

Electromechanical contactors for household and similar purposes

The European Standard EN 61095:1993 with the incorporation of amendments A11:1996 and A1:2000, has the status of a British Standard

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Cooperating organizations

The European Committee for Electrotechnical Standardization (CENELEC), under whose supervision this European Standard was prepared, comprises the national committees of the following countries:

Austria	Italy
Belgium	Luxembourg
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Germany	Spain
Greece	Sweden
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Ireland	United Kingdom

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7858	July 1993	Implements CENELEC corrigendum March 1993, which adds supersession information to EN.
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13213	25 January 2002	Correction of 7.1.4 and 8.3 and implements CENELEC corrigendum April 2001, which adds supersession information to EN title page and Foreword to amendment A1.

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National foreword

This British Standard has been prepared under the direction of the Power Electrical Engineering Standards Policy Committee and is the English language version of EN 61095:1993 *Electromechanical contactors for household and similar purposes*, including corrigendum March 1993, amendments A11:1996 and A1:2000 and corrigendum April 2001, published by the European Committee for Electrotechnical Standardization (CENELEC). It was derived by CENELEC from IEC 61095:1992, including amendment 1:2000, published by the International Electrotechnical Commission (IEC). It supersedes BS 5424-3:1998, which is withdrawn.

The CENELEC common modifications have been implemented at the relevant places in the text and are indicated by a sideline.

This standard includes requirements for contactors for distribution control in buildings and may be subject to national regulations including approval (certification) by appropriate testing authorities. These contactors have particular requirements, which include test sequences and sampling plans, to facilitate testing and approval under third-party approval (certification) schemes where mandatory requirements exist.

Contactors conforming to this standard are limited to values of operational currents and voltages appropriate to their applications. They are for use in circuits of limited prospective short-circuit fault current and need to be coordinated with an appropriate short-circuit protective device.

This standard has been aligned as far as possible with the requirements of BS EN 60947-4-1 *Electromechanical contactors and motor-starters*. It also applies to contactors which are components of an appliance, unless to otherwise stated in the particular standard covering the relevant appliance.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 44, 44a and 44b, 45 to 119 and a back cover.

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English version

Electromechanical contactors for household and similar purposes

(includes amendments A11:1996 and A1:2000)
(IEC 61095:1992 + A1:2000, modified)

Contacteurs électromécaniques pour usages domestiques et analogues
(inclut les amendements A11:1996 et A1:2000)
(CEI 61095:1992 + A1:2000 modifiée)

Elektromechanische Schütze für Hausinstallationen und ähnliche Zwecke
(enthält Änderungen A11:1996 und A1:2000)
(IEC 61095:1992 + A1:2000, modifiziert)

This European Standard was approved by CENELEC on 1992-12-09. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

The text of document 17B(CO)194/23E (CO)128, as prepared by Sub-Committee 17B: Low voltage switchgear and controlgear, of IEC Technical Committee No. 17: Switchgear and controlgear, in conjunction with Subcommittee 23E:

Circuit-breakers and similar equipment for household use, of IEC Technical Committee No. 23: Electrical accessories, was submitted to the IEC-CENELEC parallel vote in October 1991.

The reference document was approved by CENELEC as EN 61095 on 9 December 1992.

This European Standard supersedes HD 419.SI:1998.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1994-01-01
- latest date of withdrawal of conflicting national standards (dow) 1995-01-01

For products which have complied with the relevant national standard before 1995-01-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2000-01-01.

Annexes designated “normative” are part of the body of the standard. In this standard, annex ZA is normative.

Foreword to amendment A11

This amendment was prepared by Technical Committee CENELEC TC 23E, Circuit-breakers and similar devices for household and similar applications.

It was prepared in view of the application of Directive 89/366/EEC on electromagnetic compatibility.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as amendment A11 to EN61095:1993 on 1996-03-05.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1996-09-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 1996-09-01

For products which have complied with EN 61095:1993 before 1996-09-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2001-09-01

Foreword to amendment A1

The text of document 17B/1043/FDIS, future amendment 1 to IEC 61095:1992, prepared by SC 17B, Low voltage switchgear and controlgear, of IEC TC 17, Switchgear and controlgear, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 61095:1993 on 2000-08-01. This amendment supersedes EN 61095:1993/A11:1996.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2001-05-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2003-08-01

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ELECTROMECHANICAL CONTACTORS FOR HOUSEHOLD AND SIMILAR PURPOSES

1 Scope

This International Standard applies to electromechanical air break contactors for household and similar purposes provided with main contacts intended to be connected to circuits the rated voltage of which does not exceed 440 V a.c. with rated operational currents less than or equal to 63 A for utilization category AC-7a and 32 A for utilization category AC-7b, and rated conditional short-circuit current less than or equal to 6 kA.

The contactors dealt with in this standard are not normally designed to interrupt short-circuit currents. Therefore, suitable short-circuit protection (see 9.3.4) shall form part of the installation.

This standard does not apply to:

- contactors complying with IEC 947-4-1;
- semiconductor contactors;
- contactors designed for special applications;
- auxiliary contacts of contactors. These are dealt with in IEC 947-5-1.

This standard states:

- 1) The characteristics of contactors.
- 2) The conditions with which contactors shall comply with reference to:
 - a) their operation and behaviour;
 - b) their dielectric properties;
 - c) the degrees of protection provided by their enclosures, where applicable;
 - d) their construction.
 - e) their characteristics of electromagnetic compatibility.
- 3) The tests intended for confirming that these conditions have been met, and the methods to be adopted for these tests.
- 4) The test sequences and the number of samples to be submitted for certification purpose.
- 5) The information to be given with contactors or in the manufacturer's literature.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 28: 1925, *International standard of resistance for copper*.

IEC 50(151): 1978, *International Electrotechnical Vocabulary (IEV), Chapter 151: Electrical and magnetic devices.*

IEC 50(441): 1984, *International Electrotechnical Vocabulary (IEV), Chapter 441: Switchgear, controlgear and fuses.*

IEC 50(604): 1987, *International Electrotechnical Vocabulary (IEV), Chapter 604: Generation, transmission and distribution of electricity - Operation.*

IEC 50(826): 1982, *International Electrotechnical Vocabulary (IEV), Chapter 826: Electrical installations of buildings.*

IEC 68-2-3: 1969, *Environmental testing, Part 2: Tests - Test Ca: Damp heat, steady state.*

IEC 73: 1984, *Colours of indicator lights and push-buttons.*

IEC 85: 1984, *Thermal evaluation and classification of electrical insulation.*

IEC 99-1: 1970, *Lightning arresters, part 1: Non-linear resistor type arresters for a.c. systems.*

IEC 112: 1979), *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions.*

IEC 216, *Guide for the determination of thermal endurance properties of electrical insulating materials.*

IEC 364-4-443: 1990, *Electrical installations of buildings, Part 4: Protection for safety. Chapter 44: Protection against overvoltages. Section 443: Protection against overvoltages of atmospheric origin or due to switching.*

IEC 417: 1973, *Graphical symbols for use on equipment. Index, survey and compilation of single sheets.*

IEC 439-1: 1985: *Low-voltage switchgear and controlgear assemblies, Part 1: Requirements for type-tested and partially type-tested assemblies.*

IEC 445: 1988, *Identification of equipment terminals and of terminations of certain designated conductors, including general rules of an alphanumeric system.*

IEC 447: 1974, *Standard directions of movement for actuators which control the operation of electrical apparatus.*

IEC 529: 1989, *Degrees of protection provided by enclosures (IP Code).*

IEC 617-7: 1983, *Graphical symbols for diagrams, Part 7: Switchgear, controlgear and protective devices.*

IEC 664: 1980, *Insulation co-ordination within low-voltage systems including clearances and creepage distances for equipment.*

IEC 664A: 1981, *First supplement.*

IEC 695-2-1: 1980, *Fire hazard testing, Part 2: Test methods. Glow-wire test and guidance.*

IEC 707: 1981, *Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source.*

IEC 947-1: 1988, *Low-voltage switchgear and controlgear, Part 1: General rules.*

IEC 947-4-1: 1990, *Low-voltage switchgear and controlgear, Part 4: Contactors and motor-starters. Section one: Electromechanical contactors and motor-starters.*

IEC 947-5-1: 1990, *Low-voltage switchgear and controlgear, Part 5: Control-circuit devices and switching elements. Section one: Electromechanical control circuit devices.*

ISO 2039-2: 1987, *Plastics - Determination of hardness - Part 2: Rockwell hardness.*

EN 50082-1, *Electromagnetic compatibility — Generic immunity standard — Part 1: Residential, commercial and light industry.*

3 Definitions

For the purpose of this International Standard the following definitions apply.

3.1 General terms

3.1.1 over-current: A current exceeding the rated current. [IEV 441-11-06]

3.1.2 short-circuit: The accidental or intentional connection, by a relatively low resistance or impedance, of two or more points in a circuit which are normally at different voltages. [IEV 151-03-41]

3.1.3 short-circuit current: An over-current resulting from a short circuit due to a fault or an incorrect connection in an electric circuit. [IEV 441-11-07]

3.1.4 overload: Operating conditions in an electrically undamaged circuit which cause an over-current. [IEV 441-11-08]

3.1.5 overload current: An over-current occurring in an electrically undamaged circuit.

3.1.6 ambient air temperature: The temperature, determined under prescribed conditions, of the air surrounding the complete switching device or fuse. [IEV 441-11-13]

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

3.1.7 conductive part: A part which is capable of conducting current although it may not necessarily be used for carrying service current. [IEV 441-11-09]

3.1.8 exposed conductive part: A conductive part which can readily be touched and which is not normally alive, but which may become alive under fault conditions. [IEV 441-11-10]

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

3.1.9 electric shock: Pathophysiological effect resulting from an electric current passing through a human or animal body. [IEV 826-03-04]

3.1.10 live part: A conductor or conductive part intended to be energized in normal use, including a neutral conductor, but, by convention, not a PEN conductor. [IEV 826-03-01]

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

3.1.11 protective conductor (symbol PE): A conductor required by some measures for protection against electric shock for electrically connecting any of the following parts [IEV 826-04-05]:

- exposed conductive parts,
- extraneous conductive parts,
- main earthing terminal,
- earth electrode,
- earthed point of the source or artificial neutral.

3.1.12 neutral conductor (symbol N): A conductor connected to the neutral point of a system and capable of contributing to the transmission of electrical energy. [IEV 826-01-03]

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

3.1.13 enclosure: A 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 IEC 441-13-01, which applies to assemblies.

3.1.14 Integral enclosure: An enclosure which forms an integral part of the equipment.

3.1.15 utilization category (for a switching device or a fuse): A combination of specified requirements related to the condition in which the switching device or the fuse fulfils its purpose, selected to represent a characteristic group of practical applications. [IEV 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.

3.2 Switching devices

3.2.1 switching device: A device designed to make or break the current in one or more electric circuits. [IEV 441-14-01]

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

3.2.2 mechanical switching device: A switching device designed to close and open one or more electric circuits by means of separable contacts. [IEV 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, SF₆, oil.

3.2.3 semiconductor switching device: A 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 IEC 441-14-03 since a semiconductor switching device is also designed for breaking the current.

3.2.4 fuse: A 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. [IEV 441-18-01]

3.2.5 circuit-breaker: A 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. [IEV 441-14-20]

3.2.6 contactor (mechanical): A 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. [IEV 441-14-33]

NOTES (not included in IEC 441-14-33).

- 1 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.
- 2 In French, a contactor the main contacts of which are closed in the position of rest is usually called "rupteur". The word "rupteur" has no equivalent in the English language.
- 3 A contactor is usually intended to operate frequently.

3.2.7 electromagnetic contactor: A contactor, in which the force for closing the normally open main contacts or opening the normally closed main contacts is provided by an electromagnet.

3.2.8 latched contactor: A 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. [IEV 441-14-34]

NOTES

- 1 The latching, and the release of the latching, may be mechanical, electromagnetic, pneumatic, etc.
- 2 Because of the latching, the latched contactor actually acquires a second position of rest and, according to the definition 3.2.6 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.

3.2.9 semiconductor contactor (solid state contactor): A device which performs the function of a contactor by utilizing a semiconductor switching device.

NOTE - A semiconductor contactor may also contain mechanical switching devices.

3.2.10 pilot switch: A non-manual control switch actuated in response to specified conditions of an actuating quantity. [IEV 441-14-48]

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

3.2.11 push-button: A 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. [IEV 441-14-53]

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

3.2.13 surge arrester: A 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. [IEV 604-03-51]

3.3 *Parts of switching devices*

3.3.1 pole of a switching device: The 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. [IEV 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.

3.3.2 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. [IEV 441-15-02]

3.3.3 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. [IEV 441-15-03]

3.3.4 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. [IEV 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.

3.3.5 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. [IEV 441-15-05]

3.3.6 contact piece: One of the conductive parts forming a contact. [IEV 441-15-06]

3.3.7 main contact: A contact included in the main circuit of a mechanical switching device, intended to carry, in the closed position, the current of the main circuit. [IEV 441-15-07]

3.3.8 control contact: A contact included in a control circuit of a mechanical switching device and mechanically operated by this device. [IEV 441-15-09]

3.3.9 auxiliary contact: A contact included in an auxiliary circuit and mechanically operated by the switching device. [IEV 441-15-10]

3.3.10 auxiliary switch (of a mechanical switching device): A switch containing one or more control and/or auxiliary contacts mechanically operated by a switching device. [IEV 441-15-11]

3.3.11 "a" contact, make contact: A control or auxiliary contact which is closed when the main contacts of the mechanical switching device are closed and open when they are open. [IEV 441-15-12]

3.3.12 "b" contact, break contact: A control or auxiliary contact which is open when the main contacts of the mechanical switching device are closed and closed when they are open. [IEV 441-15-13]

3.3.13 release (of a mechanical switching device): A device, mechanically connected to a mechanical switching device, which releases the holding means and permits the opening or the closing of the switching device. [IEV 441-15-17]

NOTE - A release can have instantaneous, time-delay, etc., operation.

3.3.14 actuating system (of a mechanical switching device): The whole of the operating means of a mechanical switching device which transmits the actuating force to the contact pieces.

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

3.3.15 actuator: The part of the actuating system to which an external actuating force is applied. [IEV 441-15-22]

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

3.3.16 position indicating device: A part of a mechanical switching device which indicates whether it is in the open, closed, or, where appropriate, earthed position. [IEV 441-15-25]

3.3.17 terminal: A conductive part of a device provided for electrical connection to external circuits.

3.3.18 screw-type terminal: A terminal intended for the connection and disconnection of conductors or for the interconnection of two or more conductors, the connection being made, directly or indirectly, by means of screws or nuts of any kind.

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

3.3.20 thread-forming tapping screw: A tapping screw having an uninterrupted thread. It is not a function of this thread to remove material from the hole.

An example of a thread-forming tapping screw is shown in figure 1.

3.3.21 thread-cutting tapping screw: A tapping screw having an interrupted thread. The thread is intended to remove material from the hole.

An example of a thread-cutting tapping screw is shown in figure 2.

3.3.22 clamping unit: The part(s) of a terminal necessary for the mechanical clamping and the electrical connection of the conductor(s).

3.3.23 unprepared conductor: A 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.

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

3.4 *Operation of switching devices*

3.4.1 operation (of a mechanical switching device): The transfer of the moving contact(s) from one position to an adjacent position. [IEV 441-16-01]

NOTES

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

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.

3.4.2 operating cycle (of a mechanical switching device): A succession of operations from one position to another and back to the first position through all other positions, if any. [IEV 441-16-02]

3.4.3 operating sequence (of a mechanical switching device): A succession of specified operations with specified time intervals. [IEV 441-16-03]

3.4.4 automatic control: Control of an operation without human intervention, in response to the occurrence of predetermined conditions. [IEV 441-16-05]

3.4.5 closing operation (of a mechanical switching device): An operation by which the device is brought from the open position to the closed position. [IEV 441-16-08]

3.4.6 opening operation (of a mechanical switching device): An operation by which the device is brought from the closed position to the open position. [IEV 441-16-09]

3.4.7 closed position (of a mechanical switching device): The position in which the predetermined continuity of the main circuit of the device is secured. [IEV 441-16-22]

3.4.8 open position (of a mechanical switching device): The 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.

3.4.9 position of rest (of a contactor): The position which the moving elements of the contactor take up when its electromagnet or its compressed-air device is not energized. [IEV 441-16-24]

3.4.10 Inching (jogging): Energizing a motor or solenoid repeatedly for short periods to obtain small movements of the driven mechanism.

3.4.11 plugging: Stopping or reversing a motor rapidly by reversing the motor primary connections while the motor is running.

3.5 Characteristic quantities

3.5.1 nominal value: A suitable approximate quantity value used to designate or identify a component, device or equipment. [IEV 151-04-01]

3.5.2 limiting value: In a specification, the greatest or smallest admissible value of one of the quantities. [IEV 151-04-02]

3.5.3 rated value: A quantity value assigned, generally by the manufacturer, for a specified operating condition of a component, device or equipment. [IEV 151-04-03]

3.5.4 rating: The set of rated values and operating conditions. [IEV 151-04-04]

3.5.5 prospective current (of a circuit and with respect to a switching device or a fuse): The 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. [IEV 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.

3.5.6 prospective peak current: The peak value of a prospective current during the transient period following initiation. [IEV 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.

3.5.7 maximum prospective peak current (of an a.c. circuit): The prospective peak current when initiation of the current takes place at the instant which leads to the highest possible value. [IEV 441-17-04]

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

3.5.8 breaking current (of a switching device or a fuse): The current in a pole of a switching device or in a fuse at the instant of initiation of the arc during a breaking process. [IEV 441-17-07]

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

3.5.9 breaking capacity (of a switching device or a fuse): A 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. [IEV 441-17-08]

NOTES

- 1 The voltage to be stated and the conditions to be prescribed are dealt with in the relevant product standard.
- 2 For a.c. the current is expressed as the symmetrical r.m.s. value of the a.c. component.
- 3 For short-circuit breaking capacity, see 3.5.11.

3.5.10 making capacity (of a switching device): A value of prospective making current that a switching device is capable of making at a stated voltage under prescribed conditions of use and behaviour. [IEV 441-17-09]

NOTES

- 1 The voltage to be stated and the conditions to be prescribed are dealt with in the relevant product standard.
- 2 For short-circuit making capacity, see 3.5.12.

3.5.11 short-circuit breaking capacity: A breaking capacity for which the prescribed conditions include a short-circuit at the terminals of the switching device. [IEV 441-17-11]

3.5.12 short-circuit making capacity: A making capacity for which prescribed conditions include a short circuit at the terminals of the switching device. [IEV 441-17-10]

3.5.13 Joule Integral (I^2t): The integral of the square of the current over a given time interval: [IEV 441-18-23]

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

3.5.14 cut-off current; let-through current: The maximum instantaneous value of current attained during the breaking operation of a switching device or a fuse. [IEV 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.

3.5.15 applied voltage (for a switching device): The voltage which exists across the terminals of a pole of a switching device just before the making of the current. [IEV 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.

3.5.16 recovery voltage: The voltage which appears across the terminals of a pole of a switching device or a fuse after the breaking of the current. [IEV 441-17-25]

NOTES

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.

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.

3.5.17 transient recovery voltage (abbrev.: TRV): The recovery voltage during the time in which it has a significant transient character. [IEV 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.

3.5.18 power-frequency recovery voltage: The recovery voltage after the transient voltage phenomena have subsided. [IEV 441-17-27]

3.5.19 d.c. steady-state recovery voltage: The recovery voltage in a d.c. circuit after the transient voltage phenomena have subsided, expressed by the mean value where ripple is present. [IEV 441-17-28]

3.5.20 clearance: The distance between two conductive parts along a string stretched the shortest way between these conductive parts. [IEV 441-17-31]

3.5.21 creepage distance: The 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.

3.5.22 working voltage: The highest r.m.s. value of the a.c. voltage or the highest value of the d.c. voltage which may occur (locally) across any insulation at rated supply voltage, transients being disregarded, in open circuit conditions or under normal operating conditions.

3.5.23 switching overvoltage: A transient overvoltage at a given location of a system due to a specific switching operation or a fault.

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

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

3.5.26 pollution: Any addition of foreign matter, solid, liquid or gaseous (ionized gases) that may affect dielectric strength or surface resistivity.

3.5.27 pollution degree (of environmental conditions): A 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.

NOTES

1 The pollution degree of the micro-environment 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.

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

3.5.28 micro-environment (of a clearance or creepage distance): The 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 may 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.

3.5.29 overvoltage category (of a circuit or within an electrical system): A 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 on the means employed to influence the overvoltages.

NOTE - In an electrical system, the transition from one overvoltage category to one of a 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.

3.5.30 co-ordination of insulation: The 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.

3.5.31 homogeneous (uniform) field: An 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.

3.5.32 inhomogeneous (non-uniform) field: An electric field which does not have an essentially constant voltage gradient between electrodes.

3.5.33 tracking: The 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 that surface.

3.5.34 comparative tracking Index (CTI): The numerical value of the maximum voltage in volts at which a material withstands 50 drops of a test solution without tracking.

NOTES

- 1 The value of each test voltage and the CTI should be divisible by 25.
- 2 This definition is based on 2.3 of IEC 112.

4 Classification

Sub-clause 5.2 gives all data which may be used as criteria for classification.

5 Characteristics of contactors

5.1 Summary of characteristics

The characteristics shall be stated in the following terms, where such terms are applicable:

- type of contactor (see 5.2);
- rated and limiting values for main circuits (see 5.3);
- utilization category (see 5.4);
- control circuits (see 5.5);
- auxiliary circuits (see 5.6);
- co-ordination with short-circuit protective devices (see 5.7);
- switching overvoltages (see 5.8).

5.2 Type of contactor

The following shall be stated (see also clause 6):

5.2.1 Number of poles

5.2.2 Method of control

- automatic (by pilot switch or sequence control);
- non-automatic (e.g. by hand operation or by push-buttons);
- semi-automatic (i.e. partly automatic, partly non-automatic).

5.3 Rated and limiting values for main circuits

The rated values established for a contactor shall be stated in accordance with 5.3.1 to 5.4 and 5.7 to 5.8, but it may not be necessary to establish all the listed values.

5.3.1 Rated voltages

A contactor is defined by the following rated voltages:

5.3.1.1 *Rated operational voltage (U_o)*

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

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

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

NOTES

1 A contactor may be assigned a number of combinations of rated operational voltages and rated operational currents or powers for different duties and utilization categories.

2 A contactor may be assigned a number of rated operational voltages and associated making and breaking capacities for different duties and utilization categories.

3 Attention is drawn to the fact that the operational voltage may differ from the working voltage (see 3.5.22) within a contactor.

5.3.1.2 *Rated insulation voltage (U_i)*

The rated insulation voltage of a contactor is the value of voltage to which dielectric tests voltage 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 contactors without a specified rated insulation voltage, the highest value of the rated operational voltage is considered to be the rated insulation voltage.

5.3.1.3 *Rated impulse withstand voltage (U_{imp})*

The peak value of an impulse voltage of prescribed form and polarity which the contactor 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 a contactor shall be equal to or higher than the values stated for the transient overvoltages occurring in the circuit in which the contactor is fitted.

NOTE - Preferred values of rated impulse withstand voltage are given in table 16, page 129.

5.3.2 *Currents or powers*

A contactor is defined by the following currents:

5.3.2.1 *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 an unenclosed contactor in free air (see 9.3.3.3).

The value of the conventional free air thermal current shall be at least equal to the maximum value of the rated operational current (see 5.3.2.3) of the unenclosed contactor in eight-hour duty (see 5.3.4.1).

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

NOTES

- 1 This current is not a rating and is not mandatorily marked on the contactor.
- 2 An unenclosed contactor is a contactor supplied by the manufacturer without an enclosure or a contactor supplied by the manufacturer with an integral enclosure which is not normally intended to be the sole contactor protective enclosure.

5.3.2.2 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 contactor when mounted in a specified enclosure. Such tests shall be in accordance with 9.3.3.3 and are mandatory if the contactor is described as an enclosed contactor in the manufacturer's catalogues and normally intended for use with one or more enclosures of specified type and size (see note 2).

The value of the conventional enclosed thermal current shall be at least equal to the maximum value of the rated operational current (see 5.3.2.3) of the enclosed contactor in eight-hour duty (see 5.3.4.1).

If the contactor 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 the enclosed thermal current or the derating factor.

NOTES

- 1 This current is not a rating and is not mandatorily marked on the contactor.
- 2 An enclosed contactor is a contactor normally intended for use with a specified type and size of enclosure or intended for use with more than one type of enclosure.

5.3.2.3 Rated operational currents (I_o) or rated operational powers

A rated operational current of a contactor is stated by the manufacturer and takes into account the rated operational voltage (see 5.3.1.1), the conventional free air or enclosed thermal current, the rated frequency (see 5.3.3), the rated duty (see 5.3.4), the utilization category (see 5.4) and the type of protective enclosure, if any.

In the case of a contactor for the 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 contactor is intended. The manufacturer shall be prepared to state the relationship assumed between the current and the power.

5.3.3 Rated frequency

The supply frequency for which a contactor is designed and to which the other characteristic values correspond.

NOTE - The same contactor may be assigned a number or a range of rated frequencies.

5.3.4 Rated duties

The rated duties considered as normal are:

5.3.4.1 Eight-hour duty (continuous duty)

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

NOTES

- 1 This is the basic duty on which the conventional thermal currents I_{th} and I_{th0} of the contactor are determined.
- 2 Interruption means breaking the current by operating the contactor.

5.3.4.2 Intermittent periodic duty or intermittent duty

A duty with on-load periods, during which the main contacts of a contactor remain closed, having a definite relation to off-load periods, both periods being too short to allow the contactor 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.

According to the number of operating cycles which they are capable of carrying out per hour, contactors are divided into the following preferred 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. |

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

Example: An intermittent duty comprising a current flow of 32 A for 2 min within every 5 min may be stated as: 32 A, class 12, 40 %.

5.3.4.3 Temporary duty

Duty in which the main contacts of a contactor remain closed for periods insufficient to allow the contactor to reach thermal equilibrium, the un-load periods being separated by off-load periods of sufficient duration to restore equality of temperature with the cooling medium.

5.3.4.4 Periodic duty

A type of duty in which operation, whether at constant or variable load, is regularly repeated. (IEV 151-04-11)

5.3.5 Normal load and overload characteristics

This subclause gives general requirements concerning ratings under normal load and overload conditions.

Detailed requirements are given in 8.2.4.

5.3.5.1 Ability to withstand motor switching overload currents

A contactor intended for switching motors shall be capable of withstanding the thermal stresses due to starting and accelerating a motor to normal speed and due to operating overloads.

Requirements to meet these conditions are given in 8.2.4.3.

5.3.5.2 Rated making capacity

Requirements for the various utilization categories (see 5.4) are given in 8.2.4.1. The rated making and breaking capacities are only valid when the contactor is operated in accordance with the requirements of 8.2.1.1 and 8.2.1.2.

5.3.5.3 Rated breaking capacity

Requirements for the various utilization categories (see 5.4) are given in 8.2.4.1. The rated making and breaking capacities are only valid when the contactor is operated in accordance with the requirements of 8.2.1.1 and 8.2.1.2.

5.3.5.4 Conventional operational performance

Specified as a series of making and breaking operations in 8.2.4.2.

5.3.6 Rated conditional short-circuit current

The rated conditional short-circuit current of a contactor is the value of prospective current stated by the manufacturer, that the contactor, protected by a short-circuit protective device specified by the manufacturer, can withstand satisfactorily for the operating time of this device under the test conditions specified in 9.3.4.

The details of the specified short-circuit protective device shall be stated by the manufacturer.

NOTE - The rated conditional short-circuit current is expressed by the r.m.s. value of the a.c. component.

5.4 Utilization category

The utilization category of a contactor defines the intended application and is characterized by one or more of the following service conditions:

- current(s), expressed as multiple(s) of the rated operational current;
- voltage(s), expressed as multiple(s) of the rated operational voltage;
- power-factor.

The standard utilization categories are given in table 1.

Each utilization category is characterized by the values of the currents, voltages, power-factors and other data of tables 8 and 9 and by the test conditions specified in this standard.

It is therefore unnecessary to specify separately the rated making and breaking capacities as these values depend directly on the utilization category as shown in table 8.

Unless otherwise stated, contactors of utilization category AC-7b are designed on the basis of the starting characteristics of the motors compatible with the making capacities of table 8. When the starting current of a motor, with stalled rotor, exceeds these values, the operational current should be decreased accordingly.

5.4.1 Assignment of utilization categories based on the results of tests

A contactor which has been tested for one utilization category or at any combination of parameters (such as highest operational voltage and current, etc.) can be assigned another utilization category without testing provided that the test currents, voltages, power-factors, number of operating cycles, ON and OFF times given in tables 8 and 9 and the test circuit for the assigned utilization category are not more severe than those at which the contactor has been tested and the temperature-rise has been verified at a current not less than the highest assigned rated operational current in continuous duty.

Table 1 - Utilization categories

Utilization categories ¹⁾	Typical applications
AC-7a AC-7b	Slightly inductive loads Motor loads ²⁾
¹⁾ Contactors may have other utilization categories, in which case they shall comply with the requirements of IEC 947-4-1 for such categories. ²⁾ The AC-7b category may be used for occasional inching (jogging) or plugging for limited time periods; during such limited time periods the number of operations should not exceed five per minute or more than ten in a 10-minute period.	

5.5 *Control circuits*

The characteristics of control circuits are:

- kind of current;
- rated frequency;
- rated control circuit voltage U_c (nature and frequency);
- rated control supply voltage U_s (nature and frequency), where applicable;
- suitability to be connected to SELV circuits.

NOTE - A distinction has been made above between the control circuit voltage, which would appear across the "a" contacts (see 3.3.11) in the control circuit, and the control supply voltage, which is the voltage applied to the input terminals of the control circuit of the contactor and which may be different from the control circuit voltage owing to the presence of built-in transformers, rectifiers, resistors, etc.

The rated control circuit voltage and rated frequency, if any, are the values on which the operating and temperature-rise characteristics of the control circuit are based.

5.6 *Auxiliary circuits*

The characteristics of auxiliary circuits are the number and kind of contacts ("a" contact, "b" contact, etc.) in each of these circuits and their ratings according to IEC 947-5-1.

The characteristics of auxiliary contacts and switches shall comply with the requirements of that standard.

5.7 *Co-ordination with short-circuit protective devices*

Contactors are characterized by the type, ratings and characteristics of the short-circuit protective devices (SCPD) to be used to provide adequate protection of the contactor against short-circuit currents. Requirements are given in 8.2.5.

5.8 *Switching overvoltages*

The requirements are given in 8.2.6.

6 **Product Information**

6.1 *Nature of information*

The following information shall be given by the manufacturer:

6.1.1 *Identification:*

- a) the manufacturer's name or trade mark;
- b) type designation or serial number;
- c) number of this standard, if the manufacturer claims compliance.

6.1.2 Characteristics, basic rated values and utilization

- d) rated operational voltages (see 5.3.1.1);
- e) utilization category and rated operational currents (or rated powers), at the rated operational voltage (see 5.3.2.3 and 5.4);
- f) value of the rated frequency/frequencies, e.g.: 50 Hz or 50 Hz/60 Hz;
- g) rated duty with indication of the class of intermittent duty, if any (see 5.3.4).

Associated values:

- h) rated making and breaking capacities. These indications may be replaced, where applicable, by the indication of the utilization category (see table 8);

Safety and installation:

- i) rated insulation voltage (see 5.3.1.2);
- j) rated impulse withstand voltage (see 5.3.1.3), when declared;
- k) IP code, in case of an enclosed contactor (see 8.1.11);
- l) pollution degree (see 7.1.3.2);
- m) rated conditional short-circuit current (see 5.3.6) and the type, current rating and characteristics of the associated SCPD;
- n) switching overvoltages (see 5.8).

Control circuits (see 5.5):

The following information concerning control circuits shall be placed either on the coil or on the contactor:

- o) rated control circuit voltage (U_c), nature of current and rated frequency;
- p) if necessary nature of current, rated frequency and rated control supply voltage (U_s);

For contactors, the control circuit of which is intended to be connected to a SELV supply:

- q) suitability of the control circuit to be connected to a SELV supply, the main circuit being supplied with a voltage having a value greater than that of the SELV circuit.

Auxiliary circuits:

- r) ratings of auxiliary circuits (see 5.6).

6.2 Marking

Markings shall be indelible and easily legible.

Marking of the manufacturer's name or trade mark and type designation or serial number is mandatory on the contactor, preferably on the nameplate if any, to enable complete data to be obtained from the manufacturer.

NOTE - In the USA and Canada, the rated operational voltage U_o may be marked as follows:

- a) on equipment for use on three-phase - four-wire systems, by both the value of phase-to-earth voltage and that of phase-to-phase voltage, e.g. 277/480 V;
- b) on equipment for use on three-phase - three-wire systems, by the value of phase-to-phase voltage, e.g. 480 V.

The following information shall also be marked and visible after mounting:

- direction of movement of the actuator (see 8.1.4.2), if applicable;
- indication of the position of the actuator (see also 8.1.5.1 and 8.1.5.2);
- approval or certification mark, if applicable;
- for miniaturized contactors, symbol, colour code or letter code;
- terminal identification and marking (see 8.1.6.4);
- IP code and class of protection against electric shock, when applicable (marked preferably on the contactor as far as possible).

Markings shall not be placed on screws, removable washers or other removable parts.

Data under k) shall be indicated on the enclosure, if any.

Data under c) and approval mark (certification), if any, shall be indicated on the nameplate.

Data under d) to j) and l) to r) shall be included on the nameplate, or on the contactor, or in the manufacturer's published literature.

Marking of terminals shall be in accordance with annex A of this standard.

NOTE - Additional utilization categories according to IEC 947-4-1 may also be marked (see note 1 to table 1).

6.3 Instructions for installation, operation and maintenance

The manufacturer shall specify in his documents or catalogues the conditions, if any, for installation, operation and maintenance of the contactor during operation and after a fault.

If necessary, the instructions for the transport, installation and operation of the contactor shall indicate the measures that are of particular importance for the proper and correct installation, commissioning and operation of the contactor.

These documents shall indicate the recommended extent and frequency of maintenance, if any.

7 Normal service, mounting and transport conditions

7.1 Normal service conditions

Contactors complying with this standard shall be capable of operating under the following standard conditions:

7.1.1 Ambient air temperature

The ambient air temperature does not exceed +40 °C and its average over a period of 24 h does not exceed +35 °C.

The lower limit of the ambient air temperature is $-5\text{ }^{\circ}\text{C}$.

Ambient air temperature is that existing in the vicinity of the contactor if supplied without enclosure, or in the vicinity of the enclosure if supplied with an enclosure.

Contactors intended to be used in ambient air temperatures above $+40\text{ }^{\circ}\text{C}$ (particularly in tropical countries) or below $-5\text{ }^{\circ}\text{C}$ shall either be specially designed or be used according to the information given in the manufacturer's catalogue.

7.1.2 *Altitude*

The altitude of the site of installation does not exceed 2 000 m.

For installations at higher altitudes, it is necessary to take into account the reduction of the dielectric strength and the cooling effects of the air.

Contactors intended to be so used shall be designed especially or used according to an agreement between manufacturer and user.

Information in the manufacturer's catalogue may take the place of such an agreement.

7.1.3 *Atmospheric conditions*

7.1.3.1 *Humidity*

The relative humidity of the air does not exceed 50 % at a maximum temperature of $+40\text{ }^{\circ}\text{C}$. Higher relative humidities may be permitted at lower temperatures, e.g. 90 % at $+20\text{ }^{\circ}\text{C}$. Special measures may be necessary in cases of occasional condensation due to variation in temperature.

NOTE - The pollution degrees given in 7.1.3.2 define the environmental conditions more precisely.

7.1.3.2 *Pollution degree*

The pollution degree (see 3.5.27) refers to the environmental conditions for which the contactor is intended.

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

For contactors intended for use within an enclosure or provided with an integral enclosure, the pollution degree of the environment in the enclosure is applicable.

For the purpose of evaluating clearances and creepage distances, the following four degrees of pollution of the micro-environment are established (the clearances and creepage distances being according to the different pollution degrees given in tables 17 and 18).

Pollution degree 1:

No pollution or only dry, non-conductive pollution occurs.

Pollution degree 2:

Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation may be expected.

Pollution degree 3:

Conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation.

Pollution degree 4:

The pollution generates persistent conductivity caused, for instance, by conductive dust or by rain or snow.

Standard pollution degree of household and similar applications:

Contactors for household and similar applications are generally for use in a pollution degree 2 environment.

7.1.4 Normal electromagnetic environmental conditions

The normal electromagnetic environmental conditions are those which relate to low-voltage public networks such as residential, commercial and light industrial locations/installations.

7.2 Conditions during transport and storage

The conditions during transport and storage, e.g. temperature and humidity, are those defined in 7.1, except that, unless otherwise specified, the following temperature range applies during transport and storage: between $-25\text{ }^{\circ}\text{C}$ and $+55\text{ }^{\circ}\text{C}$ and, for short periods not exceeding 24 h, up to $+70\text{ }^{\circ}\text{C}$.

7.3 Mounting

The contactor shall be mounted in accordance with the manufacturer's instructions.

8 Constructional and performance requirements

8.1 Constructional requirements

The contactor with its enclosure, if any, whether integral or not, shall be designed and constructed to withstand the stresses occurring during installation and normal use and, in addition, shall provide a specified degree of resistance to abnormal heat and fire.

NOTE - An enclosed contactor is a contactor mounted in an enclosure, designed and dimensioned to contain one contactor only.

8.1.1 Materials

The suitability of materials used is verified by making the following tests on the contactor and/or, if not practicable, on parts taken from it.

- resistance to ageing (see 8.1.1.1)
- resistance to humidity (see 8.1.1.2)
- resistance to heat (see 8.1.1.3)
- resistance to abnormal heat and fire (see 8.1.1.4)
- resistance to rusting (see 8.1.1.5)

As far as resistance to heat, abnormal heat and fire hazard are concerned, priority shall be given to tests made on the contactor or on a suitable part taken from the contactor.

However, in certain cases, tests on materials may be used, for practical reasons, as an alternative to tests on the contactor.

8.1.1.1 *Resistance to ageing*

Contactors shall be resistant to ageing.

In general, it is only necessary to test contactors having (or supplied with) enclosures or parts of p.v.c. or similar thermoplastic material and parts of rubber such as sealing rings and gaskets.

Compliance is checked by inspection and, if necessary, by a test according to 9.2.1.1.

8.1.1.2 *Resistance to humidity*

The contactor shall be protected against the effects of humidity which may occur in normal service.

Compliance shall be verified by the test specified in 9.2.1.2.

8.1.1.3 *Resistance to heat*

All parts of enclosed, partially enclosed and unenclosed contactors intended to prevent access to live parts shall not be adversely affected by the highest temperature likely to be reached during normal service.

Compliance shall be verified by the tests specified in 9.2.1.3.1 and 9.2.1.3.2.

8.1.1.4 *Resistance to abnormal heat and fire*

Parts of insulating material which might be exposed to thermal stresses due to electrical effects, the deterioration of which might impair the safety of the contactor, shall not be adversely affected by abnormal heat or fire.

Compliance shall be verified by the test specified in 9.2.1.4.

If a test has to be made at more than one place on the same sample, care shall be taken to ensure that any deterioration caused by previous tests does not affect the test to be made. Small parts with surface dimensions not exceeding 14 mm x 14 mm are not subjected to the test.

8.1.1.5 *Resistance to rusting*

Ferrous parts of the contactor including enclosures and covers, but excluding pole faces of electromagnets, shall be protected against rusting.

Compliance shall be verified by the test specified in 9.2.1.5.

8.1.2 *Strength of screws or nuts other than those on terminals which are intended to be operated during installation or maintenance*

Screws or nuts intended to be operated during installation or maintenance, as recommended by the manufacturer, shall withstand the mechanical stresses occurring in normal service.

Thread-forming tapping screws and thread-cutting tapping screws intended only for mechanical assembly may be used provided they are supplied together with the piece in which they are intended to be inserted.

An example of a thread-forming tapping screw is shown in figure 1. An example of a thread-cutting tapping screw is shown in figure 2. In addition, thread-cutting tapping screws intended to be operated by the installer shall be captive with the relevant part of the accessory.

Screws or nuts which transmit contact pressure shall be in engagement with metal threads.

For electrical connections, no contact pressure shall be transmitted through insulating material other than ceramic or other material with characteristics not less suitable and compensated for any possible shrinkage or yielding.

Compliance shall be verified by inspection and by the test of 9.2.2.

8.1.3 *Clearances and creepage distances*

- a) For contactors for which the manufacturer has declared a value of rated impulse withstand voltage (U_{imp}) (see 5.3.1.3), minimum values of clearances are given in table 17 and minimum values of creepage distances in table 18, in relation with the rated insulation voltage (U_i).

Compliance is verified by the test of 9.3.3.4.1.

- b) For contactors for which the manufacturer has not declared a value of U_{imp} , clearances and creepage distances shall not be less than the values shown in table 2 when the contactor is mounted as for normal use.

Compliance is verified by the test of 9.3.3.4.2.

- c) For SELV circuits minimum values are under consideration.

Requirements for dielectric properties are given in 8.2.3.

Table 2 - Clearances and creepage distances

Description	Value mm
Clearances	
1 – between live parts of different polarity	3
2 – between live parts and exposed conductive parts ¹⁾	3(6)
Creepage distances	
1 – between live parts which are separated when the contactor is in the open position ²⁾	3
2 – between live parts of different polarity:	
– for contactors having U_n not exceeding 250 V	3
– for other contactors ($250 \text{ V} < U_n \leq 440 \text{ V}$)	4
3 – between live parts and exposed conductive parts ¹⁾	3(6)
¹⁾ If clearances and creepage distances between live parts of the contactor and exposed conductive parts can be decreased by mounting in the most unfavourable conditions the values in brackets apply. ²⁾ Not applicable to auxiliary and control contacts.	

NOTES

1 Care should be taken to provide adequate spacing between live parts of different polarity of contactors suitable for mounting close to one another.

2 For contactors whose control circuit is suitable for connection to a safety extra-low voltage supply, the main circuit being supplied with a voltage having a value greater than that of the safety extra-low voltage, creepage distances and clearances between control and main circuits shall be greater than or equal to 6 mm.

Compliance is verified by the test of 9.3.3.4.2.

8.1.4 Actuator

The requirements of 8.1.4.1 and 8.1.4.2 apply to contactors provided with a manually operated actuator.

8.1.4.1 Insulation

The actuator of the contactor shall be insulated from the live parts for the rated insulation voltage and, if applicable, the rated impulse withstand voltage.

Moreover:

- if the activator is made of metal, it shall be capable of being satisfactorily connected to a protective conductor unless it is provided with additional reliable insulation;
- if it is made of or covered by insulating material, any internal metal part which might become accessible in the event of insulation failure shall also be insulated from live parts for the rated insulation voltage.

8.1.4.2 Direction of movement

The direction of movement of the actuator shall comply with the requirements of IEC 447: 1974.

8.1.4.3 *Mounting*

Actuators mounted on removable panels or opening doors shall be so designed that when the panels are replaced or the doors closed, the actuator will engage correctly with the associated mechanism.

8.1.5 *Indication of the OFF and ON positions*

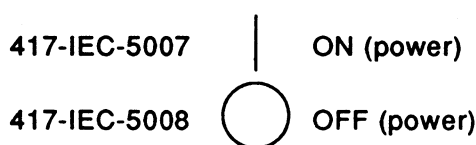
8.1.5.1 *Indicating means*

When a contactor is provided with means for indicating the closed and open positions, these positions shall be unambiguous and clearly indicated.

NOTE - In the case of enclosed contactors, the indication may or may not be visible from the outside.

This is done by means of a position indicating device (see 3.3.16).

If symbols are used, they shall indicate the closed and open positions respectively, in accordance with IEC 417:



For contactors operated by means of two push-buttons, only the push-button designated for the opening operation shall be red or marked with the symbol "O".

Red colour shall not be used for any other push-button.

The colours of other push-buttons, illuminated push-buttons and indicator lights shall be in accordance with IEC 73.

8.1.5.2 *Indication by the actuator*

When the actuator is used to indicate the position of the contacts, it shall automatically take up or stay in, when released, the position corresponding to that of the moving contacts; in this case, the actuator shall have two distinct rest positions corresponding to those of the moving contacts, but for automatic opening, a third distinct position of the actuator may be provided.

8.1.6 *Terminals*

8.1.6.1 *Constructional requirements*

All parts of terminals which maintain contact and carry current shall be of metal having adequate mechanical strength.

Terminal connections shall be such that the conductors may be connected by means of screws, springs or other equivalent means so as to ensure that the necessary contact pressure is maintained.

Terminals shall be so constructed that the conductors can be clamped between suitable surfaces without any significant damage either to conductors or terminals.

Terminals shall not allow the conductors to be displaced, or be displaced themselves in a manner detrimental to the operation of the contactor and the insulation voltage shall not be reduced below the rated values.

The requirements of this subclause shall be verified by the tests of 9.2.4.2, 9.2.4.3 and 9.2.4.4, as applicable.

NOTE - North American countries have particular requirements for terminals suitable for aluminium conductors and marking to identify the use of aluminium conductors.

8.1.6.2 Connecting capacity

The manufacturer shall state the type (rigid - solid or stranded - or flexible), the minimum and the maximum cross-sections of conductors for which the terminal is suitable and, if applicable, the number of conductors simultaneously connectable to the terminal. However, the maximum cross-section shall not be smaller than that stated in 9.3.3.3 for the temperature-rise test and the terminal shall be suitable for conductors of the same type (rigid - solid or stranded - or flexible) at least two sizes smaller, as given in the appropriate column of table 3.

Standard values of cross-sections of round copper conductors (both metric and AWG/MCM sizes) are shown in table 3 which also gives the approximate relationship between ISO metric and AWG/MCM sizes.

Table 3 - Standard cross-sections of round copper conductors

ISO cross-section mm ²	AWG/MCM	
	Size	Equivalent cross-section mm ²
0,2	24	0,205
—	22	0,324
0,5	20	0,519
0,75	18	0,82
1	—	—
1,5	16	1,3
2,5	14	2,1
4	12	3,3
6	10	5,3
10	8	8,4
16	6	13,3
25	4	21,2
35	2	33,6

NOTE - The dash, when it appears, counts as a size when considering connecting capacity.

8.1.6.3 *Connection*

Terminals for connection to external conductors shall be readily accessible during installation.

Clamping screws and nuts shall not serve to fix any other component although they may hold the terminals in place or prevent them from turning.

8.1.6.4 *Terminal identification and marking*

Terminals shall be clearly and permanently identified in accordance with IEC 445.

Terminals intended exclusively for the neutral conductor shall be identified by the letter "N", in accordance with IEC 445.

The protective earth terminal shall be identified in accordance with 8.1.8.3.

Additional requirements for terminal identification and marking are given in annex A.

8.1.7 *Additional requirements for contactors provided with a neutral pole*

When a contactor is provided with a pole intended only for connecting the neutral, this pole shall be clearly identified to that effect by the letter "N" (see 8.1.6.4).

A switched neutral pole shall not break before and shall not make after the other poles.

The value of the conventional thermal current shall be identical for all poles.

8.1.8 *Provisions for earthing*

8.1.8.1 *Constructional requirements*

The exposed conductive parts (e.g. chassis, framework and fixed parts of metal enclosures) other than those which cannot constitute a danger shall be electrically interconnected and connected to a protective earth terminal for connection to an earth electrode or to an external protective conductor.

This requirement can be met by the normal structural parts providing adequate electrical continuity and applies whether the contactor is used on its own or incorporated in an assembly.

Exposed conductive parts are not considered to constitute a danger if they cannot be touched on large areas or grasped with the hand or if they are of small size (approximately 50 mm x 50 mm) or are so located as to exclude any contact with live parts.

Examples of these are screws, rivets, nameplates, transformer cores, electromagnets and certain parts of releases, irrespective of their size.

8.1.8.2 *Protective earth terminal*

The protective earth terminal shall be readily accessible and so placed that the connection of the contactor to the earth electrode or to the protective conductor is maintained when the cover or any other removable part is removed.

The protective earth terminal shall be suitably protected against corrosion.

In the case of contactors with conductive structures, enclosures, etc., means shall be provided if necessary to ensure electrical continuity between the exposed conductive parts of the contactors and the metal sheathing of connecting conductors.

The protective earth terminal shall have no other function, except when it is intended to be connected to a PEN conductor (see note to 3.1.12). In that case, it shall also have the function of a neutral terminal in addition to meeting the requirements applicable to the protective earth terminal.

8.1.8.3 *Protective earth terminal marking and identification*

The protective earth terminal shall be clearly and permanently identified by its marking.

The identification shall be achieved by colour (green-yellow mark) or by the notation PE, or PEN as applicable, in accordance with 5.3 of IEC 445, or, in the case of PEN, by a graphical symbol for use on contactors.

The graphical symbol to be used is symbol:



of IEC 417.

NOTE – The symbol  (417-IEC-5017) previously recommended shall be progressively superseded by the preferred symbol 417-IEC-5019 given above.

8.1.9 *Enclosures*

The following requirements are applicable only to enclosures supplied or intended to be used with the contactor.

8.1.9.1 *Design*

The enclosure shall be so designed that when it is opened and other protective means, if any, have been removed, all parts requiring access for installation and maintenance, as prescribed by the manufacturer, are readily accessible.

Sufficient space shall be provided inside the enclosure for the accommodation of external conductors from their point of entry into the enclosure to the terminals to ensure adequate connection.