IEC 61230	NOTE	Harmonized as EN 61230.
IEC 61812-1	NOTE	Harmonized as EN 61812-1.
IEC 62271-103	NOTE	Harmonized as EN 62271-103.
IEC 62271-110:2009	NOTE	Harmonized as EN 62271-110:2009 (not modified).

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60282-1	-	High-voltage fuses - Part 1: Current-limiting fuses	EN 60282-1	-
IEC 60417	Data- base	Graphical symbols for use on equipment	-	-
IEC 60644	-	Specification for high voltage fuse-links for motor circuit application	EN 60644	-
IEC 62271-1	2007	High-voltage switchgear and controlgear - Part 1: Common specifications	EN 62271-1	2008
IEC 62271-100	2008	High-voltage switchgear and controlgear - Part 100: Alternating current circuit-breakers	EN 62271-100	2009
IEC 62271-102	-	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches	EN 62271-102	-
IEC 62271-200	2003	High-voltage switchgear and controlgear - Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV	EN 62271-200	2004

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 106: Alternating current contactors, contactor-based controllers and motor-starters

1 General

1.1 Scope and object

This part of IEC 62271 is applicable to a.c. contactors and/or contactor-based controllers and motor-starters designed for indoor installation and operation at frequencies up to and including 60 Hz on systems having voltages above 1 000 V but not exceeding 24 000 V.

It is applicable only to three-pole devices for use in three-phase systems, and single-pole devices for use in single-phase systems. Two-pole contactors and starters for use in single-phase systems are subject to agreement between manufacturer and user.

Contactors and/or starters dealt with in this standard typically do not have adequate short-circuit interruption capability. In this context, this standard gives requirements for

- motor starters associated with separate short-circuit protective devices;
- controllers - contactors combined with short-circuit protective devices (SCPD).

Contactors intended for closing and opening electric circuits and, if combined with suitable relays, for protecting these circuits against operating overloads are covered in this standard.

This standard is also applicable to the operating devices of contactors and to their auxiliary equipment.

Motor-starters intended to start and accelerate motors to normal speed, to ensure continuous operation of motors, to switch off the supply from the motor and to provide means for the protection of motors and associated circuits against operating overloads are dealt with.

Motor-starter types included are

- direct-on-line starters;
- reversing starters;
- two-direction starters;
- reduced kVA (voltage) starters;
 - auto-transformer starters;
 - rheostatic starters;
 - reactor starters.

This standard does not apply to

- circuit-breaker-based motor-starters;
- single-pole operation of multi-pole contactors or starters;
- two-step auto-transformer starters designed for continuous operation in the starting position;
- unbalanced rheostatic rotor starters, i.e. where the resistances do not have the same value in all phases;

- equipment designed not only for starting, but also for adjustment of speed;
- liquid starters and those of the "liquid-vapour" type;
- semiconductor contactors and starters making use of semiconductor contactors in the main circuit;
- rheostatic stator starters;
- contactors or starters designed for special applications.

This standard does not deal with components contained in contactors and contactor-based motor-starters, for which individual specifications exist.

NOTE 1 Thermal electrical relays are covered by IEC 60255-8.

NOTE 2 High-voltage current-limiting fuses are covered by IEC 60282-1 and IEC 60644.

NOTE 3 Metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV are covered by IEC 62271-200.

NOTE 4 Disconnectors and earthing switches are covered by IEC 62271-102.

NOTE 5 High-voltage switches above 1 kV and less than 52 kV are covered by IEC 62271-103¹.

The object of this standard is to state

- a) the characteristics of contactors and starters and associated equipment;
- b) the conditions with which contactors or starters shall comply with reference to:
 - 1) their operation and behaviour,
 - 2) their dielectric properties,
 - 3) the degrees of protection provided by their enclosures, where applicable,
 - 4) their construction,
 - 5) for controllers, interactions between the various components, for example SCPD co-ordination;
- c) the tests intended for confirming that these conditions have been met, and the methods to be adopted for these tests;
- d) the information to be given with the equipment or in the manufacturer's literature.

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 60282-1, *High-voltage fuses – Part 1: Current-limiting fuses*

IEC 60417, *Graphical symbols for use on equipment*

IEC 60644, *Specification for high-voltage fuse-links for motor circuit applications*

IEC 62271-1:2007, *High-voltage switchgear and controlgear – Part 1: Common specifications*

IEC 62271-100:2008, *High-voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers*

¹ To be published

IEC 62271-102, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

IEC 62271-200:2003, *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

2 Normal and special service conditions

2.1 Normal service conditions

Subclause 2.1 of IEC 62271-1 is applicable with the following addition:

For outdoor installations, refer to 8.102.6.

2.2 Special service conditions

Subclause 2.2 of IEC 62271-1 is applicable with the following exception:

2.2.1 Altitude

Subclause 2.2.1 of IEC 62271-1 is applicable with the following addition:

NOTE Above 1 000 m it is often necessary to make adjustments. See 8.102.7.

3 Terms and definitions

For the purposes of this standard, the terms and definitions given in Clause 3 of IEC 62271-1, as well as the following, apply.

3.1 General terms and definitions

3.1.101

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 structures, intended in principle for the control of electric energy consuming equipment

[IEC 60050-441:1984, 441-11-03]

3.1.102

over-current

current exceeding the rated current

[IEC 60050-441:1984, 441-11-06]

3.1.103

short-circuit current

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

[IEC 60050-441:1984, 441-11-07]

3.1.104**overload**

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

[IEC 60050-441:1984, 441-11-08]

3.1.105**conductive part**

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

[IEC 60050-441:1984, 441-11-09]

3.1.106**ambient air temperature**

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

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

[IEC 60050-441:1984, 441-11-13]

3.2 Assemblies of switchgear and controlgear

Clause 3.2 of IEC 62271-1 applies

3.3 Parts of assemblies

Clause 3.3 of IEC 62271-1 applies.

3.4 Switching devices**3.4.101****switching device**

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

[IEC 60050-441:1984, 441-14-01]

3.4.102**mechanical switching device**

switching device (such as a contactor or a disconnector) designed to close and open one or more electric circuits by means of separable contacts

[IEC 60050-441:1984, 441-14-02, modified]

3.4.103**disconnector**

mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements

NOTE 1 A disconnector is capable of opening and closing a circuit either when negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the poles of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying for a specified time currents under abnormal conditions such as those of short circuit.

NOTE 2 A withdrawable contactor assembly may be used as a disconnector.

NOTE 3 In North America, this device is also called an isolating means or an isolating switch.

[IEC 60050-441:1984, 441-14-05, modified]

3.4.104
earthing switch

mechanical switching device for earthing parts of a circuit, capable of withstanding for a specified time currents under abnormal conditions such as those of short circuit, but not required to carry current under normal conditions of the circuit

NOTE An earthing switch may have a short-circuit making capacity.
[IEC 60050-441:1984, 441-14-11]

3.4.105
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

NOTE Contactors may be designated according to the method by which the force for closing the main contacts is provided.
[IEC 60050-441:1984, 441-14-33]

3.4.106
electromagnetic contactor

contactor in which the force for closing or opening the main contacts is provided by an electromagnet

3.4.107
vacuum contactor

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

3.4.108
SF₆ contactor

contactor in which the main contacts open and close within an SF₆ gas-filled compartment

3.4.109
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 The latching, and the release of the latching, may be mechanical, electromagnetic, pneumatic, etc.
[IEC 60050-441:1984, 441-14-34, modified]

3.4.110
starter

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

[IEC 60050-441:1984, 441-14-38, modified]

3.4.110.1
direct-on-line starter

starter which connects the line voltage across the motor terminals in one step

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

3.4.110.2
reversing starter

starter intended to cause the motor to reverse the direction of rotation by reversing the motor primary connections even when the motor is running

3.4.110.3**two-direction starter**

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

3.4.110.4**reduced kVA (voltage) starter**

starter which reduces the starting kVA of the motor

NOTE Reduced kVA starters may include auto-transformer, reactor, rheostatic starters.

3.4.110.5**auto-transformer starter**

starter which uses one or more reduced voltages derived from an auto-transformer

3.4.110.6**rheostatic starter**

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

NOTE A rheostatic starter generally consists of three basic parts, which may 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 rotor circuit;
- the mechanical switching devices for cutting out the resistor(s) successively.

[IEC 60050-441:1984, 441-14-42, modified]

3.4.110.7**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

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

3.4.110.8**reactor starter****primary reactor starter**

starter that includes a reactor connected in series with the stator winding of an alternating current motor to furnish reduced voltage for starting

3.4.110.9**electromagnetic starter**

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

3.4.110.10***n*-step starter**

starter in which there are ($n - 1$) intermediate accelerating positions between the off and full on positions

NOTE 1 A starter in which there is no intermediate accelerating position between the OFF and ON positions is a single step or direct-on-line starter (see 3.4.110.1).

NOTE 2 A starter in which there is only one intermediate accelerating position between the OFF and ON positions is known as a two-step starter.

NOTE 3 A three-step rheostatic starter has two sections of resistors used for starting.

[IEC 60050-441:1984, 441-14-41, modified]

3.4.111
controller
combination starter

equipment consisting of a contactor, overload protection, a manual externally operated disconnecter and a short-circuit protective device (SCPD), mounted and wired in a dedicated enclosure

NOTE 1 A dedicated enclosure is an enclosure specifically designed and dimensioned for its application, in which all tests are conducted, and which may also include an earthing function.

NOTE 2 A controller may be used for functions other than motor starting, for example transformer control and protection.

3.4.111.1
transformer controller

combination of all the switching means necessary to energize and de-energize a transformer in combination with suitable overload protection

3.4.111.2
capacitor controller

combination of all the switching means necessary to energize and de-energize a capacitor or capacitor bank in combination with suitable protection

3.4.112
short-circuit protective device
SCPD

device intended to protect a circuit or parts of a circuit against short-circuit currents by interrupting them

NOTE Usually this function is provided by fuses.

3.4.113
contactor class C1

contactor with a low probability of restrike during capacitive current breaking as demonstrated by the type tests (see 4.112)

3.4.114
contactor class C2

contactor with a very low probability of restrike during capacitive current breaking as demonstrated by type tests (see 4.112)

3.5 Parts of contactors and motor starters

3.5.101
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

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.

[IEC 60050-441:1984, 441-15-01]

3.5.102
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

[IEC 60050-441:1984, 441-15-02]

3.5.103

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

[IEC 60050-441:1984, 441-15-03]

3.5.104

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

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.

[IEC 60050-441:1984, 441-15-04]

3.5.105

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

[IEC 60050-441:1984, 441-15-07]

3.5.106

control contact

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

[IEC 60050-441:1984, 441-15-09]

3.5.107

auxiliary contact

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

[IEC 60050-441:1984, 441-15-10]

3.5.108

"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

[IEC 60050-441:1984, 441-15-12]

3.5.109

"b" contact

break contact

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

[IEC 60050-441:1984, 441-15-13]

3.6 Operation

3.6.101

operation (of a mechanical switching device)

transfer of the moving contact(s) from one position to an adjacent position

NOTE 1 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.

[IEC 60050-441:1984, 441-16-01]

3.6.102

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

NOTE 1 This may be a closing operation followed by an opening operation.

NOTE 2 A succession of operations not forming an operating cycle is referred to as an operating series.

[IEC 60050-441:1984, 441-16-02, modified]

3.6.103

closing operation (of a mechanical switching device)

operation by which the device is brought from the open position to the closed position

[IEC 60050-441:1984, 441-16-08]

3.6.104

opening operation (of a mechanical switching device)

operation by which the device is brought from the closed position to the open position

[IEC 60050-441:1984, 441-16-09]

3.6.105

closed position (of a mechanical switching device)

position in which the predetermined continuity of the main circuit of the device is secured

[IEC 60050-441:1984, 441-16-22]

3.6.106

open position (of a mechanical switching device)

position in which the predetermined clearance between open contacts in the main circuit of the device is secured

[IEC 60050-441:1984, 441-16-23]

3.6.107

position of rest (of a contactor)

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

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

3.6.108

overload relay or release

over-current relay or release intended for protection against overloads (including, where applicable, operating transformer(s) and interconnections)

3.6.109

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

3.6.110**current setting of an overload relay or release**

value of current for which the relay or release is adjusted and in accordance with which its operating conditions are defined

3.6.111**current setting range of an overload relay or release**

range between the minimum and maximum values over which the current setting of the relay or release can be adjusted

3.6.112**phase failure sensitive overload relay or release**

multi-pole overload relay or release which, in accordance with specified requirements, operates at a current value lower than its current setting in the case of current unbalance

3.6.113**under-current (under-voltage) relay or release**

measuring relay or release which operates automatically when the current through it (or the voltage applied to it) is reduced below a pre-determined value

3.6.114**starting time (of a rheostatic starter)**

period of time during which the starting resistors or parts of them carry current

NOTE The starting time of a starter is shorter than the total starting time of the motor, which takes into account the last period of acceleration following the switching operation ON position.

3.6.115**starting time (of an auto-transformer starter)**

period of time during which the auto-transformer carries current

NOTE The starting time of a starter is shorter than the total starting time of the motor, which takes into account the last period of acceleration following the switching operation ON position.

3.6.116**open transition (with an auto-transformer starter)**

circuit arrangement so that the supply to the motor is interrupted and reconnected when changing over from one step to another

NOTE The transition stage is not considered an additional step.

3.6.117**closed transition (with an auto-transformer starter)**

circuit arrangement so that the supply to the motor is not interrupted (even momentarily) when changing over from one step to another

NOTE The transition stage is not considered an additional step.

3.6.118**inching****jogging**

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

3.6.119**plugging**

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

3.7 Characteristic quantities

3.7.101

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

[IEC 60050-441:1984, 441-17-07]

3.7.102

breaking capacity (of a switching device or a fuse)

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

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

NOTE 2 For switching devices, the breaking capacity may be termed according to the kind of current included in the prescribed conditions, e.g. line charging breaking capacity, cable charging breaking capacity, single capacitor bank breaking capacity, etc.

[IEC 60050-441:1984, 441-17-08]

3.7.103

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

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

[IEC 60050-441:1984, 441-17-09]

3.7.104

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

[IEC 60050-441:1984, 441-17-17]

3.7.105

recovery voltage

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

NOTE 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 or the steady-state recovery voltage alone exists.

[IEC 60050-441:1984, 441-17-25]

3.7.106

transient recovery voltage

TRV

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

NOTE 1 The transient recovery voltage may be oscillatory or non-oscillatory, or a combination of these, depending on the characteristics of the circuit and the switching device. It includes the voltage shift of the neutral of a polyphase circuit.

NOTE 2 The transient recovery voltage in three-phase circuits is, unless otherwise stated, that across the first pole to clear, because this voltage is generally higher than that which appears across each of the other two poles.

[IEC 60050-441:1984, 441-17-26]

3.7.107**prospective transient recovery voltage** (of a circuit)

transient recovery voltage following the breaking of the prospective symmetrical current by an ideal switching device

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.

[IEC 60050-441:1984, 441-17-29]

3.7.108**power frequency recovery voltage**

recovery voltage after the transient voltage phenomena have subsided

[IEC 60050-441:1984, 441-17-27]

3.7.109**prospective current** (of a circuit and with respect to a controller situated therein)

current that would flow in the circuit if each pole of the controller were replaced by a conductor of negligible impedance

[IEC 60050-441:1984, 441-17-01, modified]

3.7.110**prospective peak current**

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

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.

[IEC 60050-441:1984, 441-17-02]

3.7.111**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

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

[IEC 60050-441:1984, 441-17-04]

3.7.112**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

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

[IEC 60050-441:1984, 441-17-06]

3.7.113**minimum breaking current**

minimum value of prospective current that a fuse-link is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

[IEC 60050-441:1984, 441-18-29]

3.7.114

cut-off current

let-through current

maximum instantaneous value of current attained during the breaking operation of a switching device or a fuse

[IEC 60050-441:1984, 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.

3.7.115

take-over current

current coordinate of the intersection between the release initiated opening time of the contactor and the time-current characteristic of the SCPD

[IEC 60050-441:1984, 441-17-16 modified]

3.7.116

minimum take-over current

current determined by the point of intersection of the time-current characteristics of the SCPD and the contactor corresponding to

- a) the maximum break time plus, where applicable, the maximum operating time of an external over-current or earth-fault relay;
- b) the minimum pre-arcing time of the SCPD

AC1 NOTE See also Figure 9. **AC1**

3.7.117

maximum take-over current

current determined by the point of intersection of the time-current characteristics of the SCPD and the contactor corresponding to

- a) the minimum opening time of the contactor, or minimum response time if operated by an overcurrent relay and/or time delay devices;
- b) the maximum operating time of the SCPD of highest rated current

AC1 NOTE See also Figure 9. **AC1**

3.7.118

maximum acceptable power dissipation

power which is dissipated by the controller when fitted with fuses of maximum power dissipation as determined by the temperature-rise tests

3.7.119

fused short-circuit current

conditional short-circuit current when the current limiting device is a fuse

[IEC 60050-441:1984, 441-17-21]

3.7.120

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

[IEC 60050-441:1984, 441-17-24]

3.7.121

vacant

3.7.122**release-initiated opening time** (of the contactor)

opening time defined according to the tripping method as stated below with any time-delay device forming an integral part of the contactor adjusted to a specified setting:

- a) for a contactor tripped by any form of auxiliary power, the interval of time between the instant of energizing the opening release, the contactor being in the closed position, and the instant when the arcing contacts have separated in all poles;
- b) for a contactor tripped (other than by the striker) by a current in the main circuit without the aid of any form of auxiliary power, the interval of time between the instant at which, the contactor being in the closed position, the current in the main circuit reaches the operating value of the over-current release and the instant when the arcing contacts have separated in all poles

3.7.123**minimum release-initiated opening time** (of the contactor)

release-initiated opening time when the specified setting of any time-delay device forming an integral part of the contactor is its minimum setting

3.7.124**maximum release-initiated opening time** (of the contactor)

release-initiated opening time when the specified setting of any time-delay device forming an integral part of the contactor is its maximum setting

3.7.125**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

[IEC 60050-441:1984, 441-17-37]

3.7.126**break time** (of the contactor in a release-operated controller)

interval of time between the beginning of the release-initiated opening time of the contactor and the instant of final arc extinction in all poles

NOTE This term may be qualified by prefixing it with "minimum" or "maximum" depending upon the opening time and the arcing time used.

3.101 Fuses**3.101.1****fuse**

device that by the fusing of one or more of its specially 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

[IEC 60050-441:1984, 441-18-01]

3.101.2**striker**

mechanical device forming part of a fuse-link which, when the fuse operates, releases the energy required to cause operation of other apparatus or indicators, or to provide interlocking

[IEC 60050-441:1984, 441-18-18]

3.101.3**pre-arcing time****melting time**

interval of time between the beginning of a current large enough to cause a break in the fuse element(s) and the instant when an arc is initiated

[IEC 60050-441:1984, 441-18-21]

3.101.4
operating time
total clearing time

sum of the pre-arcing time and the arcing time

[IEC 60050-441:1984, 441-18-22]

3.101.5
Joule integral
 I^2t

integral of the square of the current over a given time interval:

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

NOTE 1 The pre-arcing I^2t is the I^2t integral extended over the pre-arcing time of the fuse.

NOTE 2 The operating I^2t is the I^2t integral extended over the operating time of the fuse.

NOTE 3 The energy in joules liberated in one ohm of resistance in a circuit protected by a fuse is equal to the value of the operating I^2t expressed in A²s.

[IEC 60050-441:1984, 441-18-23]

4 Ratings

Clause 4 of IEC 62271-1 is applicable with the additions and exceptions indicated below.

A contactor, starter or controller in the correct condition of maintenance and adjustment shall be able to withstand all the stresses that occur in service, provided that these do not exceed its rated characteristics.

The characteristics of a contactor, starter or controller, including its operating devices and auxiliary equipment that shall be used to determine the ratings, are given in Table 1.

Under this heading, consideration is also given to the characteristics which are not necessarily ratings but need to be taken into consideration in the specification and design stages.

The use of an SCPD other than that utilized in the type tests may change the ratings of the combination. In this case, the new ratings shall be assigned by the manufacturer.

NOTE Ratings may differ between the table columns.

Table 1 – Ratings and characteristics

Rating/characteristic		Contactor 3.4.105	Starter 3.4.110	Controller 3.4.111
<i>(A) Rated characteristics</i>				
a) Rated voltage (U_r)	4.1	X	X	X
b) Rated insulation levels (U_d , U_p)	4.2	X	X	X
c) Rated frequency (f_r)	4.3	X	X	X
d) Rated operational current (I_e) or rated operational power	4.101	X	X	X
e) Rated short-time withstand current (I_k)	4.5	X	X	X
f) Rated peak withstand current (I_p)	4.6	X	X	X
g) Rated duration of short-circuit (t_k)	4.7	X	X	X
h) Rated short-circuit breaking current (I_{sc})	4.107			X
i) Rated short-circuit making current (I_{ma})	4.107			X
j) Rated duties	4.102	X	X	(X)
k) Rated load and overload characteristics, by utilization category	4.103, 4.104	X	X	X
l) Rated supply voltage of operating devices, and of auxiliary and control circuits (U_a)	4.8	X	X	X
m) Rated supply frequency of operating devices and of auxiliary circuits	4.9	X	X	X
n) Rated pressure of compressed gas supply for insulation and/or operation	4.10	X	X	X
<i>(B) Characteristics to be given on request</i>				
a) Thermal current (I_{th})	4.4.101	X	X	X
b) Electrical endurance	4.106	X		
c) Coordination with short-circuit protective devices	4.107	X	X	X
d) Damage classification	4.107.3	X	X	X
e) Short-circuit breaking capacity	4.107, 6.104	X	X	
f) Short-circuit making capacity	4.107, 6.104	X	X	
g) Motor switching characteristics	6.108	X		
h) Take-over current for release-operated controller	4.107.2			X
i) Rated capacitive switching current	4.112	X		X
<i>(C) Characteristics dependent on starter type</i>				
a) Automatic change-over devices and automatic acceleration control devices	4.108		X	X
b) Starting auto-transformer or reactor characteristics	4.109		X	X
c) Starting resistor characteristics	4.110		X	X
X: applicable for this configuration				
(X): applicable, but see NOTE 2 of 4.102.2 regarding intermittent duty				

4.1 Rated voltage (U_r)

The rated voltage indicates the upper limit of the highest voltage of the system for which the device is intended. Standard values of rated voltages are:

2,5 kV – 3,6 kV – 5,0 kV – 7,2 kV – 12 kV – 15 kV – 17,5 kV – 24 kV

For rheostatic rotor starters, the rated voltage refers to the stator.

4.1.101 Rated rotor voltage (U_{ro})

For rheostatic rotor starters, the value of the rated voltage is that of the voltage which, when combined with a rated rotor current, determines the application of the rotor circuit including its mechanical switching devices and to which are referred the making and breaking capacities, the type of duty and the starting characteristics.

It is taken as equal to the voltage measured between slip-rings, with the motor stopped and the rotor open-circuited, when the stator is supplied at its rated voltage.

The rated rotor voltage is only applied for a short duration during the starting period. For this reason, it is permissible that the rated rotor voltage exceeds the rated rotor insulation voltage by 100 %.

The maximum voltage between the different live parts (for example switching devices, resistors, connecting parts, etc.) of the rotor circuit of the starter will vary and account shall be taken of this fact in choosing the equipment and its disposition.

4.2 Rated insulation level (U_d , U_p)

Subclause 4.2 of IEC 62271-1 is applicable with the following additions.

For rheostatic rotor starters, the rated insulation level refers to the stator.

NOTE The insulation levels for 2,5 kV and 5,0 kV systems are 3,6 kV and 7,2 kV respectively.

4.2.101 Rated rotor insulation level

For rheostatic rotor starters, the rated rotor insulation level is that which is assigned to the devices inserted in the rotor circuit as well as the unit they are part of (connecting links, resistors, enclosure), and to which dielectric tests and creepage distances are referred.

4.2.102 Rated starting voltage (U_{tap}) of an auto-transformer starter

The rated starting voltage of an auto-transformer starter is the reduced voltage derived from the transformer.

Preferred values of rated starting voltage (U_{tap}) are 50 %, 65 % or 80 % of the rated voltage.

4.2.103 Rated starting voltage (U_{tap}) of a reactor starter

The rated starting voltage of a reactor starter is the reduced voltage derived from the impedance of the reactor and the motor current before rotation.

Preferred values of rated starting voltage (U_{tap}) are 50 %, 65 % or 80 % of the rated voltage.

4.3 Rated frequency (f_r)

The rated frequency is the supply frequency for which the device is designed and to which the other characteristic values correspond. The standard values of the rated frequency are 50 Hz and 60 Hz.

4.4 Rated normal current and temperature rise

4.4.1 Rated normal current (I_r)

A rated normal current is normally not assigned to the contactor or motor starter. When contactors or motor starters are combined into larger assemblies, the rated normal current of the connecting busbars shall be in accordance with IEC 62271-200.

See also thermal current (4.4.101).

4.4.2 Temperature rise

IEC 62271-1 applies and, and for fuses, IEC 60282-1 applies.

Subclause 4.4.2 of IEC 62271-1 is applicable with the following addition.

It is recognized that a controller may be fitted with types and ratings of fuses other than those utilized in the temperature-rise tests and this may change the thermal current of the controller. For any particular case, the thermal current of the controller shall be assigned by the manufacturer. For further information, see the application guide (Clause 8).

A contactor or starter is also defined by its rated operational currents or powers. See 4.101.

4.4.101 Thermal current (I_{th})

The thermal current is the maximum current carried on continuous duty (see 4.102.1) without the temperature rise of the various parts exceeding the limits specified in 6.5. Selection from the R10 series is not applicable.

Because, in an auto-transformer or reactor starter, the auto-transformer or reactor is energized only intermittently, a maximum temperature rise 15 K greater than the limits stated in the appropriate component standard (for example IEC 60076-2 or IEC 60076-11:2004) is permissible for the windings of the transformer or reactor when the starter is operated according to the requirements of 4.102 and 4.111.

4.4.101.1 Stator thermal current (I_{ths})

For motor starters, the stator thermal current is the maximum current it can carry on continuous duty without the temperature rise of its several parts exceeding the limits specified in 4.4.2 when tested in accordance with 6.5.3.

4.4.101.2 Rotor thermal current (I_{thr})

For rheostatic rotor starters, the rotor thermal current is the maximum current that those parts of the starter through which the rotor current flows in the ON position, (after cutting out resistors) can carry continuously without their temperature rise exceeding the limits specified in 4.4.2 when tested in accordance with 6.5.3.

4.5 Rated short-time withstand current (I_k)

Subclause 4.5 of IEC 62271-1 is applicable with the following addition.

For a contactor, or starter, this is the r.m.s. value of the current which can be carried in a closed position for a time sufficient for an external SCPD to operate. Alternatively, the value of current may be assigned for use of a specified SCPD. In this case, the value of the current need not be selected from the R10 series. For a controller, this is the prospective r.m.s. value of current.

4.6 Rated peak withstand current (I_p)

Subclause 4.6 of IEC 62271-1 is applicable.

4.7 Rated duration of short circuit (t_k)

Subclause 4.7 of IEC 62271-1 is applicable with the following addition.

Alternatively, the interval of time for which a contactor, or starter, can carry its short-time withstand current may be that resulting from operation of the specified SCPD.

4.8 Rated supply voltage of closing and opening devices, and of auxiliary and control circuits (U_a)

Subclause 4.8 of IEC 62271-1 is applicable with the following addition.

A single-phase control supply voltage of 110 V a.c. is recognized in addition to those in Table 5 of IEC 62271-1.

NOTE 1 For starters with short-time rated coils such as closing and trip coils for latched contactors, operating limits should be agreed between manufacturer and user.

The drop-out voltage shall be not higher than 75 %, nor (with worn contacts) lower than 10 % of the rated control supply voltage U_a .

NOTE 2 Drop-out voltage is the voltage below which the contactor changes state.

NOTE 3 Close voltage is the voltage above which the contactor will fully close.

The close and drop-out values specified above are applicable after the coils have reached a stable temperature corresponding to indefinite application of 100 % U_a . In the case of a.c. coils, the voltage limits apply at rated frequency.

4.9 Rated supply frequency of closing and opening devices, and of auxiliary circuits (f_a)

Subclause 4.9 of IEC 62271-1 is applicable.

4.10 Rated pressure of compressed gas supply for controlled pressure systems

Subclause 4.10 of IEC 62271-1 is applicable.

4.101 Rated operational current (I_e) or rated operational power

A rated operational current of a contactor or starter is stated by the manufacturer and takes into account the rated voltage (see 4.1), the rated frequency (see 4.3), the rated duties (see 4.102), the utilization category (see 4.104) and the type of protective enclosure, if appropriate.

In the case of contactors or starters for direct switching of individual motors, the indication of a rated operational current may be replaced or supplemented by the indication of the maximum rated power output, at the rated voltage considered, of the motor for which it is