

FINAL VERSION

VERSION FINALE

**Electrical accessories – Circuit-breakers for overcurrent protection
for household and similar installations –
Part 1: Circuit-breakers for a.c. operation**

**Petit appareillage électrique – Disjoncteurs pour la protection
contre les surintensités pour installations domestiques et analogues –
Partie 1: Disjoncteurs pour le fonctionnement en courant alternatif**

CONTENTS

FOREWORD	8
1 Scope	10
2 Normative references	11
3 Terms and definitions	12
3.1 Devices	12
3.2 General terms	13
3.3 Constructional elements	15
3.4 Conditions of operation	18
3.5 Characteristic quantities	18
3.6 Definitions related to insulation co-ordination	23
4 Classification	25
4.1 General	25
4.2 According to the number of poles:	25
4.3 According to the protection against external influences:	25
4.4 According to the method of mounting:	25
4.5 According to the methods of connection	25
4.5.1 According to the fixation system:	25
4.5.2 According to the type of terminals:	26
4.6 According to the instantaneous tripping current (see 3.5.17)	26
4.7 According to the I^2t characteristic	26
5 Characteristics of circuit-breakers	26
5.1 List of characteristics	26
5.2 Rated quantities	26
5.2.1 Rated voltages	26
5.2.2 Rated current (I_n)	27
5.2.3 Rated frequency	27
5.2.4 Rated short-circuit capacity (I_{cn})	27
5.3 Standard and preferred values	27
5.3.1 Preferred values of rated voltage	27
5.3.2 Preferred values of rated current	28
5.3.3 Standard values of rated frequency	28
5.3.4 Values of rated short-circuit capacity	28
5.3.5 Standard ranges of instantaneous tripping	29
5.3.6 Standard values of rated impulse withstand voltage (U_{imp})	29
6 Marking and other product information	30
7 Standard conditions for operation in service	32
7.1 General	32
7.2 Ambient air temperature range	32
7.3 Altitude	32
7.4 Atmospheric conditions	32
7.5 Conditions of installation	32
7.6 Pollution degree	32
8 Requirements for construction and operation	32
8.1 Mechanical design	32
8.1.1 General	32

8.1.2	Mechanism	33
8.1.3	Clearances and creepage distances and solid insulation	34
8.1.4	Screws, current-carrying parts and connections	37
8.1.5	Terminals for external conductors	37
8.1.6	Non-interchangeability	40
8.1.7	Mechanical mounting of plug-in type circuit-breakers	40
8.2	Protection against electric shock	40
8.3	Dielectric properties and isolating capability	41
8.3.1	General	41
8.3.2	Dielectric strength at power frequency	41
8.3.3	Isolating capability	41
8.3.4	Dielectric strength at rated impulse withstand voltage (U_{imp})	41
8.4	Temperature-rise	41
8.4.1	Temperature-rise limits	41
8.4.2	Ambient air temperature	42
8.5	Uninterrupted duty	42
8.6	Automatic operation	42
8.6.1	Standard time-current zone	42
8.6.2	Conventional quantities	43
8.6.3	Tripping characteristic	43
8.7	Mechanical and electrical endurance	44
8.8	Performance at short-circuit currents	44
8.9	Resistance to mechanical shock and impact	44
8.10	Resistance to heat	45
8.11	Resistance to abnormal heat and to fire	45
8.12	Resistance to rusting	45
8.13	Power loss	45
8.14	Electromagnetic immunity	45
8.15	Electromagnetic emission	45
9	Tests	46
9.1	Type tests and test sequences	46
9.2	Test conditions	46
9.3	Test of indelibility of marking	47
9.4	Test of reliability of screws, current-carrying parts and connections	48
9.5	Tests of reliability of screw-type terminals for external copper conductors	49
9.6	Test of protection against electric shock	51
9.7	Test of dielectric properties	51
9.7.1	Resistance to humidity	51
9.7.2	Insulation resistance of the main circuit	52
9.7.3	Dielectric strength of the main circuit	53
9.7.4	Insulation resistance and dielectric strength of auxiliary circuits	53
9.7.5	Verification of impulse withstand voltages (across clearances and across solid insulation) and of leakage current across open contacts	54
9.8	Test of temperature-rise and measurement of power loss	57
9.8.1	Ambient air temperature	57
9.8.2	Test procedure	57
9.8.3	Measurement of the temperature of parts	57
9.8.4	Temperature-rise of a part	57
9.8.5	Measurement of power loss	57

9.9	28-day test.....	58
9.10	Test of tripping characteristic	58
9.10.1	General	58
9.10.2	Test of time-current characteristic.....	58
9.10.3	Test of instantaneous tripping, of correct opening of the contacts and of the trip-free function	58
9.10.4	Test of effect of single-pole loading on the tripping characteristic of multipole circuit-breakers.....	60
9.10.5	Test of effect of ambient temperature on the tripping characteristic	60
9.11	Verification of mechanical and electrical endurance	60
9.11.1	General test conditions	60
9.11.2	Test procedure	61
9.11.3	Condition of the circuit-breaker after test	61
9.12	Short-circuit tests.....	61
9.12.1	General	61
9.12.2	Values of test quantities	62
9.12.3	Tolerances on test quantities	62
9.12.4	Test circuit for short-circuit performance.....	63
9.12.5	Power factor of the test circuit	64
9.12.6	Measurement and verification of I^2t and of the peak current (I_p)	64
9.12.7	Calibration of the test circuit	64
9.12.8	Interpretation of records	65
9.12.9	Condition of the circuit-breaker for test	65
9.12.10	Behaviour of the circuit-breaker during short-circuit tests.....	66
9.12.11	Test procedure	67
9.12.12	Verification of the circuit breaker after short circuit tests.:.....	72
9.13	Mechanical stresses	72
9.13.1	Mechanical shock	72
9.13.2	Resistance to mechanical stresses and impact	73
9.14	Test of resistance to heat.....	76
9.15	Resistance to abnormal heat and to fire	77
9.16	Test of resistance to rusting.....	78
Annex A (informative)	Determination of short-circuit power factor	92
Annex B (normative)	Determination of clearances and creepage distances	93
Annex C (normative)	Test sequences and number of samples	98
Annex D (informative)	Co-ordination under short-circuit conditions between a circuit-breaker and another short-circuit protective device (SCPD) associated in the same circuit.....	104
Annex E (normative)	Special requirements for auxiliary circuits for safety extra-low voltage.....	111
Annex F (informative)	Examples of terminals	112
Annex G (informative)	Correspondence between ISO and AWG copper conductors	115
Annex H (normative)	Arrangement for short-circuit test.....	116
Annex I (normative)	Routine tests	119
Annex J (normative)	Particular requirements for circuit-breakers with screwless-type terminals for external copper conductors.....	120
Annex K (normative)	Particular requirements for circuit-breakers with flat quick-connect terminations.....	129

Annex L (normative) Specific requirements for circuit-breakers with screw-type terminals for external untreated aluminium conductors and with aluminium screw-type terminals for use with copper or with aluminium conductors	136
Bibliography.....	146
Figure 1 – Thread forming tapping screw (3.3.22)	79
Figure 2 – Thread cutting tapping screw (3.3.23)	79
Figure 3 – Typical diagram for all short circuit tests except for 9.12.11.2.2)	79
Figure 4 – Typical diagram for short circuit tests according to 9.12.11.2.2)	80
Figure 5 – Detail of impedance Z and Z_1	80
Figure 6 – Example of short-circuit making or breaking test record in the case of a single-pole device on single phase AC	82
Figure 7 – Mechanical shock test apparatus (9.13.1)	83
Figure 8 – Standard test finger (9.6)	84
Figure 9 – Mechanical impact test apparatus (9.13.2)	85
Figure 10 – Striking element for pendulum for mechanical impact test apparatus (9.13.2).....	86
Figure 11 – Mounting support for mechanical impact test (9.13.2).....	87
Figure 12 – Example of mounting of a flush-type circuit-breaker for mechanical impact test (9.13.2).....	88
Figure 13 – Example of mounting of a panel board type circuit-breaker for mechanical impact test (9.13.2).....	89
Figure 14 – Application of force for mechanical test on a rail-mounted circuit-breaker (9.13.2.4).....	90
Figure 15 – Ball-pressure test apparatus.....	90
Figure 16 – Example of application of force for mechanical test on two-pole plug-in circuit-breaker, the holding in position of which depends solely on the plug-in connections (9.13.2.5)	91
Figure 17 – Diagrammatic representation (9.15)	91
Figure B.1 – Examples of methods of measuring creepage distances and clearances.....	97
Figure D.1 – Overcurrent co-ordination between a circuit-breaker and a fuse or back-up protection by a fuse – Operating characteristics	109
Figure D.2 – Total selectivity between two circuit-breakers	109
Figure D.3 – Back-up protection by a circuit-breaker – Operating characteristics	110
Figure F.1 – Examples of pillar terminals	112
Figure F.2 – Examples of screw terminals and stud terminals	113
Figure F.3 – Examples of saddle terminals.....	114
Figure F.4 – Examples of lug terminals	114
Figure H.1 – Example of test arrangement.....	117
Figure H.2 – Grid circuit.....	117
Figure H.3 – Grid circuit.....	118
Figure J.1 – Example of test set-up.....	126
Figure J.2 – Examples of screwless-type terminals	127
Figure K.1 – Example of position of the thermocouple for measurement of the temperature-rise	132
Figure K.2 – Dimensions of male tabs.....	133

Figure K.3 – Dimensions of round dimple detents (see Figure K.2)	134
Figure K.4 – Dimensions of rectangular dimple detents (see Figure K.2).....	134
Figure K.5 – Dimensions of hole detents	134
Figure K.6 – Dimensions of female connectors	135
Figure L.1 – General arrangement for the test.....	144
Figure L.2	144
Figure L.3	145
Figure L.4	145
Figure L.5	145
Figure L.6	145
Table 1 – Preferred values of rated voltage.....	28
Table 2 – Ranges of instantaneous tripping	29
Table 3 – Rated impulse withstand voltage as a function of the nominal voltage of the installation	30
Table 4 – Minimum clearances and creepage distances.....	35
Table 5 – Connectable cross-sections of copper conductors for screw-type terminals	38
Table 6 – Temperature-rise values.....	42
Table 7 – Time-current operating characteristics.....	43
Table 8 – Maximum power loss per pole	45
Table 9 – List of type tests	46
Table 10 – Cross-sectional areas (S) of test copper conductors corresponding to the rated currents	47
Table 11 – Screw thread diameters and applied torques	49
Table 12 – Pulling forces	50
Table 13 – Test voltage of auxiliary circuits	54
Table 14 – Test voltage for verification of impulse withstand voltage	56
Table 15 – Test voltage for verifying the suitability for isolation, referred to the rated impulse withstand voltage of the circuit breakers and the altitude where the test is carried out	56
Table 16 – Applicability of short-circuit tests	62
Table 17 – Power factor ranges of the test circuit	64
Table 18 – Ratio k between service short-circuit capacity (I_{CS}) and rated short-circuit capacity (I_{CN}).....	69
Table 19 – Test procedure for I_{CS} in the case of single- and two-pole circuit-breakers	69
Table 20 – Test procedure for I_{CS} in the case of three- and four-pole circuit-breakers.....	70
Table 21 – Test procedure for I_{CS} in the case of three-phase tests for single-pole circuit-breakers of rated voltage 230/400 V.....	70
Table 22 – The test procedure for I_{CN}	71
Table 23 – Test procedure for I_{CN} in the case of three-phase tests for single-pole circuit-breakers of rated voltage 230/400 V	71
Table C.1 – Test sequences	99
Table C.2 – Number of samples for full test procedure.....	100
Table C.3 – Reduction of samples for series of circuit-breakers having different numbers of poles	102

Table C.4 – Test sequences for a series of circuit-breakers being of different instantaneous tripping classifications	103
Table J.1 – Conductors and their theoretical diameters	123
Table J.2 – Cross-sections of copper conductors connectable to screwless-type terminals	123
Table J.3 – Pull forces	125
Table K.1 – Informative table on colour code of female connectors in relationship with the cross section of the conductor	130
Table K.2 – Overload test forces	131
Table K.3 – Dimensions of tabs	132
Table K.4 – Dimensions of female connectors	135
Table L.1 – Marking for terminals	137
Table L.2 – Connectable cross-sections of aluminium conductors for screw-type terminals	138
Table L.3 – List of tests according to the material of conductors and terminals	139
Table L.4 – Connectable conductors and their theoretical diameters	139
Table L.5 – Cross sections (<i>S</i>) of aluminium test conductors corresponding to the rated currents	140
Table L.6 – Test conductor length	141
Table L.7 – Equalizer and busbar dimensions	141
Table L.8 – Test current as a function of rated current	143
Table L.9 – Example of calculation for determining the average temperature deviation <i>D</i>	143

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRICAL ACCESSORIES –
CIRCUIT-BREAKERS FOR OVERCURRENT PROTECTION
FOR HOUSEHOLD AND SIMILAR INSTALLATIONS –****Part 1: Circuit-breakers for a.c. operation**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

DISCLAIMER

This Consolidated version is not an official IEC Standard and has been prepared for user convenience. Only the current versions of the standard and its amendment(s) are to be considered the official documents.

This Consolidated version of IEC 60898-1 bears the edition number 2.1. It consists of the second edition (2015-03) [documents 23E/881/FDIS and 23E/894/RVD] and its corrigendum (2015-11), and its amendment 1 (2019-12) [documents 23E/1156/FDIS and 23E/1157/RVD]. The technical content is identical to the base edition and its amendment.

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.

International Standard IEC 60898-1 has been prepared by sub-committee 23E: Circuit-breakers and similar equipment for household use, of IEC technical committee 23: Electrical accessories.

This second edition constitutes a technical revision.

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

- a) Revision of 9.5 Terminals
- b) Revision of the test of glow wire
- c) Simplification of the figures for short circuit tests.

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

The following differing practices of a less permanent nature exist in the countries indicated below.

- Annex J, Clause J.1: Upper limit of current for use of screwless terminals is 16 A (CZ, DK, NL and CH; upper limit of current for use of screwless terminals is 30 A (Japan).
- J.3.3: Only universal screwless-type terminals are accepted (AT, BE, CN, DK, DE, ES, FR, IT, PT, SE and CH).

In this standard, the following print types are used:

- Requirements proper: in roman type.
- *Test specifications: in italic type.*
- Explanatory matter: in smaller roman type.

A list of all parts in the IEC 60898 series, published under the general title *Electrical accessories – Circuit-breakers for overcurrent protection for household and similar installations*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

ELECTRICAL ACCESSORIES – CIRCUIT-BREAKERS FOR OVERCURRENT PROTECTION FOR HOUSEHOLD AND SIMILAR INSTALLATIONS –

Part 1: Circuit-breakers for a.c. operation

1 Scope

This part of IEC 60898 applies to a.c. air-break circuit-breakers for operation at 50 Hz, 60 Hz or 50/60 Hz, having a rated voltage not exceeding 440 V (between phases), a rated current not exceeding 125 A and a rated short-circuit capacity not exceeding 25 000 A.

As far as possible, it is in line with the requirements contained in IEC 60947-2.

NOTE 1 Additional requirements are necessary for circuit-breakers used in locations having more severe overvoltage conditions.

These circuit-breakers are intended for the protection against overcurrents of wiring installations of buildings and similar applications; they are designed for use by uninstructed people and do not require maintenance.

They are intended for use in an environment with pollution degree 2 and overvoltage category III.

For an environment with a higher pollution degree, enclosures giving the appropriate degree of protection are used.

They are suitable for isolation.

Circuit-breakers of this standard, with exception of those rated 120 V or 120/240 V (see Table 1), are suitable for use in IT systems.

This standard also applies to circuit-breakers having more than one rated current, provided that the means for changing from one discrete rating to another is not accessible in normal service and that the rating cannot be changed without the use of a tool.

This standard does not apply to

- circuit-breakers intended to protect motors;
- circuit-breakers, the current setting of which is adjustable by means accessible to the user.

For circuit-breakers having a degree of protection higher than IP20 according to IEC 60529, for use in locations where arduous environmental conditions prevail (e.g. excessive humidity, heat or cold or deposition of dust) and in hazardous locations (e.g. where explosions are liable to occur), special constructions may be required.

This standard does not apply to circuit-breakers for a.c. and d.c. operation, which is covered by IEC 60898-2.