



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS C 8211 : 2004

**Circuit-breakers for overcurrent
protection for household and
similar installations**

ICS 29.120.50; 91.140.50

Reference number : JIS C 8211 : 2004 (E)

PROTECTED BY COPYRIGHT

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS C 8211:1999** is replaced with this Standard.

This revision has been made based on **IEC 60898-1:2002** *Electrical accessories—Circuit-breakers for overcurrent protection for household and similar installations—Part 1: Circuit-breakers for a.c. operation* and Amendment 1 (2002) for the purposes of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Date of Establishment: 1999-03-20

Date of Revision: 2004-12-20

Date of Public Notice in Official Gazette: 2004-12-20

Investigated by: Japanese Industrial Standards Committee

Standards Board

Technical Committee on Electricity Technology

JIS C 8211:2004, First English edition published in 2006-06

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

© JSA 2006

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Printed in Japan

Contents

	Page
Introduction.....	1
1 Scope	1
2 Normative references	4
3 Definitions	5
4 Classification	15
5 Characteristics of circuit-breakers	17
6 Marking and other product information	21
7 Standard conditions for operation in service	23
8 Requirements for construction and operation	24
9 Tests	24
Annex 1 (normative) Circuit-breakers corresponding to specification of JIS C 0364	39
Annex 2 (normative) Circuit-breakers corresponding to customary Electrical Facility Rule	90
Annex A (informative) Determination of short-circuit power factor	109
Annex B (normative) Determination of clearances and creepage distances	111
Annex C (normative) Number of samples to be submitted and test sequences to be applied for verification of conformity (13.5 of ISO/IEC Guide 2: 1991)	113
Annex D (informative) Co-ordination under short-circuit conditions between a circuit-breaker and another short-circuit protective device (SCPS) associated in the same circuit	119
Annex E (normative) Special requirements for auxiliary circuits for safety extra-low voltage	127
Annex F (informative) Examples of terminals	128
Annex G (informative) Correspondence between ISO and AWG copper conductors	131
Annex H (normative) Arrangement for short-circuit test.....	132
Annex I (normative) Routine tests	134

Annex J (normative)	Particular requirements for circuit-breakers with screwless type terminals for external copper conductors	135
Annex K (normative)	Particular requirements for circuit-breakers with flat quick-connect terminations	143
Annex XA (normative)	Circuit-breakers which also serve for protection of induction motors	149
Annex XB (normative)	Circuit-breakers with protection against neutral-line failure in single-phase three-wire system	152
Annex XC (informative)	Conventional circuit-breakers for lamp distribution switchboard	157
Annex XD (informative)	Circuit-breakers for branch circuit of low-voltage panel board for household use	159
Annex XE (normative)	Insulation distance of equipment not marked with its rated impulse withstand voltage	161
Annex XF (informative)	Comparison table between JIS and corresponding International Standard	170

Circuit-breakers for overcurrent protection for household and similar installations

Introduction This Japanese Industrial Standard has been prepared based on the first edition of **IEC 60898-1** *Electrical accessories—Circuit-breakers for overcurrent protection for household and similar installations—Part 1: Circuit-breakers for a.c. operation* published in 2002 and Amendment 1 (2002) with some modifications of the technical contents. The compilation is based on edition 1.1 published in 2002.

The portions given sidelines or dotted underlines are the matters modified from the original International Standard. A list of modifications with the explanations is given in Annex XF (informative).

Annexes 1, 2, B, C, E, H, I, J, K, XA, XB and XE are additional requirements of this Standard. Annexes A, D, F, G, XC, XD and XF are informative.

1 Scope This Standard specifies a.c. air-break moulded-case circuit-breakers for household and similar installations having a rated voltage not exceeding a.c. 440 V (between lines) or a.c. 300 V (voltage to earth) with a frequency of 50 Hz or 60 Hz, a rated current not exceeding 150 A and a rated breaking capacity not exceeding 25 kA (hereafter referred to as “circuit-breakers”).

In this Standard, two kinds of current-breakers different in performances resulted from the difference in the requirements of electrical facility regulation are specified in the following Annexes.

Annex 1: Circuit-breakers corresponding to specification of **JIS C 0364**: Electrical installations of buildings

Annex 2: Circuit-breakers corresponding to customary electrical facility rule

NOTE 1 Customary Electrical Facility Rule means the interpretation of sections 3 to 271 of technical standard of electrical facilities based on Electricity Utilities Industry Law.

Further, circuit-breakers covered by Annex 1 shall not be used in the circuit based on customary Electrical Facility Rule, and circuit-breakers covered by Annex 2 shall not be used in the circuit based on **JIS C 0364**.

As far as possible this Standard is in line with the requirements contained in **JIS C 8201-2-1**.

These circuit-breakers are intended for the protection against overcurrents of distribution facilities of housings and similar facilities, they are designed for use by uninstructed people and for not being maintained.

The circuit-breakers covered by this Standard are intended for use in an environment of pollution degree 2.

Circuit-breakers covered by Annex 1 of this Standard are suitable for isolation. For circuit-breakers covered by Annex 2, the manufacturer shall declare whether they are suitable for isolation or not.

Circuit-breakers covered by Annex 1 of this Standard have a value of impulse withstand voltage (U_{imp}). For circuit-breakers covered by Annex 2, the manufacturer shall select whether he declare the value of impulse withstand voltage (U_{imp}) or not. However, circuit-breakers covered by Annex 2 without declaration of the value of impulse withstand voltage (U_{imp}) have a value of lightning impulse withstand voltage.

In circuit-breakers of this Standard, the device which changes the rating shall not be accessible during normal service.

If the rating can not be changed without the use of a tool, the tripping mechanism may be capable of setting plural rated currents.

This Standard, excluding Annex XA, 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 **JIS C 0920**, 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.

Additional requirements for circuit-breakers which also serve for protection of induction motors, are shown in Annex XA.

Additional requirements for circuit-breakers with protection against neutral line failure in single-phase three wire circuit are shown in Annex XB.

Additional requirements for conventional circuit-breakers for lamp distribution switchboard, are shown in Annex XC.

Additional requirements for circuit-breakers for branch-circuit of low voltage panel board for household use, are shown in Annex XD.

Additional requirements for insulation distances of equipment not marked with its rated impulse withstand voltage, are shown in Annex XE.

Residual current operated circuit-breakers for household and similar use are specified in **JIS C 8222**.

A guide for co-ordination under short-circuit conditions between a circuit-breaker and another short-circuit protective device (SCPDs) is given in Annex D.

- NOTES
- 2 For more severe overvoltage conditions, circuit-breakers complying with other standards (e.g. **JIS C 8201-2-1**) should be used.
 - 3 For an environment with a higher pollution degree, enclosures giving the appropriate degree of protection should be used.
 - 4 Circuit-breakers within the Annex 1 this Standard may also be used for protection against electric shock in case of fault, depending on their tripping characteristics and on the characteristics of the installation. The criterion of application for such purposes is dealt with by **JIS C 0364** series.

Information : In **413.1.4.4** of **JIS C 0364-4-41**, there is a provision which says “the overcurrent protective device is usable for the protection against indirect contact in TT system only in such a case that R_A (sum of the resistance of protective conductor connecting exposed current carrying parts and the earthing resistance of earthed pole) is very low. It is difficult to manage the R_A low, therefore in original electrical facilities construction rule in this country, the protection against electric shock is carried out by means of circuit-breaker with residual current protection but not of circuit-breaker (overcurrent protection function).

This Standard contains all requirements necessary to ensure compliance with the operational characteristics required for these devices by type tests.

It also contains the details relative to test requirements and methods of testing necessary to ensure reproducibility of test results.

This Standard states

- a) the characteristics of circuit-breakers;
- b) the conditions with which circuit-breakers shall comply, with reference to:
 - 1) their operation and behaviour in normal service;
 - 2) their operation and behaviour in case of overload;
 - 3) their operation and behaviour in case of short-circuits up to their rated short-circuit breaking capacity;
 - 4) their dielectric properties;
- c) the tests intended for confirming that these conditions have been met and the methods to be adopted for the tests;
- d) the data to be marked on the devices;
- e) the test sequences to be carried out and the number of samples to be submitted for certification purposes (see Annex C);
- f) the co-ordination under short-circuit conditions with another short-circuit protective device (SCPD) associated in the same circuit (see Annex D);
- g) the routine tests to be carried out on each circuit-breaker to reveal unacceptable variations in material or manufacture, likely to affect safety (see Annex I).

NOTE 5 The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are **IDT** (identical), **MOD** (modified), and **NEQ** (not equivalent) according to **ISO/IEC Guide 21**.

IEC 60898-1:2002 *Electrical accessories—Circuit-breakers for over-current protection for household and similar installations—Part 1: Circuit-breakers for a.c. operation* and Amendment 1 (2002) (MOD)

2 Normative references The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. If the indication of the year of coming into effect (or the year of publication) is given to these referred standards, only the edition of the indicated year constitutes the provision of this Standard but the revision and amendment made thereafter do not apply. The normative references without the indication of the year of coming into effect (or the year of publication) apply only to the most recent edition (including amendments).

JIS C 0364 series *Electrical installations of buildings*

NOTE : **IEC 60364** (all parts) *Electrical installations of buildings* is identical with the said standard series.

JIS C 0364-4-41 *Electrical installations of buildings—Part 4: Protection for safety—Chapter 41: Protection against electric shock*

NOTE : **IEC 60364-4-41** :1992 *Electrical installations of buildings, Part 4: Protection for safety, Chapter 41: Protection against electric shock* is identical with the said standard.

JIS C 0364-4-473 *Electrical installations of buildings—Part 4: Protection for safety—Chapter 47: Application of protective measures for safety—Section 473: Measures of protection against overcurrent*

NOTE : **IEC 60364-4-473** :1977 *Electrical installations of buildings—Part 4: Protection for safety—Chapter 47: Application of protective measures for safety—Section 473: Measures of protection against overcurrent* and Amendment 1: 1998 are identical with the said standard.

JIS C 0664 *Insulation coordination for low-voltage equipment Part 1: Principles, requirements and tests*

NOTE : **IEC 60664-1** *Insulation coordination for equipment within low-voltage systems—Part 1: Principles, requirements and tests* is equivalent to the said standard.

JIS C 0920 *Degrees of protection provided by enclosures (IP Code)*

NOTE : **IEC 60529** *Degrees of protection provided by enclosures (IP Code)* is identical with the said standard.

JIS C 2134 *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions*

NOTE : **IEC 60112** *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions* is identical with the said standard.

JIS C 3307 *600 V Polyvinyl chloride insulated wires*

JIS C 3662 series *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V*

NOTE : **IEC 60227** (all parts) *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V* is identical with the said standard.

JIS C 8201-1 *Low-voltage switchgear and controlgear—Part 1: General rules*

NOTE : **IEC 60947-1:1999** *Low voltage switchgear and controlgear—Part 1: General rules* and Amendment 1: 2000 are equivalent to the said standard.

JIS C 8201-2-1 *Low-voltage switchgear and controlgear—Part 2-1: Circuit-breakers*

NOTE : **IEC 60947-2** *Low voltage switchgear and controlgear—Part 2: Circuit-breakers* is equivalent to the said standard.

JIS C 8201-2-2 *Low-voltage switchgear and controlgear—Part 2-2: Circuit-breakers incorporating residual current protection*

NOTE : **IEC 60947-2** *Low voltage switchgear and controlgear—Part 2: Circuit-breakers* is equivalent to the said standard.

JIS C 8222 *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)*

NOTE : **IEC 61009-1** *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)—Part 1: General rules* is equivalent to the said standard.

JIS C 8269 series *Low-voltage fuses*

NOTE : **IEC 60269** (all parts) *Low-voltage fuses* is identical with the said standard series.

JIS C 60695-2-10 *Fire hazard testing—Glow-wire apparatus and common test procedure*

NOTE : **IEC 60695-2-1/0:2000** *Fire hazard testing—Part 2-1/0: Glowing/hot-wire based test methods—Glow-wire apparatus and common test procedure* is identical with the said standard.

IEC 60050 (441) *International Electrotechnical Vocabulary (IEV), Chapter 441: Switchgear, controlgear and fuses*

IEC 60060-1:1989 *High-voltage test techniques Part 1: General definitions and test requirements*

IEC 60417 (all parts) *Graphical symbols for use on equipment*

ISO/IEC Guide 2:1991 *General terms and their definitions concerning standardization and related activities*

3 Definitions For the purpose of this Standard the following principal definitions apply:

3.1 Devices

3.1.1 switching device (IEV 441-14-01) a device designed to make or break the current in one or more electric circuits

3.1.2 mechanical switching device (IEV 441-14-02) a switching device designed to close and open one or more electric circuits by means of separable contacts

3.1.3 fuse (IEV 441-18-01, modified) a switching device that, by the melting of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted and breaks the current when this exceeds a given value for a sufficient time

3.1.4 circuit-breaker (mechanical) (IEV 441-14-20, modified) a mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time, and automatically breaking currents under specified abnormal circuit conditions such as those of short-circuit

3.1.5 plug-in circuit-breaker a circuit-breaker having one or more plug-in terminals (see 3.3.20) and designed for use with appropriate means for the plug-in connection

3.2 General terms

3.2.1 overcurrent (IEV 441-11-06) a current exceeding the rated current

3.2.2 overload current (IEV 441-15-08) overcurrent occurring in an electrically undamaged circuit

NOTE : An overload current may cause damage if sustained for a sufficient time.

3.2.2.1 overshoot a current which flows instantaneously when an incandescent lamp is burnt and which is larger than that under normal state

3.2.3 short-circuit current (IEV 441-11-07, modified) overcurrent resulting from a fault of negligible impedance between points intended to be at different potentials in normal service

NOTE : A short-circuit current may result from a fault or from an incorrect connection.

3.2.4 main circuit (of a circuit-breaker) all the conductive parts of a circuit-breaker included in the circuit which it is designed to close and open

3.2.5 control circuit (of a circuit-breaker) circuit (other than a path of the main circuit) intended for the closing operation or opening operation, or both, of the circuit-breaker

3.2.6 auxiliary circuit (of a circuit-breaker) all the conductive parts of a circuit-breaker intended to be included in a circuit other than the main circuit and the control circuit of the circuit-breaker

3.2.7 pole (of a circuit-breaker) that part of a circuit-breaker associated exclusively with one electrically separated conducting path of its main circuit provided with contacts intended to connect and disconnect the main circuit itself and excluding those portions which provide a means for mounting and operating the poles together

3.2.7.1 protected pole pole provided with an overcurrent release (also called element) (see 3.3.6)

3.2.7.2 unprotected pole pole without overcurrent release (see 3.3.6), but otherwise generally capable of the same performance as a protected pole of the same circuit-breaker

NOTES 1 To ensure compliance with this requirement, the unprotected pole may be of the same construction as the protected pole(s), or of a particular construction.

- 2 If the short-circuit capacity of the unprotected pole is different from that of the protected pole(s), this has to be indicated by the manufacturer.

3.2.7.3 switched neutral pole pole only intended to switch the neutral, and not intended to have a short-circuit capacity

3.2.8 closed position position in which the predetermined continuity of the main circuit of the circuit-breaker is secured

3.2.9 open position position in which the predetermined clearance between open contacts in the main circuit of the circuit-breaker is secured

3.2.10 air temperature

3.2.10.1 ambient air temperature (IEV 441-11-13, modified) the temperature, determined under prescribed conditions, of the air surrounding the circuit-breaker (for an enclosed circuit-breaker, it is the air outside the enclosure)

3.2.10.2 reference ambient air temperature the ambient air temperature on which the time-current characteristics are based

3.2.11 operation transfer of the moving contact(s) from the open position to the closed position or vice versa

NOTE : If distinction is necessary, an operation in the electrical sense (make or break) is referred to as a “switching operation” and an operation in the mechanical sense (close or open) is referred to as a “mechanical operation”.

3.2.12 operating cycle succession of operations from one position to another and back to the first position

3.2.13 operation sequence (of a mechanical switching device) (IEV 441-16-03) a succession of specified operations with specified time intervals

3.2.14 uninterrupted duty duty in which the main contacts of a circuit-breaker remain closed whilst carrying a steady current without interruption for long periods (which could be weeks, months, or even years)

3.3 Constructional elements

3.3.1 main contact contact included in the main circuit of a circuit-breaker and intended to carry in the closed position the current of the main circuit

3.3.2 arcing contact (IEV 441-15-08) contact on which the arc is intended to be established

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

3.3.3 control contact contact included in a control circuit of a circuit-breaker and mechanically operated by the circuit-breaker

3.3.4 auxiliary contact contact included in an auxiliary circuit and mechanically operated by the circuit-breaker (e.g. for indicating the position of the contacts)

3.3.5 release device, mechanically connected to (or integrated into) a circuit-breaker, which releases the holding means and permits the automatic opening of the circuit-breaker

3.3.6 overcurrent release release which causes a circuit-breaker to open, with or without time-delay, when the current in the release exceeds a pre-determined value

NOTE : In some cases this value can depend upon the rate of rise of current.

3.3.7 inverse time-delay overcurrent release overcurrent release which operates after a time-delay inversely dependent upon the value of the overcurrent

NOTE : Such a release may be designed so that the time-delay approaches a definite minimum for high values of overcurrent.

3.3.8 direct overcurrent release overcurrent release directly energized by the current in the main circuit of a circuit-breaker

3.3.9 overload release overcurrent release intended for protection against overloads

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

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

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

3.3.12 terminal conductive part of a device, provided for re-usable electrical connection to external circuits

3.3.13 screw-type terminal terminal for the connection and subsequent disconnection of a conductor or the interconnection of two or more conductors, capable of being dismantled, the connection being made, directly or indirectly, by means of screws or nuts of any kind

3.3.14 pillar terminal (box terminal or solderless terminal) screw-type terminal in which the conductor is inserted into a hole or cavity, where it is clamped under the shank of the screw(s). The clamping pressure may be applied directly by the shank of the screw or through an intermediate clamping element to which pressure is applied by the shank of the screw

NOTE : Examples of pillar terminals are shown in Annex F, figure F.1.

3.3.15 screw terminal screw-type terminal in which the conductor is clamped under the head of the screw. The clamping pressure may be applied directly by the head of the screw or through an intermediate part, such as a washer, a clamping plate or an anti-spread device

NOTE : Examples of screw terminals are shown in Annex F, figure F.2.

3.3.16 stud terminal screw-type terminal in which the conductor is clamped under a nut. The clamping pressure may be applied directly by a suitably shaped nut or through an intermediate part, such as a washer, a clamping plate or an anti-spread device

NOTE : Examples of stud terminals are shown in Annex F, figure F.2.

3.3.17 saddle terminal screw-type terminal in which the conductor is clamped under a saddle by means of two or more screws or nuts

NOTE : Examples of saddle terminals are shown in Annex F, figure F.3.

3.3.18 lug terminal screw terminal or stud terminal, designed for clamping a cable lug or a bar by means of a screw or nut

NOTE : Examples of lug terminals are shown in Annex F, figure F.4.

Information : This is also called pressurizing terminal or copper-bar connecting terminal.

3.3.19 screwless terminal connecting terminal for the connection and subsequent disconnection of one conductor or the interconnection of two or more conductors capable of being dismantled, the connection being made, directly or indirectly, by means of springs, wedges, eccentrics (which converts circular motion into front-rear motion) or cones, etc., without special preparation of the conductor other than removal of insulation

3.3.20 plug-in terminal terminal the electrical connection and disconnection of which can be effected without displacing the conductors of the corresponding circuit. The connection is effected without the use of a tool and is provided by the resilience of the fixed and/or moving parts and/or by springs

3.3.21 tapping screw screw manufactured from a material having a greater resistance to deformation when applied by rotary insertion to a hole in a material having a lesser resistance to deformation. The screw is made with a tapered thread, the taper being applied to the core diameter of the thread at the end section of the screw. The thread produced by application of the screw is formed securely only after sufficient revolutions have been made to exceed the number of threads on the tapered section

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

NOTE : An example of thread-forming tapping screw is shown in attached figure 1.

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

NOTE : An example of thread-cutting tapping screw is shown in attached figure 2.

3.4 Conditions of operation

3.4.1 closing operation operation by which the circuit-breaker is brought from the open position to the closed position

3.4.2 opening operation operation by which the circuit-breaker is brought from the closed position to the open position

3.4.3 dependent manual operation (IEV 441-16-13) an operation solely by means of directly applied manual energy, such that the speed and force of the operation are dependent upon the action of the operator

3.4.4 independent manual operation (IEV 441-16-16) a stored energy operation where the energy originates from manual power, stored and released in one continuous operation, such that the speed and force of the operation are independent of the action of the operator

3.4.5 trip-free circuit-breaker a circuit-breaker, the moving contacts of which return to and remain in the open position when the automatic opening operation is initiated after the initiation of the closing operation, even if the closing command is maintained

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

3.5 Characteristic quantities Unless otherwise specified, all values of current and voltage are r.m.s. values.

3.5.1 rated value stated value of any one of the characteristic quantities assigned by the manufacturer that serve to define the working conditions for which the circuit-breaker is designed and built

3.5.2 prospective current (of a circuit, and with respect to a circuit-breaker) (IEV 441-17-01, modified) current that would flow in the circuit if each pole of the circuit-breaker were replaced by a conductor of negligible impedance

NOTE : The prospective current may be qualified in the same manner as an actual current, for example prospective breaking current, prospective peak current.

3.5.3 prospective peak current (IEV 441-17-02) the peak value of a prospective current during the transient period following initiation

NOTE : The definition assumes that the current is established by an ideal circuit-breaker, that is, with instantaneous transition from infinite to zero impedance. For circuits where the current can follow several different paths, for example polyphase circuits, it further assumes that the current is established simultaneously in all poles, even if the current in only one pole is considered.

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

NOTE : For a multipole circuit-breaker in a polyphase circuit, the maximum prospective peak current refers to a single pole only.

3.5.5 short-circuit (making and breaking) capacity alternating component of the prospective current, expressed by its r.m.s. value, which the circuit-breaker is designed to make, to carry for its opening time and to break under specified conditions

3.5.5.1 ultimate short-circuit breaking capacity the breaking capacity for which the prescribed conditions according to a specified test sequence do not include the capability of the circuit-breaker to carry 0.85 times its non-tripping current for the conventional time

3.5.5.2 service short-circuit breaking capacity the breaking capacity for which the prescribed conditions according to a specified test sequence include the capability of the circuit-breaker to carry 0.85 times its non-tripping current for the conventional time

3.5.5.3 instantaneous trip level for short-circuit protection of power-supply cords the function to interrupt instantaneously the short-circuit current flowing through the cord within a prescribed extent, to suppress generation of fire due to ignition of surrounding combustible substances when short-circuit state appears due to contact of cores resulted from deterioration of insulating covering of appliance cords

3.5.6 breaking current current in a pole of a circuit-breaker at the instant of initiation of the arc during a breaking operation

3.5.7 applied voltage the voltage which exists across the terminals of a pole of a circuit-breaker just before the making of the current

NOTE : This definition refers to a single-pole device. For a multipole device the applied voltage is the voltage across the supply terminals of the device.

3.5.8 recovery voltage (IEV 441-17-25, modified) the voltage which appears across the terminals of a pole of a circuit-breaker after the breaking of the current

NOTES 1 This voltage may be considered as comprising two successive intervals of time, one during which a transient voltage exists, followed by a second one during which power-frequency voltage alone exists.

2 This definition refers to a single-pole device. For a multipole device the recovery voltage is the voltage across the supply terminals of the device.

3.5.8.1 transient recovery voltage (IEV 441-17-26, modified) recovery voltage during the time in which it has a significant transient character

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

3.5.8.2 power-frequency recovery voltage (IEV 441-17-27) recovery voltage after the transient voltage phenomena have subsided

3.5.9 opening time time measured from the instant at which, the circuit-breaker being in the closed position, the current in the main circuit reaches the operating value of the overcurrent release to the instant when the arcing contacts have separated in all poles

NOTE : The opening time is commonly referred to as tripping time, although, strictly speaking, tripping time applies to the time between the instant of initiation of the opening time and the instant at which the opening command becomes irreversible.

3.5.10 arcing time

3.5.10.1 arcing time of a pole (IEV 441-17-37, modified) interval of time between the instant of initiation of the arc in a pole and the instant of final arc extinction in that pole

3.5.10.2 arcing time of a multipole circuit-breaker (IEV 441-17-38) interval of time between the instant of first initiation of an arc and the instant of final extinction in all poles

3.5.11 break time interval of time between the beginning of the opening time of a circuit-breaker and the end of the arcing time

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

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

3.5.13 I^2t characteristic of a circuit-breaker curve giving the maximum values of I^2t as a function of the prospective current under stated conditions of operation

3.5.14 co-ordination between overcurrent protective devices in series

3.5.14.1 overcurrent protective co-ordination of overcurrent protective devices (2.5.22 of JIS C 8201-1) co-ordination of two or more overcurrent protective devices in series to ensure overcurrent discrimination (selectivity) and/or back-up protection

3.5.14.2 overcurrent discrimination (IEV 441-17-15) co-ordination of the operating characteristics of two or more overcurrent protective devices in series such that, on the incidence of overcurrents within stated limits, the device intended to operate within these limits does so, while the other(s) does (do) not

3.5.14.3 back-up protection (2.5.24 of JIS C 8201-1) overcurrent co-ordination of two overcurrent protective devices in series, where the protective device, generally but not necessarily on the supply side, effects the overcurrent protection with or without the assistance of the other protective device and prevents excessive stress on the latter

3.5.14.4 total discrimination (total selectivity) (2.17.2 of JIS C 8202-2-1) overcurrent discrimination where, in the presence of two overcurrent protective devices in series, the protective device on the load side effects the protection without causing the other protective device to operate

3.5.14.5 partial discrimination (partial selectivity) (2.17.3 of JIS C 8202-2-1) overcurrent discrimination where, in the presence of two overcurrent protective devices in series, the protective device on the load side effects the protection up to a given level of overcurrent, without causing the other protective device to operate

3.5.14.6 selectivity limit current I_s (2.17.4 of JIS C 8202-2-1) current co-ordinate of the intersection between the total time-current characteristic of the protective device on the load side and the pre-arcing (for fuses), or tripping (for circuit-breakers) time-current characteristic of the other protective device

The selectivity limit current (see Annex D figure D.1) is a limiting value of current

- below which, in the presence of two overcurrent protective devices in series, the protective device on the load side completes its breaking operation in time to prevent the other protective device from starting its operation (i.e. selectivity is ensured);
- above which, in the presence of two overcurrent protective devices in series, the protective device on the load side may not complete its breaking operation in time to prevent the other protective device from starting its operation (i.e. selectivity is not ensured)

3.5.14.7 take-over current I_B (IEV 441-17-16) current co-ordinate of the intersection between the time-current characteristics of two overcurrent protective devices

NOTE : The take-over current is the current co-ordinate of the intersection between the maximum break-time/current characteristics of two overcurrent protective devices in series.

3.5.14.8 conditional short-circuit current (of a circuit or a switching device) (2.5.29 of JIS C 8201-1) prospective current that a circuit or a switching device, protected by a specified short-circuit protective device, can satisfactorily withstand for the total operating time of that device under specified conditions of use and behaviour

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

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

3.5.14.9 rated conditional short-circuit current I_{nc} (4.3.6.4 of JIS C 8201-1) value of prospective current, stated by the manufacturer, which the equipment, 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 in the relevant product standard

Details of the specified short-circuit protective device shall be shown by the manufacturer.

3.5.15 conventional non-tripping current I_{nt} specified value of current which the circuit-breaker is capable of carrying for a specified time (conventional time) without tripping

3.5.16 conventional tripping current I_t specified value of current which causes the circuit-breaker to trip within a specified time (conventional time)

3.5.17 instantaneous tripping current minimum value of current causing the circuit-breaker to operate automatically without intentional time-delay

3.6 Definitions related to insulation co-ordination

3.6.1 insulation co-ordination (1.3.1 of JIS C 0664) mutual correlation of insulation characteristics of electrical equipment taking into account the expected micro-environment and the influencing stresses

3.6.2 working voltage (1.3.5 of JIS C 0664) highest r.m.s. value of the a.c. or d.c. voltage across any particular insulation which can occur when the equipment is supplied at rated voltage

NOTES 1 Transients are disregarded.

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

3.6.3 overvoltage (1.3.7 of JIS C 0664) any voltage having a peak value exceeding the corresponding peak value of maximum steady-state voltage at normal operating conditions

3.6.4 impulse withstand voltage (1.3.8.1 of JIS C 0664) highest peak value of impulse voltage of prescribed form and polarity, which does not cause breakdown of the insulation under specific conditions

3.6.5 overvoltage category (1.3.10 of JIS C 0664) numeral defining a transient overvoltage condition

3.6.6 macro-environment (1.3.12.1 of JIS C 0664) environment of the room or other location, in which the equipment is installed or used

3.6.7 micro-environment (1.3.12.2 of JIS C 0664) immediate environment of the insulation which particularly influences the dimensioning of the creepage distances

3.6.8 pollution (1.3.11 of JIS C 0664) any addition of foreign matter, solid, liquid or gaseous that can result in a reduction of electric strength or surface resistivity of the insulation

3.6.9 pollution degree (1.3.13 of JIS C 0664) numeral characterising the expected pollution of the micro-environment

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

3.6.10 isolation (isolating function) (2.1.19 of JIS C 0664) function intended to cut off the supply from the whole installation or a discrete section of it by separating it from every source of electrical energy for reason of safety

3.6.11 isolating distance clearance between open contacts, meeting the safety requirements specified for isolation purposes

3.6.12 clearance (see Annex B and Annex XE) (IEV 441-17-31, modified) shortest distance in air between two conductive parts along a string stretched the shortest way between these conductive parts

NOTE : For the purpose of determining a clearance to accessible parts, the accessible surface of an insulating enclosure is considered conductive as if it was covered by a metal foil wherever it can be touched by a hand or a standard test finger according to attached figure 9.

3.6.13 creepage distance (see Annex B and Annex XE) shortest distance along the surface of an insulating material between two conductive parts

NOTE : For the purpose of determining a creepage distance to accessible parts, the accessible surface of an insulating enclosure is considered conductive as if it was covered by a metal foil wherever it can be touched by a hand or a standard test finger according to attached figure 9.

4 Classification Circuit-breakers are classified according to several criteria.

4.1 According to the number of poles:

- single-pole circuit-breakers;
- two-pole-circuit-breakers with one protected pole (element);
- two-pole circuit-breakers with two protected poles (elements);
- three-pole circuit-breakers with three protected poles (elements);
- three-pole circuit-breakers with two protected poles (elements);
- four-pole circuit-breakers with three protected poles (elements);
- four-pole circuit-breakers with four protected poles (elements).

NOTE : The pole which is not a protected pole may be

- “unprotected” (see 3.2.7.2), or
- “switched neutral” (see 3.2.7.3).

4.2 According to the protection against external influences:

- enclosed-type (not requiring an appropriate enclosure);
- unenclosed-type (for use with an appropriate enclosure).

4.3 According to the method of mounting:

- surface-type;
- flush-type;
- panel board type, also referred to as distribution board type.

NOTE : These types may be intended to be rail mounted.

4.4 According to the methods of connection

4.4.1 According to the fixation system:

- circuit-breakers, the electrical connections of which are not associated with the mechanical mounting;
- circuit-breakers, the electrical connections of which are associated with the mechanical mounting.

NOTE : Examples of this type are:

- plug-in type;
- bolt-on type;
- screw-in type.

Some circuit-breakers may be of the plug-in type or bolt-on type on the line side only, the load terminals being usually suitable for wiring connection.

4.4.2 According to the type of terminals:

- circuit-breakers with screw-type terminals for external copper conductors;
- circuit-breakers with screwless type terminals for external copper conductors;
NOTE 1 The requirements for circuit-breakers equipped with this type of terminals are given in Annex J.
- circuit-breakers with flat quick-connect terminals for external copper conductors;
NOTE 2 The requirements for circuit-breakers equipped with this type of terminals are given in Annex K.

4.5 According to the instantaneous tripping current (see 3.5.17)

- B-type;
- C-type;
- D-type;
- J-type.

4.6 According to the I^2t characteristic In addition to the I^2t characteristic provided by the manufacturer, circuit-breakers may be classified according to their I^2t characteristic.

4.7 According to the electrical facility rule

- circuit-breakers for electrical installations of buildings to be worked in accordance with **JIS C 0364** (circuit-breakers stated in Annex 1);
- circuit-breakers for electrical facilities to be worked in accordance with customary electrical facility rule (circuit-breakers stated in Annex 2).

5 Characteristics of circuit-breakers

5.1 List of characteristics The characteristics of a circuit-breaker shall be stated in the following terms:

- number of poles (see 4.1);
- protection against external influences (see 4.2);
- method of mounting (see 4.3);
- method of connection (see 4.4);
- rated operational voltage (see 5.3.1);
- rated current (see 5.3.2);
- rated frequency (see 5.3.3);
- instantaneous tripping current (see 4.5 and 5.3.5);
- value of rated short-circuit breaking capacity (see 5.3.4);
- I^2t characteristic (see 3.5.13);
- I^2t classification (see 4.6).

5.2 Rated quantities

5.2.1 Rated voltages

5.2.1.1 Rated operational voltage (U_e) The rated operational voltage (hereafter referred to as “rated voltage”) of a circuit-breaker is the value of voltage, assigned by the manufacturer, to which its performance (particularly the short-circuit performance) is referred.

NOTE : The same circuit-breaker may be assigned a number of rated voltages and associated rated short-circuit breaking capacities.

5.2.1.2 Rated insulation voltage (U_i) The rated insulation voltage of a circuit-breaker is the value of voltage, assigned by the manufacturer, to which dielectric test voltages and creepage distances are referred.

Unless otherwise stated, the rated insulation voltage is the value of the maximum rated voltage of the circuit-breaker. In no case shall the maximum rated voltage exceed the rated insulation voltage.

5.2.1.3 Rated impulse withstand voltage (U_{imp}) The rated impulse withstand voltage of a circuit-breaker (declared) shall be equal to or higher than the standard values of rated impulse withstand voltage given in table 3.

5.2.2 Rated current (I_n) A current assigned by the manufacturer as the current which the circuit-breaker is designed to carry in uninterrupted duty (see 3.2.14), at a specified reference ambient air temperature. The standard reference ambient air temperature is 30 °C for circuit-breakers of Annex 1. This is 25 °C or 40 °C for circuit-breakers of Annex 2. If a different reference ambient air temperature for the circuit-breaker is used, the effect shall be taken into account.

5.2.3 Rated frequency The rated frequency of a circuit-breaker is the power frequency for which the circuit-breaker is designed and to which the values of the other characteristics correspond.

The same circuit-breaker may be assigned a number of rated frequencies.

5.2.4 Rated short-circuit capacity (I_{cn}) The rated short-circuit capacity of a circuit-breaker is the value of the ultimate short-circuit breaking capacity (see **3.5.5.1**) assigned to that circuit-breaker by the manufacturer.

NOTE : A circuit-breaker having a given rated short-circuit capacity, excluding circuit-breakers of Annex 2, has a corresponding service short-circuit capacity (I_{cs}) (see table 18 of Annex 1).

5.3 Standard and preferred values

5.3.1 Preferred values of rated voltage Preferred values of rated voltage are given in table 1.

Table 1 Preferred values of rated voltage

Circuit-breakers	Circuit supplying the circuit-breaker	Rated voltage V
Single-pole, one element (protected pole)	Single-phase, 2-wire system, phase to earthed middle conductor	100
	Single-phase, 2-wire system, phase to earthed wire	100, 200
	Single-phase, 2-wire system, phase to neutral	240
Two-pole, one element (protected pole)	Single-phase, 2-wire system, phase to earthed middle conductor	100
	Single-phase, 2-wire system, phase to earthed wire	100, 200
	Single-phase, 2-wire system, phase to neutral	240
Two-pole, two elements (protected poles)	Single-phase, 2-wire system, phase to earthed middle conductor	100
	Single-phase, 2-wire system, phase to earthed wire	100, 200
	Single-phase, 2-wire system, phase to neutral	240
	Single-phase, 2-wire system, phase to phase	200, 415
	Single-phase, 2-wire system, phase to phase (for neutral earthed circuit)	100/200
Three-pole, two elements (protected poles)	Single-phase, 3-wire system	100/200
Three-pole, three elements (protected poles)	Single-phase, 3-wire system	100/200
	Three-phase, 3-wire system	200, 415
Four-pole, three or four elements (protected poles)	Three-phase, 4-wire system	415 240/415

NOTES 1 The earthed middle conductor means the conductor to be connected to the pole provided in the middle of power supply (e.g. neutral pole in single-phase 3-wire system).

The middle conductor is the wire lead out from the middle point of one phase in single-phase 3-wire system. In this country this is generally called neutral point or neutral conductor.

The term middle conductor is used to avoid confusion arising between the neutral conductor of three-phase 4-wire system taken out of star connection generally used in Europe and the lead-out wire from one phase of V connection, three-phase 4-wire system, etc. largely adopted in this country. In other **IEC** standards, the term middle conductor is used in distribution systems including d.c. distribution system.

- 2 Earthed-side wire means one side of power supply which is not the voltage phase. The earthed side wire is the wire in low voltage lines earthed due to technical necessity.
- 3 Neutral conductor means the wire to be connected to the neutral point of star connection in three-phase 3-wire system.
- 4 The 240 V or 415 V stated in this Standard may be replaced by 230 V or 400 V respectively.
- 5 The power supply circuit and the rated voltages in this table are applicable to such system that the voltage to earth does not exceed 300 V.

5.3.2 Preferred values of rated current Preferred values of rated current are:

3 - 5 - 6 - 8 - 10 - 13 - 15 - 16 - 20 - 25 - 30 - 32 - 40 - 50 - 60 - 63 - 75 - 80 - 100 -
120 - 125 - 150 (A)

5.3.3 Standard values of rated frequency Standard values of rated frequency are 50 Hz and 60 Hz.

5.3.4 Standard values of rated short-circuit capacity

5.3.4.1 Standard values up to and including 10 000 A Standard values of rated short-circuit capacities up to and including 10 000 A are:

1 000 - 1 500 - 2 500 - 3 000 - 4 500 - 5 000 - 6 000 - 7 500 - 10 000 (A)

The corresponding power factor ranges are given in **9.12.5**.

5.3.4.2 Values above 10 000 A up to and including 25 000 A For values above 10 000 A up to and including 25 000 A the preferred values are:

14 000 - 15 000 - 18 000 - 20 000 - 22 000 - 25 000 (A)

The corresponding power factor range is given in **9.12.5**.

5.3.5 Standard ranges of instantaneous tripping Standard ranges of instantaneous tripping are given in table 2.

Table 2 Ranges of instantaneous tripping

Type	Range
B	Above $3I_n$ up to and including $5I_n$
C	Above $5I_n$ up to and including $10I_n$
D	Above $10I_n$ up to and including $20I_n$ ⁽¹⁾
J ⁽²⁾	Range assigned by the manufacturer, if instantaneous tripping is provided
Notes ⁽¹⁾ For special cases values up to $50 I_n$ may also be used.	
⁽²⁾ Including the one without instantaneous tripping.	

5.3.6 Standard values of rated impulse withstand voltage (U_{imp}) Table 3 gives the standard values of rated impulse withstand voltages of circuit-breakers declaring rated impulse withstand voltage (U_{imp}) as a function of the nominal voltage of the installation. For circuit-breakers covered by Annex 1, declaration of rated impulse withstand voltage (U_{imp}) is mandatory. For circuit-breakers covered by Annex 2 the said declaration is choice of the manufacturer.

Table 3 Rated impulse withstand voltage as a function of the nominal voltage of the installation

Rated impulse withstand voltage U_{imp} kV	Nominal voltage of the installation		
	Three-phase systems V	Single-phase system with mid-point earthed V	Single-phase system V
2.5 ⁽¹⁾	—	100/200 ⁽²⁾	100
4 ⁽¹⁾	200, 240/415	100/200 ⁽²⁾	200
NOTES 1 For test voltages to check the insulation, see Annex 1 table 14. 2 For test voltages to check the isolation distance across open contacts, see Annex 1 table 13.			
Notes (1) The values 3 kV and 5 kV respectively are used for verifying the isolating distances across open contacts at the altitude of 2 000 m (see tables 4a and 13 of Annex 1). (2) It is under consideration to select these voltages based on the overvoltage category level.			

6 Marking and other product information Each circuit-breaker shall be marked in a durable manner with the following:

- a) manufacturer's name or trade mark;
- b) product classification:
 - 1) type designation, catalogue number or serial number;
 - 2) standard number: **JIS C 8211**;
 - 3) classification of circuit-breakers: marking clearly showing that the circuit-breaker is covered by Annex 1 or Annex 2:
 Example : For the one covered by Annex 1; "Annex 1", "Ann 1", etc.
 Example : For the one covered by Annex 2: "Annex 2", "Ann 2", etc.
- c) rated voltage(s);
- d) rated current:
 - 1) for circuit-breakers with symbol of instantaneous tripping B, C or D, rated current is marked without unit mark "A" following to the said tripping symbol:
 Example : B16
 - 2) for circuit-breakers with symbol of instantaneous tripping J, the marking shall be made with the unit symbol "A" attached to the value of rated current:
 Example : 20A
- e) rated frequency if the circuit-breaker is designed only for one frequency (see **5.3.3**);

- f) rated short-circuit capacity, in amperes (A) or kiloamperes (kA);
- g) wiring diagram, unless the correct mode of connection is evident;
- h) reference ambient air temperature;
- i) degree of protection (only if different from **IP20**);
- j) for type D circuit-breakers: the maximum instantaneous tripping current, if higher than $20 I_n$ (see table 2);
- k) rated impulse withstand voltage (U_{imp}) (applicable to circuit-breakers declared);
- l) applicable wires:
 - For Annex 1 “70 °C wires” or “70 °C cables”
 - For Annex 2 “60 °C wires” or “60 °C cables”
- m) cords expressing “with instantaneous trip for short-circuit protection of power supply cords”.

Marking **d)** i.e. instantaneous tripping symbols B, C and D and rated circuit shall be readily visible when the circuit-breaker is installed. If, for small devices, the available space is insufficient, markings **a)**, **b)**, **c)**, **e)**, **f)**, **h)**, **i)**, **j)**, **l)** and **m)** may be put on the side or on the back of the circuit-breaker. Marking **g)** may be on the inside of any cover which has to be removed in order to connect the supply wires but shall not be on a label loosely attached to the circuit-breaker. Any other information not marked shall be given in the manufacturer’s documentation.

The suitability for isolation, if provided by circuit-breakers of this Standard, shall be indicated by the symbol  on the device.

When affixed, this marking may be included in a wiring diagram, where it may be combined with symbols of other functions e.g. overload protection, or other symbols of **IEC/TC3**. When the symbol is used on its own (i.e. not in a wiring diagram), combination with symbols of other functions is not allowed.

If a degree of protection higher than **IP20** according to **JIS C 0920** is marked on the device, it shall comply with it, whichever the method of installation. If the higher degree of protection is obtained only by a specific method of installation and/or with the use of specific accessories (e.g. terminal covers, enclosures, etc.), this shall be specified in the manufacturer’s literature.

The manufacturer shall make available, on request, the I^2t characteristic (see **3.5.13**).

The manufacturer may indicate the I^2t classification (see **4.6**) and mark the circuit-breakers accordingly.

For circuit-breakers (other than those operated by means of push-buttons) the open position shall be indicated by the symbol **O** (circle) or **OFF** and the closed position by the symbol **I** (a short vertical straight line) or **ON**. Additional national symbols for this indication are allowed. These indications shall be readily visible when the circuit-breaker is installed.

NOTE 1 As for the above indication, symbols may be placed side by side.

For circuit-breakers operated by means of two push-buttons, only the push-button designed for the opening operation shall be red and/or be marked with the symbol $\bigcirc$ (circle) or OFF.

NOTE 2 As for the above indication, symbols may be placed side by side.

Red shall not be used for any other push-button of the circuit-breaker.

If a push-button is used for closing the contacts and is clearly identified as such, its depressed position is sufficient to indicate the closed position.

If a single push-button is used for closing and opening the contacts and is identified as such, the button remaining in its depressed position is sufficient to indicate the closed position. On the other hand, if the button does not remain depressed, an additional means indicating the position of the contacts shall be provided.

For circuit-breakers with multiple current ratings, the maximum value shall be marked in accordance with marking **d**), and in addition the value for which the circuit-breaker is adjusted shall be indicated without ambiguity.

If it is necessary to distinguish between the supply and the load terminals, the former shall be indicated by arrows pointing towards the circuit-breaker or by "Line" and the latter by arrows pointing away from the circuit-breaker or by "Load", placed close to the respective terminals. If marking by arrows and marking by letters are placed side by side, they shall be made to avoid erroneous connections.

Terminals intended exclusively for the neutral shall be indicated by the letter N. For plug-in terminal, "W" may be used. In a circuit-breaker for single-phase 3-wire system, the centre terminal shall be neutral conductor terminal.

Terminals intended for the protective conductor, if any, shall be indicated by the symbol $\perp$ (IEC 60417-5019).

NOTE 3 The symbol $\perp$, (IEC 60417-5017), previously recommended, will be progressively superseded by the preferred symbol IEC 60417-5019 given above.

Marking shall be indelible and easily legible, and shall not be placed on screws, washers or other removable parts.

Compliance is checked by inspection and by the test of **9.3**.

7 Standard conditions for operation in service Circuit-breakers complying with this Standard shall be capable of operating under the following standard conditions.

7.1 Ambient air temperature range 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 °C.

Circuit-breakers intended to be used in ambient air temperatures above +40 °C (particularly in tropical countries) or below -5 °C shall either be specially designed or be used according to the information given in the manufacturer's catalogue.

7.2 Altitude In general the altitude of the site of installation does not exceed 2 000 m (6 600 ft).

For installations at higher altitudes, it is necessary to take into account the reduction of the dielectric strength and of the cooling effect of the air. Circuit-breakers intended to be so used shall be designed specially or used according to an agreement between manufacturer and user. Information given in the manufacturer's catalogue may take the place of such an agreement.

7.3 Atmospheric conditions The air is clean and its relative humidity does not exceed 85 % at a maximum temperature of +40 °C.

Higher relative humidities may be permitted at lower temperatures, for example 90 % at +20 °C.

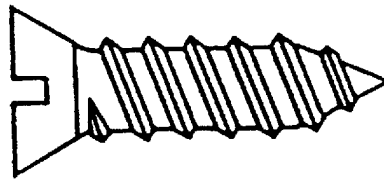
Care should be taken by appropriate means (for example drain holes) of moderate condensation which may occasionally occur due to variations in temperature.

7.4 Conditions of installation The circuit-breaker shall be installed in accordance with the manufacturer's instructions.

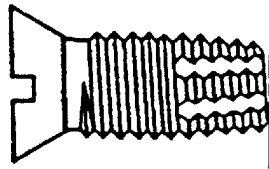
7.5 Pollution degree Circuit-breakers to this Standard are intended for environment with pollution degree 2, i.e. normally only non-conductive pollution occurs; occasionally, however, a temporary conductivity caused by condensation may be expected.

8 Requirements for construction and operation They are specified in Annex 1 and Annex 2.

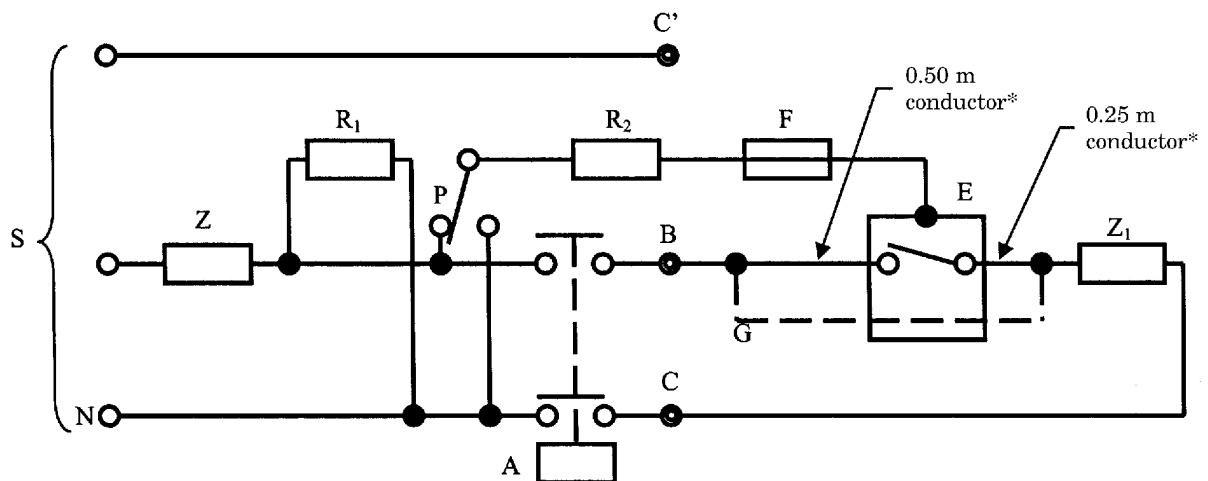
9 Tests They are specified in Annex 1 and Annex 2.



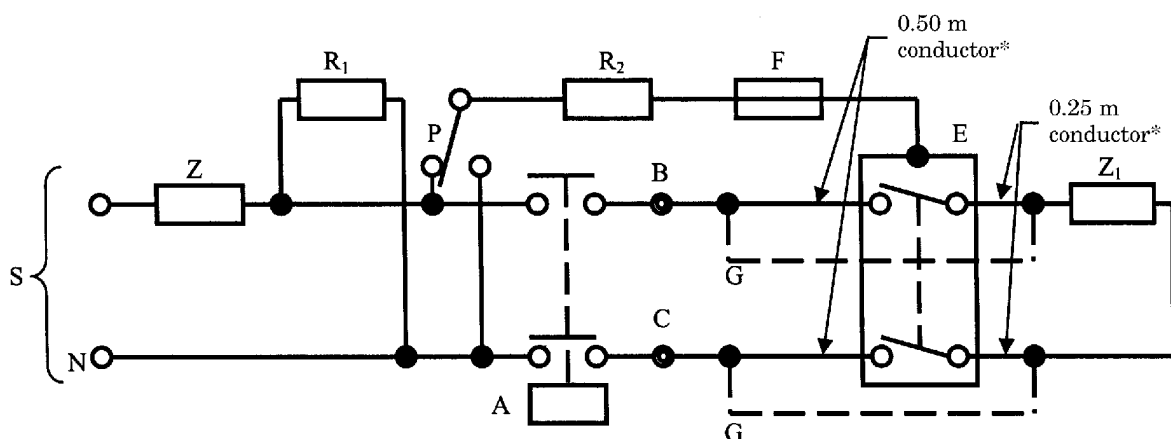
Attached Figure 1 Thread forming tapping screw 3.3.22



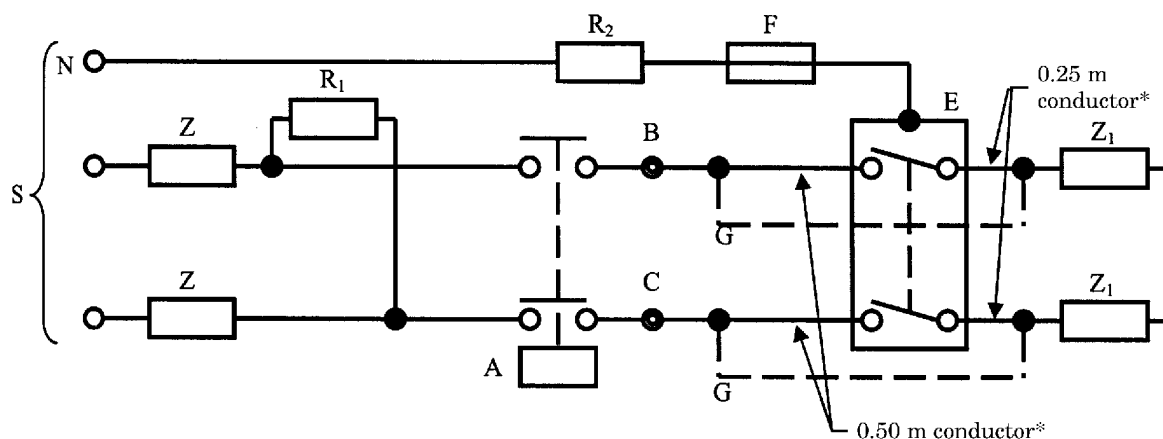
Attached Figure 2 Thread cutting tapping screw 3.3.23



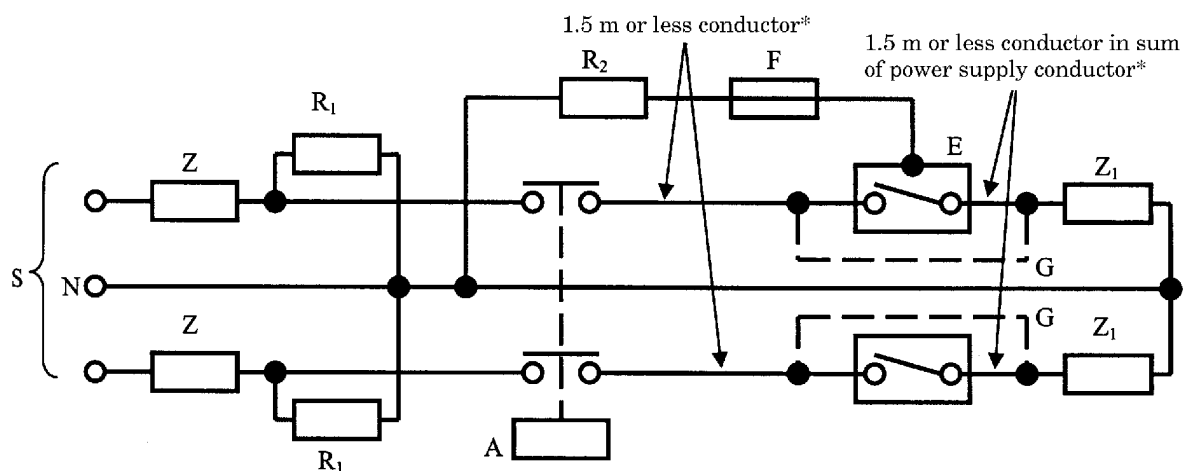
Attached Figure 3 Short-circuit test circuit for single pole circuit-breaker



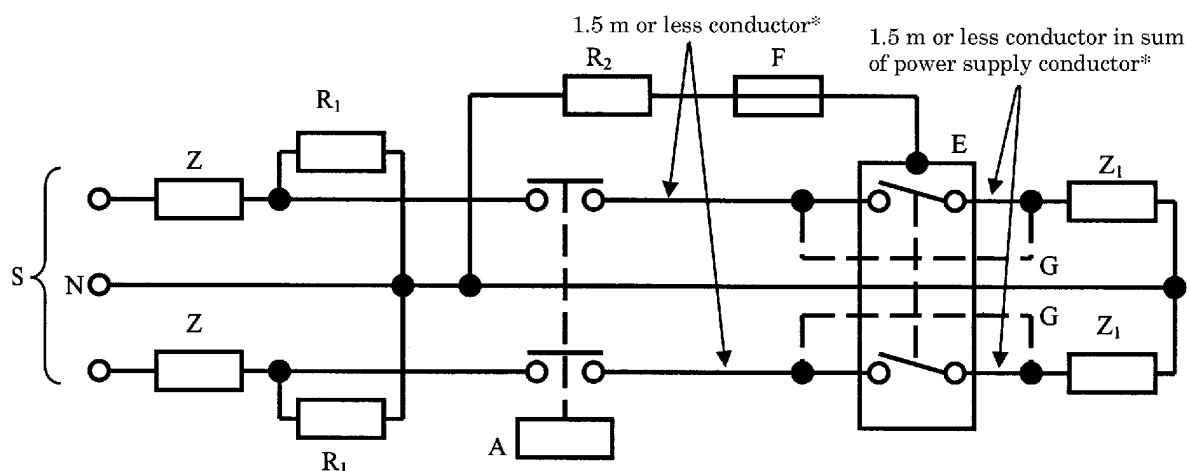
Attached Figure 4a Short-circuit test circuit for two-pole circuit-breaker with one element



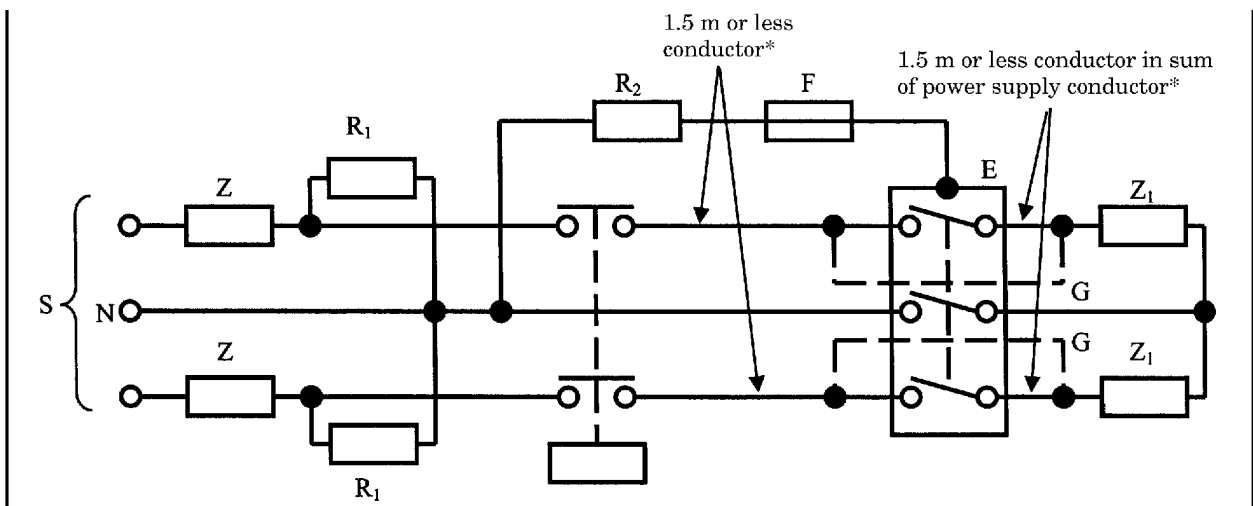
Attached Figure 4b Short-circuit test circuit for two-pole circuit-breaker with two elements



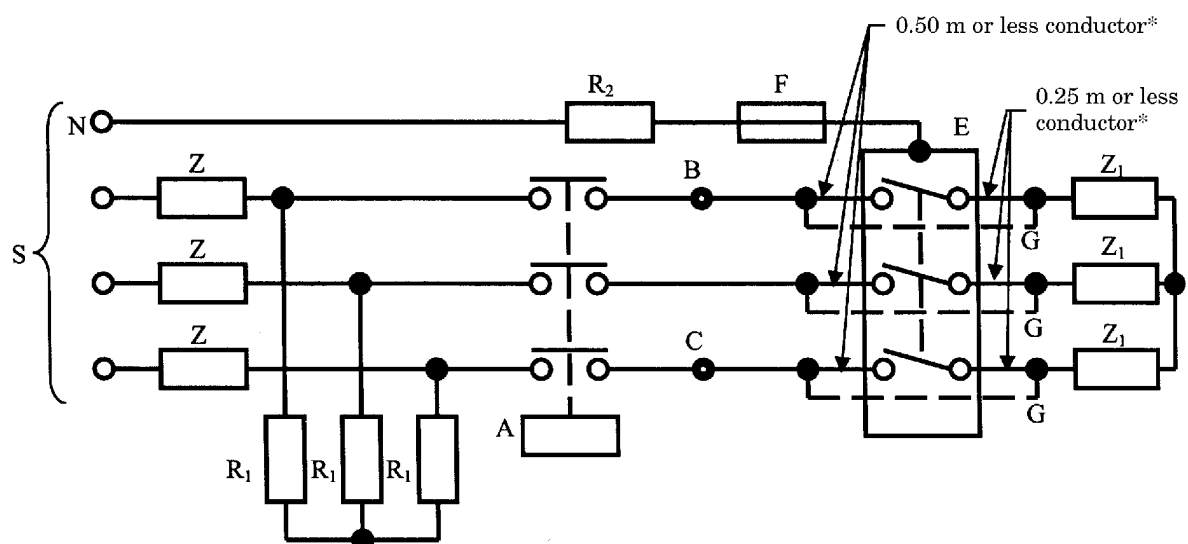
Attached Figure 4c Short-circuit test circuit for single pole circuit-breaker for single-phase three-wire system of rated voltages 100/200 V



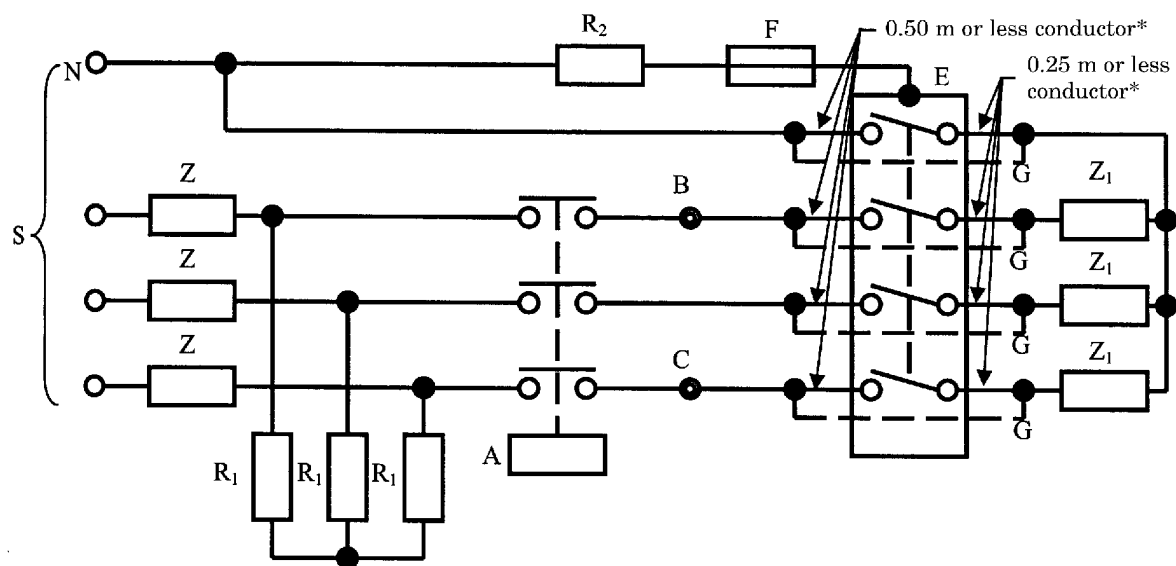
Attached Figure 4d Short-circuit test circuit for two-pole circuit-breaker with two elements for single-phase three-wire system of rated voltages 100/200 V



Attached Figure 4e Short-circuit test circuit for three-pole circuit-breaker for single-phase three-wire system of rated voltages 100/200 V



Attached Figure 5 Short-circuit test circuit for three-pole circuit-breaker



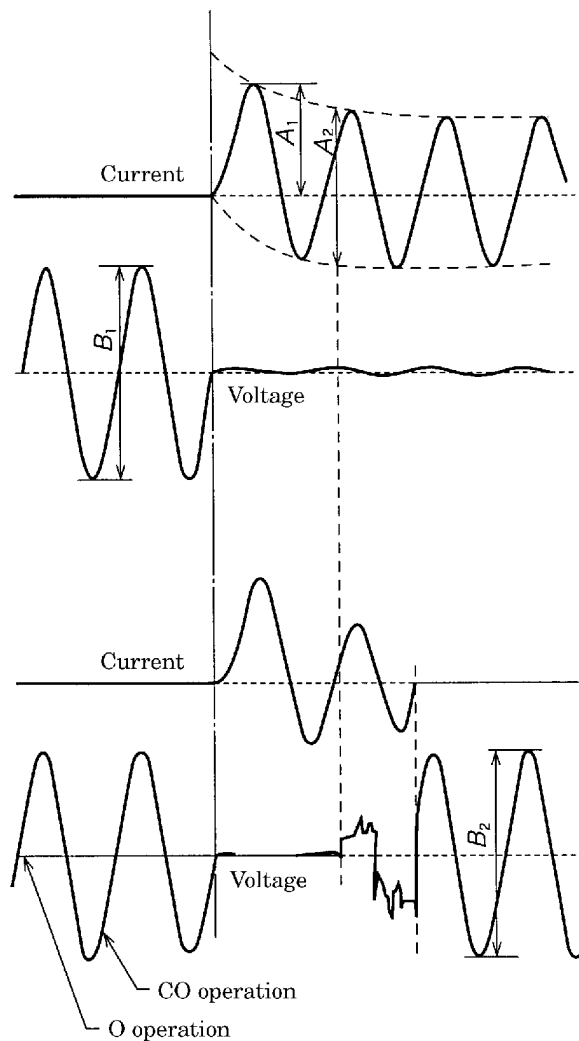
Attached Figure 6 Short-circuit test circuit for four-pole circuit-breaker

Symbols in attached figures 3 to 6 mean the following:

- S : supply source
- N : neutral
- Z : impedances for adjusting the current to the rated short-circuit capacity
- Z₁ : impedances for adjusting the test to values lower than the rated short-circuit capacity (may be located on supply side)
- R₁ : resistors
- E : enclosure or support
- A : auxiliary switch synchronized with to the voltage wave
- G : negligible impedance connection for circuit calibration
- R₂ : resistor 0.5 Ω
- F : fuse
- P : selector switch
- B, C and C' : points of connection with grid shown in Annex H (see 9.12.9.1 of Annex 1)

Note * Refer to Annex 1 table 5a (see 9.12.4 of Annex 1) or Annex 2 table 5b (see 9.12.4 of Annex 2)

Attached Figures 3 to 6 Test circuits for short-circuit tests



a) Calibration of circuit

A_1 = Prospective peak making current

$\frac{A_2}{2\sqrt{2}}$ = Prospective symmetrical breaking current (r.m.s. value)

$\frac{B_1}{2\sqrt{2}}$ = Applied voltage (r.m.s. value)
(see 3.5.7)

b) O or CO operation

$\frac{A_2}{2\sqrt{2}}$ = Breaking capacity (r.m.s. value)

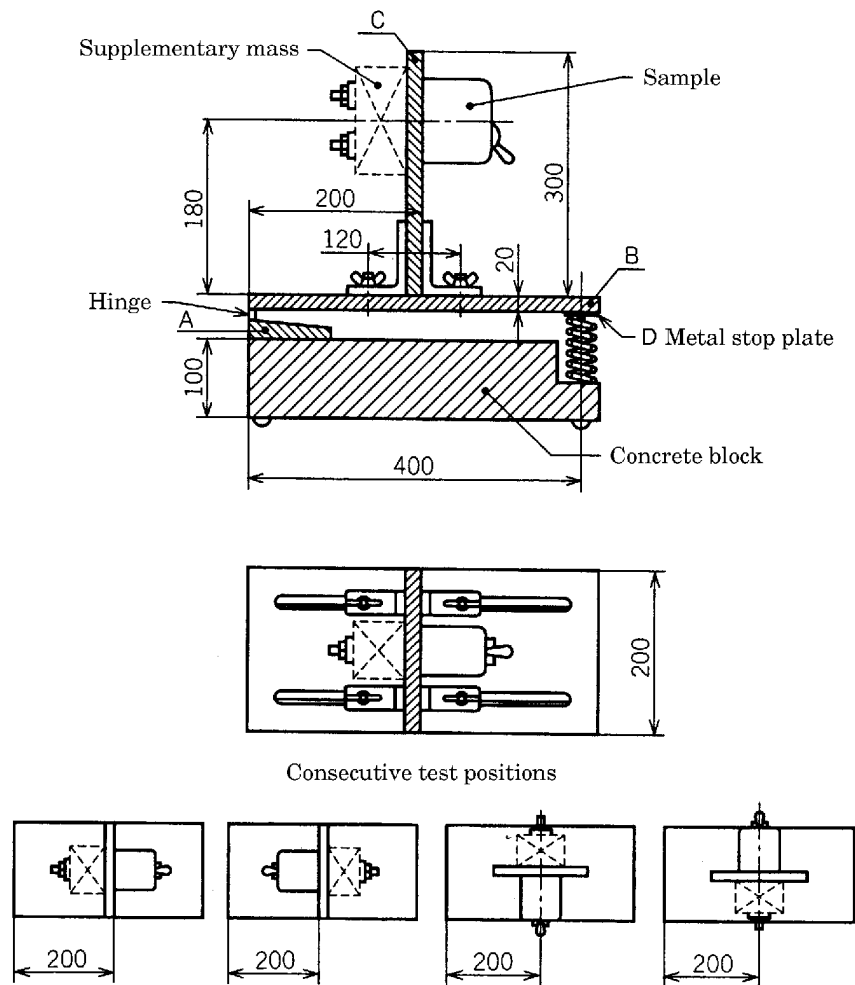
A_1 = Making capacity (peak value)

$\frac{B_2}{2\sqrt{2}}$ = Recovery voltage (r.m.s. value)
(see 3.5.8)

NOTE : The amplitude of the voltage trace, after initiation of the test current, varies according to the relative positions of the closing device, the adjustable impedances, and the voltage sensing devices, and according to the test diagram.

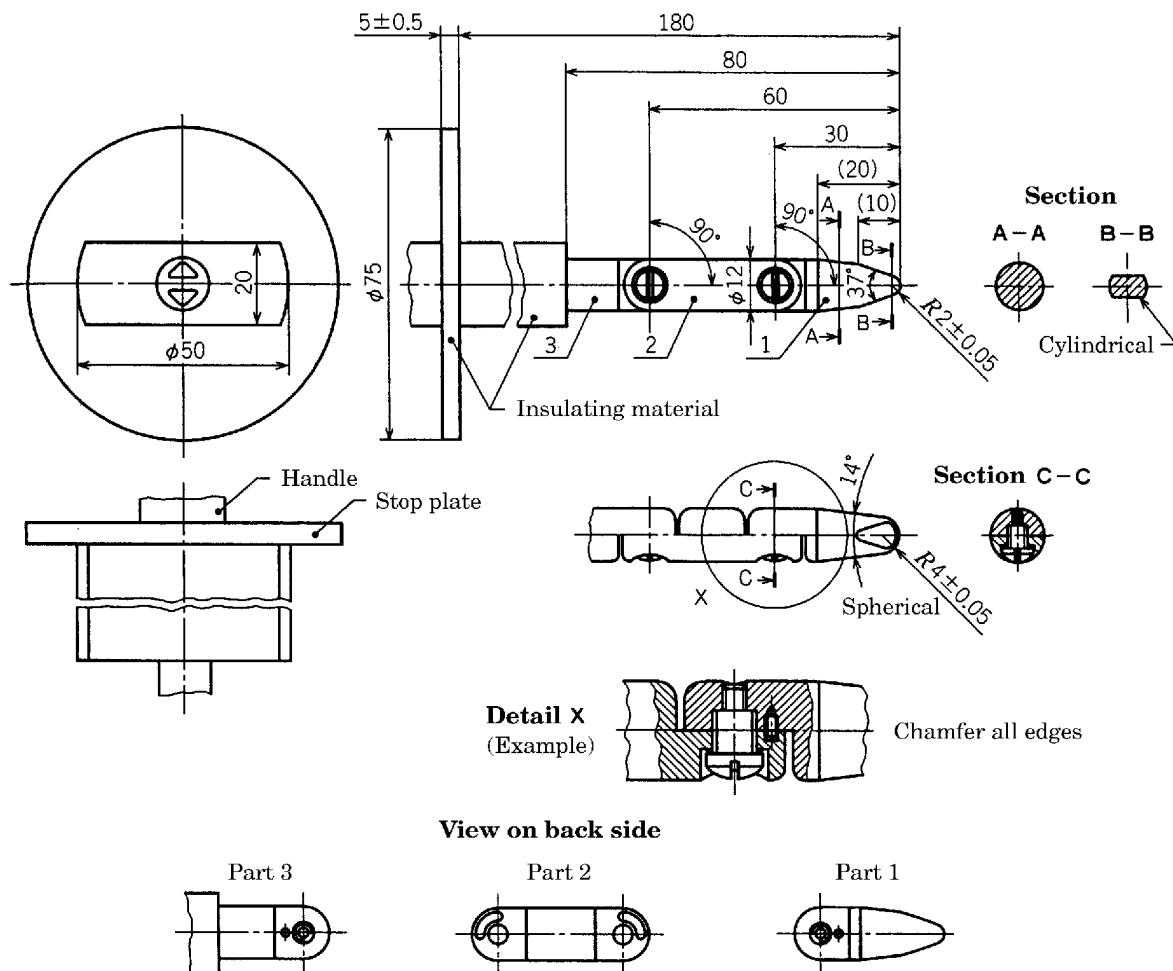
Attached Figure 7 Example of short-circuit making or breaking test record in the case of a single-pole device on single phase a.c.

Unit: mm



Attached Figure 8 Mechanical shock test apparatus (see 9.13.1 of Annex 1 or Annex 2)

Unit: mm



Tolerances on dimensions without specific tolerance

on angles $\begin{smallmatrix} 0 \\ -10' \end{smallmatrix}$

on linear dimensions:

up to 25 mm $\begin{smallmatrix} 0 \\ -0.05 \end{smallmatrix}$

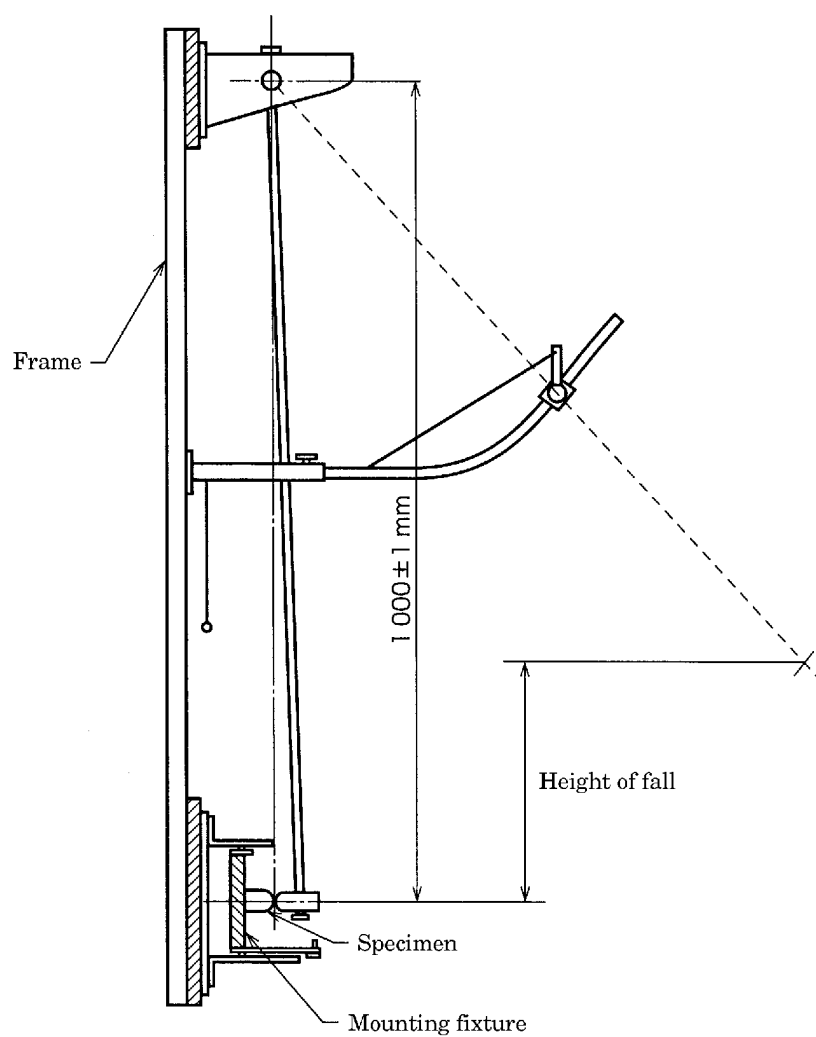
over 25 mm: ± 0.2

Material of finger: e.g. heat-treated steel

Both joints of this finger may be bent through an angle of $90^\circ \begin{smallmatrix} +10^\circ \\ 0 \end{smallmatrix}$, but in the one and same direction only.

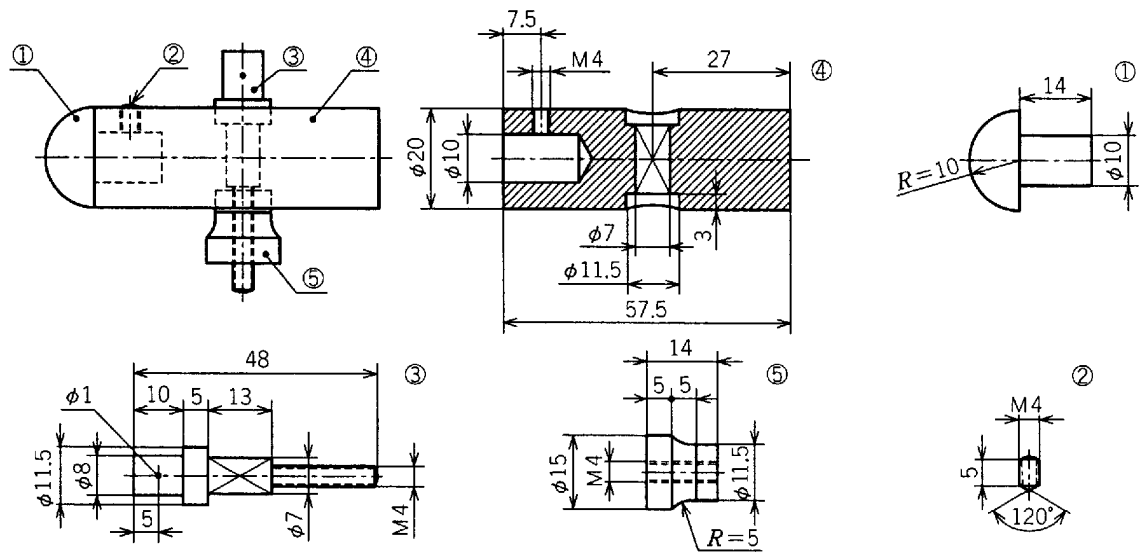
Using the pin and groove solution is only one of the possible approaches in order to limit the bending angle to 90° . For this reason dimensions and tolerances of these details are not given in the drawing. The actual design must ensure a 90° bending angle with a 0° to $+10^\circ$ tolerance.

Attached Figure 9 Standard test finger (see 9.6 of Annex 1 or Annex 2)



Attached Figure 10 Mechanical impact test apparatus (see 9.13.2 of Annex 1 or Annex 2)

Unit: mm



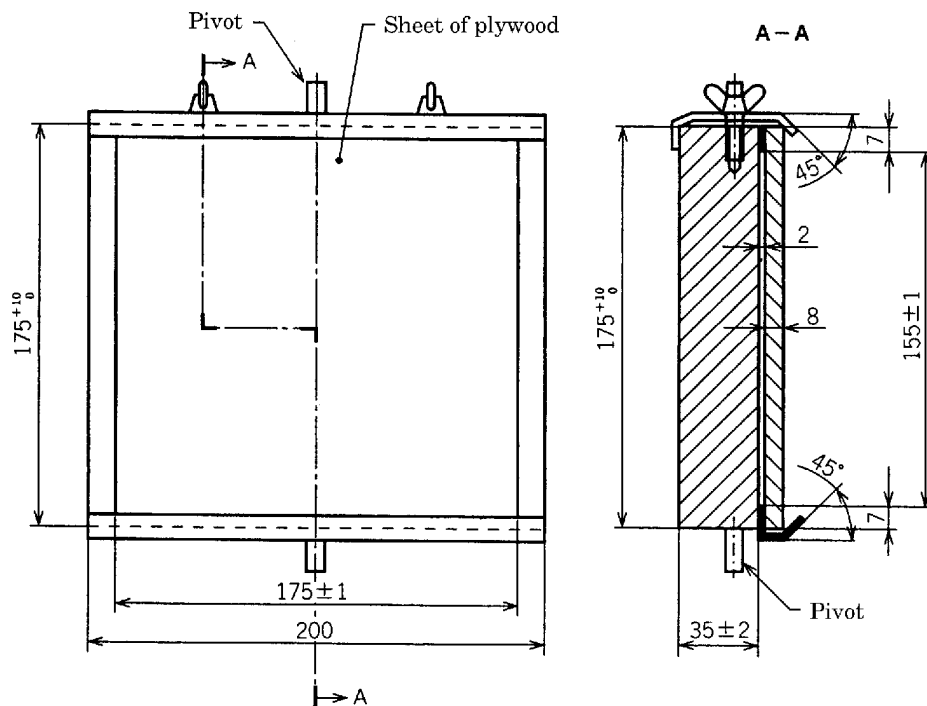
Material of the parts:

① : polyamide

②③④⑤ : steel Fe 360

Attached Figure 11 Striking element for pendulum for mechanical impact test apparatus (see 9.13.2 of Annex 1 or Annex 2)

Unit: mm

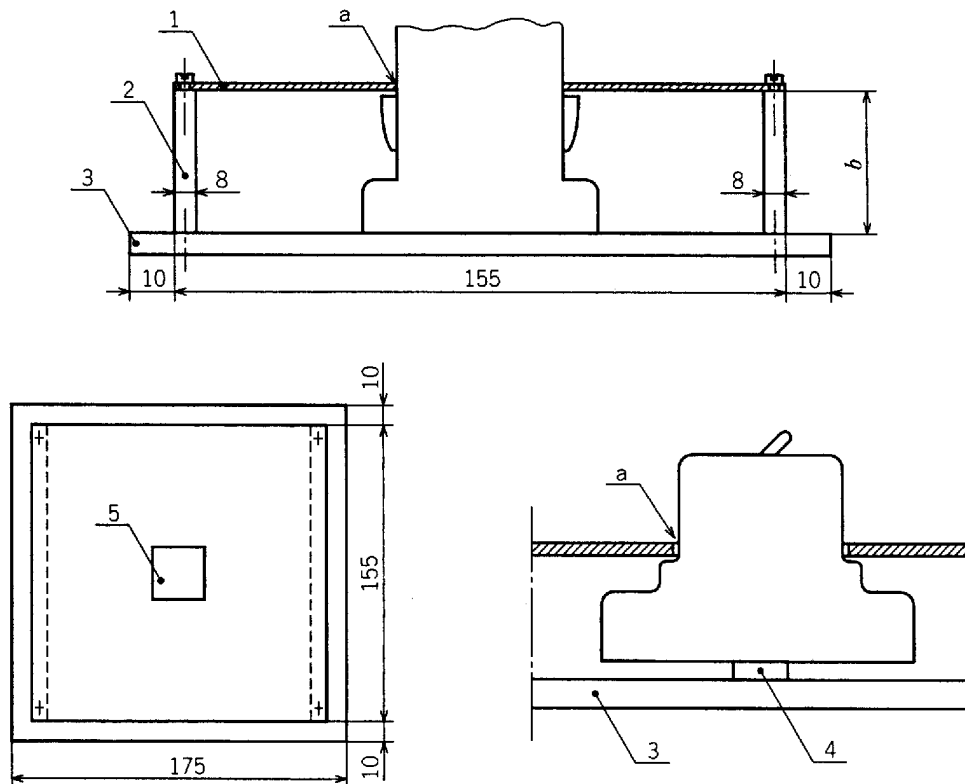


Key

- 1 Main support of mass (10 ± 1) kg
- 2 Pivots for rotation about a vertical axe
- 3 Mounting plate (of wood for surface-type; for the other types, see attached figures 13 and 14)
- 4 Clamps to permit horizontal movement

Attached Figure 12 Mounting support for mechanical impact test
(see 9.13.2 of Annex 1 or Annex 2)

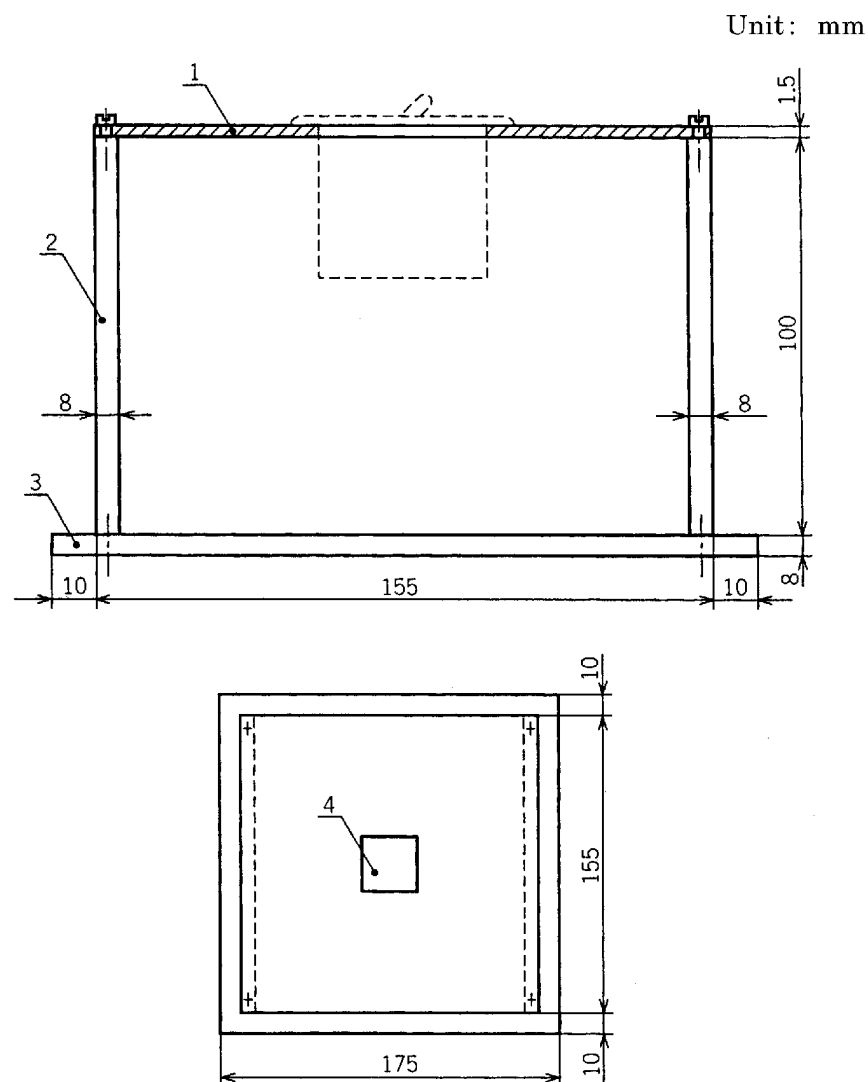
Unit: mm



Key

- 1 Interchangeable steel plate with a thickness of 1 mm
 - 2 Aluminium plates with a thickness of 8 mm
 - 3 Mounting plate
 - 4 Rail for circuit-breakers designed for rail mounting
 - 5 Cut-out for the circuit-breaker in the steel plate
- a) the distance between the edges of the cut-out and the faces of the circuit-breaker shall be between 1 mm and 2 mm.
- b) the height of the aluminium plates shall be such that the steel plate rests on the supports of the circuit-breaker or, if the circuit-breaker has no such support, the distance from live parts, which are to be protected by an additional cover plate, to be on the underside of the steel, is 8 mm.

Attached Figure 13 Example of mounting for a rear fixed circuit-breaker for mechanical impact test (see 9.13.2 of Annex 1 or Annex 2)

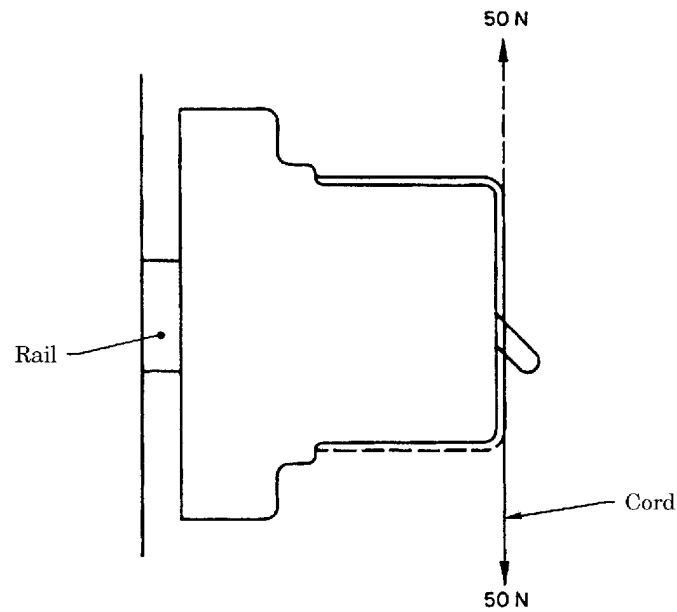


Key

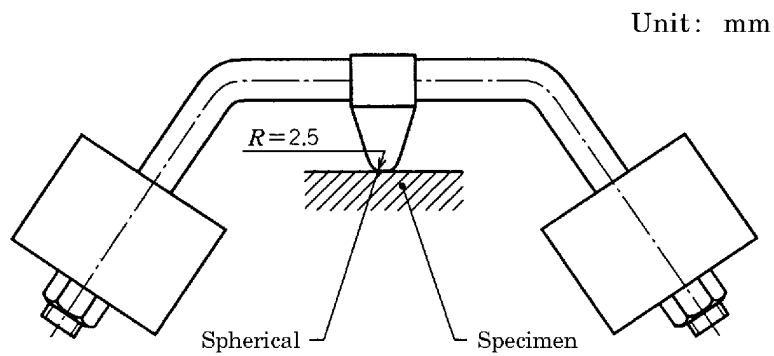
- 1 Interchangeable steel plate with a thickness of 1.5 mm
- 2 Aluminium plates with a thickness of 8 mm
- 3 Mounting late
- 4 Cut-out for the circuit-breaker in the steel plate

NOTE : In particular cases the dimensions may be increased.

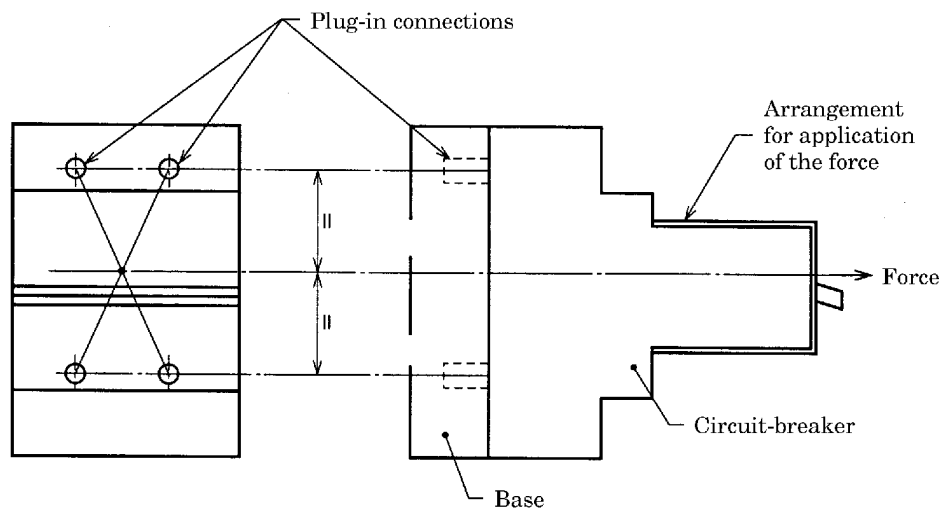
Attached Figure 14 Example of mounting of a panel board type circuit-breaker for mechanical impact test (see 9.13.2 of Annex 1 or Annex 2)



Attached Figure 15 Application of force for mechanical test on a rail-mounted circuit-breaker (see 9.13.2.3 of Annex 1 or Annex 2)



Attached Figure 16 Ball-pressure test apparatus



Attached Figure 17 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 (see 9.13.2.4 of Annex 1 or Annex 2)

Annex 1 (normative)

Circuit-breakers corresponding to specification of JIS C 0364

Introduction This Annex covers moulded-case circuit-breakers for household and similar installations to be installed in accordance with **JIS C 0364** series (hereafter referred to as “circuit-breakers”).

The performance tests of these circuit-breakers are planned based on the use of insulating wires with allowable temperature of insulation of 70 °C (PCV 70 °C standard wires) specified in **JIS C 3662-3**.

This Annex starts clause 8 since clauses 1 to 7 form the text of this Standard.

8 Requirements for construction and operation

8.1 Mechanical design

8.1.1 General Circuit-breakers shall be so designed and constructed that, in normal use, their performance is reliable and without danger to the user or surroundings.

In general, compliance is checked by carrying out all the relevant tests specified.

8.1.1.1 Open-circuit by undervoltage release 7.2.1.2.2 in Annex 1 to **JIS C 8201-2-1** shall apply.

Compliance is checked in accordance with **8.3.3.3.2 c)** and **8.3.3.3.3** in Annex 1 to **JIS C 8201-2-1**.

8.1.1.2 Open-circuit by voltage release 7.2.1.2.3 in Annex 1 to **JIS C 8201-2-1** shall apply.

Compliance is checked in accordance with **8.3.3.3.2 d)** and **8.3.3.3.3** in Annex 1 to **JIS C 8201-2-1**.

8.1.2 Mechanism The moving contacts of all poles of multipole circuit-breakers shall be so mechanically coupled that all poles, except the switched neutral, if any, make and break substantially together, whether operated manually or automatically, even if an overload occurs on one protected pole only.

The switched neutral pole (see **3.2.7.3** in the text) of multipole circuit-breakers shall not close after and shall not open before the protected poles.

Compliance is checked by inspection and by manual test, using any appropriate means (e.g. indicator lights, oscilloscope, etc.).

If a pole having an appropriate short-circuit making and breaking capacity is used as a neutral pole (other than switched neutral pole) (see **3.2.7.3** in the text), the operation shall either one of the following:

- a) All poles including the neutral pole operate substantially together.

- b) The neutral poles come in contact before other poles, in the case of closing; and separate after other poles, in the case of opening.
- c) The neutral poles come in contact before either one pole in two voltage phases, in the case of closing; and separate after one pole in two voltage phases, in the case of opening.

Circuit-breakers shall have a trip-free mechanism.

It shall be possible to switch the circuit-breaker on and off by hand. For plug-in type circuit-breakers without operating handle, this requirement is not considered met by the fact that the circuit-breaker can be removed from its base.

Circuit-breakers shall be so constructed that the moving contacts can come to rest only in the closed position (see **3.2.8** in the text) or in the open position (see **3.2.9** in the text), even when the operating means is released in an intermediate position.

Circuit-breakers shall provide in the open position (see **3.2.9** in the text) an isolation distance in accordance with the requirements necessary to satisfy the isolating function (see **8.3**). Indication of the open and closed position of the main contacts shall be provided by one or both of the following means:

- the position of the actuator (this being preferred), or
- a separate mechanical indicator.

If a separate mechanical indicator is used to indicate the position of the main contacts, this shall show the colour red for the closed position (ON) and the colour green for the open position (OFF).

The means of indication of the contact position shall be reliable.

Compliance is checked by inspection and by the tests of **9.10.2**.

Circuit-breakers shall be designed so that the actuator, front plate or cover can only be correctly fitted in a manner which ensures correct indication of the contact position.

Compliance is checked by inspection and by the tests of **9.12.12.1** and **9.12.12.2**.

Where the operating means is used to indicate the position of the contacts, the operating means, when released, shall automatically take up the position corresponding to that of the moving contact(s); in this case, the operating means shall have two distinct rest positions corresponding to the position of the contacts but, for automatic opening, a third distinct position of the operating means may be provided.

The action of the mechanism shall not be influenced by the position of enclosures or covers and shall be independent of any removable part.

A cover sealed in position by the manufacturer is considered to be a non-removable part.

If the cover is used as a guiding means for push-buttons, it shall not be possible to remove the buttons from the outside of the circuit-breaker.

Operating means shall be securely fixed on their shafts and it shall not be possible to remove them without the aid of a tool. Operating means directly fixed to covers are allowed.

If the operating means has an “up-down” movement, when the circuit-breaker is mounted as in normal use, the contacts shall be closed by the up movement.

NOTE 1 Provisionally in certain countries down-closing movement is allowed.

Compliance is checked by inspection and by manual test.

When means are provided or specified by the manufacturer to lock the operating means in the open position, locking in that position shall only be possible when the main contacts are in the open position.

NOTE 2 Locking of the operating means in the closed position is permitted for particular applications.

Compliance is checked by inspection, taking into account the instructions of the manufacturer.

8.1.3 Clearances and creepage distances (see Annex B) The minimum required clearances and creepage distances are given in Annex 1 table 4a which is based on the circuit-breaker being designed for operating in an environment with degree of pollution 2. However, the clearances of items 2, 4 and 5 may be reduced provided that the tests at rated impulse voltage are withstood.

The insulating materials are classified into material groups on the basis of their comparative tracking index (CTI) according to **2.7.1.1** and **2.7.1.3** of **JIS C 0664**.

Annex 1 Table 4a Minimum clearances and creepage distances

	Minimum clearances mm			Minimum creepage distances ⁽⁵⁾ ⁽⁶⁾ mm											
				Group IIIa ⁽⁸⁾ (175 ≤ CTI < 400) ⁽⁴⁾				Group II (400 ≤ CTI < 600) ⁽⁴⁾				Group I (600 ≤ CTI) ⁽⁴⁾			
	Rated voltage V			Working voltage ⁽⁵⁾ V											
	<i>U</i> _{imp}														
	2.5 kV	4 kV	4 kV												
Description	<u>100,</u> <u>100/</u> <u>200</u>	<u>100/</u> <u>200</u>	<u>200,</u> <u>240/</u> <u>415,</u> <u>415</u>	> 25 ≤ 50 ⁽⁹⁾	120	250	400	> 25 ≤ 50 ⁽⁹⁾	120	250	400	> 25 ≤ 50 ⁽⁹⁾	120	250	400
1. between live parts which are separated when the main contacts are in the open position ⁽¹⁾	2.0	<u>3.0</u>	4.0	1.2	2.0	4.0	4.0	0.9	2.0	4.0	4.0	0.6	2.0	4.0	4.0
2. between live parts of different polarity ⁽¹⁾	1.5	3.0	3.0	1.2	1.5	3.0	4.0	0.9	1.5	3.0	3.0	0.6	1.5	3.0	3.0
3. between circuits supplied from different sources, one of which being PELV or SELV ⁽⁷⁾	3.0	6.0	8.0	—	3.0	6.0	8.0	—	3.0	6.0	8.0	—	3.0	6.0	8.0
		—		Rated voltage V											
				<u>100,</u> <u>100/200</u>	<u>200,</u> <u>240/415</u>	<u>100,</u> <u>100/200</u>	<u>200,</u> <u>240/415</u>	<u>100,</u> <u>100/200</u>	<u>200,</u> <u>240/415</u>	<u>100,</u> <u>100/200</u>	<u>200,</u> <u>240/415</u>				
4. between live parts and — accessible surfaces of operating means — screws or other means for fixing covers which have to be removed when mounting the circuit-breaker — surface on which the circuit-breaker is mounted ⁽²⁾ — screws or other means for fixing the circuit-breaker ⁽²⁾ — metal covers or boxes ⁽²⁾ — other accessible metal parts — metal frames supporting flush-type circuit-breakers	1.5	3.0	3.0	1.5	4.0	1.5	3.0	1.5	3.0	1.5	3.0	1.5	3.0	1.5	3.0
5. between live metal parts of the mechanism and — accessible metal parts ⁽³⁾ — screws or other means for fixing the circuit-breaker — metal frames supporting flush-type circuit breakers		<u>2.0</u>													

Notes	(1) For auxiliary and control contacts the values are given in the relevant standard.
	(2) The values are doubled if clearances and creepage distances between live parts of the device and the metallic screen or the surface on which the circuit-breaker is mounted are not dependent on the design of the circuit-breaker only, so that they can be reduced when the circuit-breaker is mounted in the most unfavourable condition.
	(3) Including a metal foil in contact with the surfaces of insulating material which are accessible after installation for normal use. The foil is pushed into corners, grooves, etc., by means of a straight unjointed test finger according to 9.6 (see attached figure 9 in the text).
	(4) See IEC 60112 .
	(5) Interpolation is allowed in determining creepage distances corresponding to voltage values intermediate to those listed as working voltage. For determination of creepage distances see Annex B.
	(6) Creepage distances cannot be less than the associated clearances.
	(7) To cover all different voltages including ELV in an auxiliary contact.
	(8) For material group IIIb ($100\text{ V} \leq \text{CTI} < 175\text{ V}$) the values for material group IIIa multiplied by 1.6 apply.
	(9) For working voltages up to and including 25 V reference may be made to JIS C 0664 .
NOTES	1 The values given for 400 V are also valid for 440 V.
	2 The parts of the neutral path, if any, are considered to be live parts.
	3 Dimensioning rules for solid insulation are under consideration.
	4 Care should be taken to provide adequate clearances and creepage distances between live parts of different polarity of circuit-breakers, e.g. of the plug-in type mounted close to one another.

8.1.4 Screws, current-carrying parts and connections

8.1.4.1 Connections, whether electrical or mechanical, shall withstand the mechanical stresses occurring in normal use.

Screws operated when mounting the circuit-breaker during installation shall not be of the thread-cutting type.

NOTE 1 Screws (or nuts) which are operated when mounting the circuit-breaker include screws for fixing covers or cover-plates, but not connecting means for screwed conduits and for fixing the base of a circuit-breaker.

Compliance is checked by inspection and by the test of **9.4**.

NOTE 2 Screwed connections are considered as checked by the tests of **9.8**, **9.9**, **9.12**, **9.13** and **9.14**.

8.1.4.2 For screws in engagement with a thread of insulating material and which are operated when mounting the circuit-breaker during installation, correct introduction of the screw into the screw hole or nut shall be ensured.

Compliance is checked by inspection and by manual test.

NOTE : The requirement with regard to correct introduction is met, if introduction of the screw in a slanting manner is prevented, for example by guiding the screw by the part to be fixed by a recess in the female thread, or by the use of a screw with the leading thread removed.

8.1.4.3 Electrical connections shall be so designed that contact pressure is not transmitted through insulating material other than ceramic, pure mica or other material with characteristics no less suitable, unless there is sufficient resilience in the metallic parts to compensate for any possible shrinkage or yielding of the insulating material.

Compliance is checked by inspection.

NOTE : The suitability of the material is considered in respect of the stability of the dimensions.

8.1.4.4 Current-carrying parts and connections including parts intended for protective conductors, if any, shall be of

- copper;
- an alloy containing at least 58 % copper for parts worked cold, or at least 50 % copper for other parts;
- other metal or suitably coated metal, no less resistant to corrosion than copper and having mechanical properties no less suitable.

NOTE : New requirements and appropriate tests for determining the resistance to corrosion are under consideration. These requirements should permit other materials to be used if suitably coated.

The requirements of this subclause do not apply to contacts, magnetic circuits, heater elements, bimetals, current-limiting materials, shunts, parts of electronic devices nor to screws, nuts, washers, clamping plates and similar parts of terminals.

8.1.5 Terminals for external conductors

8.1.5.1 Terminals for external conductors shall be such that the conductors may be connected so as to ensure that the necessary contact pressure is maintained permanently.

Connection arrangements intended for busbar connection are admissible, provided they are not used for the connection of cables.

Such arrangements may be either of the plug-in or of the bolt-on type.

The terminals shall be readily accessible under the intended conditions of use.

Compliance is checked by inspection, by the tests of **9.5** for screw-type terminals, by specific tests for plug-in or bolt-on circuit-breakers included in the standard, or by the tests of Annex J or K, as relevant for the type of connection.

8.1.5.2 Circuit-breakers shall be provided with terminals which shall allow the connection of copper conductors having nominal cross-sectional areas as shown in Annex 1 table 5a.

NOTE : Examples of possible designs of screw-type terminals are given in Annex F.

Compliance is checked by inspection, by measurement and by fitting in turn one conductor of the smallest and one of the largest cross-sectional area as specified.

Annex 1 Table 5a Connectable cross-sections of copper conductors for screw-type terminals

Rated current ⁽¹⁾ A	Range of nominal cross-sections to be clamped mm ²
Up to and including 13	1 to 2.5
above 13 up to and including 16	1 to 4
above 16 up to and including 25	1.5 to 6
above 25 up to and including 32	2.5 to 10
above 32 up to and including 50	4 to 16
above 50 up to and including 80	10 to 25
above 80 up to and including 100	16 to 35
above 100 up to and including 125	25 to 50
above 125 up to and including 150	35 to 50
Note ⁽¹⁾ It is required that, for current ratings up to and including 50 A, terminals be designed to clamp solid conductors as well as rigid stranded conductors; the use of flexible conductors is permitted. Nevertheless, it is permitted that terminals for conductors having cross-sections from 1 mm² up to 6 mm² be designed to clamp solid conductors only. NOTE : For AWG copper conductors see Annex G.	

8.1.5.3 The means for clamping the conductors in the terminals shall not serve to fix any other component, although they may hold the terminals in place or prevent them from turning.

Compliance is checked by inspection and by the tests of **9.5**.

8.1.5.4 Terminals for rated currents up to and including 32 A shall allow the conductors to be connected without special preparation.

Compliance is checked by inspection.

NOTE : The term “special preparation” covers soldering of the wire of the conductor, use of cable lugs, formation of eyelets, etc., but not the use of crimp-type terminals, the reshaping of the conductor before its introduction into the terminal or the twisting of a flexible conductor to consolidate the end.

8.1.5.5 Terminals shall have adequate mechanical strength. Screws and nuts for clamping the conductors shall have a metric **ISO** thread or a thread comparable in pitch and mechanical strength.

Compliance is checked by inspection and by the tests of **9.4** and **9.5.1**.

8.1.5.6 Terminals shall be so designed that they clamp the conductor without undue damage to the conductor.

Compliance is checked by inspection and by the test of **9.5.2**.

8.1.5.7 Terminals shall be so designed that they clamp the conductor reliably and between metal surfaces.

Compliance is checked by inspection and by the tests of **9.4** and **9.5.1**.

8.1.5.8 Terminals shall be so designed or positioned that neither a rigid solid conductor nor a wire of a stranded conductor can slip out while the clamping screws or nuts are tightened.

This requirement does not apply to lug terminals.

Compliance is checked by the test of **9.5.3**.

8.1.5.9 Terminals shall be so fixed or located that, when the clamping screws or nuts are tightened or loosened, the terminals shall not work loose from their fixings to circuit-breakers.

NOTES 1 These requirements do not imply that the terminals shall be so designed that their rotation or displacement is prevented, but any movement must be sufficiently limited so as to prevent non-compliance with the requirements of this Standard.

- 2 The use of sealing compound or resin is considered to be sufficient for preventing a terminal from working loose, provided that
- the sealing compound or resin is not subject to stress during normal use intended by the manufacturer, and
 - the effectiveness of the sealing compound or resin is not impaired by temperatures attained by the terminal under the most unfavourable conditions specified in this Standard.

Compliance is checked by inspection, by measurement and by the test of **9.4**.

8.1.5.10 Clamping screws or nuts of terminals intended for the connection of protective conductors shall be adequately secured against accidental loosening.

Compliance is checked by manual test.

NOTE : In general, the designs of terminals (examples of which are shown in Annex F) provide sufficient resilience to comply with this requirement; for other designs, special provisions, such as the use of an adequately resilient part which is not likely to be removed inadvertently, may be necessary.

8.1.5.11 Pillar terminals shall allow full insertion and reliable clamping of the conductor.

Compliance is checked by inspection after a solid conductor of the largest cross-sectional area specified for the relevant rated current in Annex 1 table 5a has been fully inserted and fully clamped by applying the torques according to Annex 1 table 10.

8.1.5.12 Screws and nuts of terminals intended for the connection of external conductors shall be in engagement with a metal thread and the screws shall not be of the tapping screw type.

8.1.6 (Provision of the original International Standard is not adopted)

8.1.7 Mechanical mounting of plug-in type circuit-breakers The mechanical mounting of plug-in type circuit-breakers, the holding in position of which does not depend solely on their plug-in connection(s), shall be reliable and have adequate stability.