

JIS

JAPANESE INDUSTRIAL STANDARD

Low-voltage circuit breakers

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Low-voltage circuit breakers

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1. Scope

This Japanese Industrial Standard specifies low-voltage circuit breakers having a rated thermal current not exceeding 8000 A (rated short-circuit breaking capacity not exceeding 200 kA) used for the electric circuit not exceeding 600 V a.c. of frequency 50 Hz or 60 Hz, or not exceeding 750 V d.c. (hereafter referred to as the "circuit-breakers").

Remarks 1. The above-mentioned circuit breakers, mean the ones generally used for make and break as well as protection of electric circuit irrespective of the existence of overcurrent release. For molded case circuit breakers (JIS C 8370), residual current operated circuit breakers (JIS C 8371), d.c. high speed circuit breakers, and field circuit breakers, however, this standard is not applicable.

2. The following Standards are cited in this Standard:

JIS B 7411 Etched-Stem Liquid-in-Glass Thermometers, Total Immersion Type

JIS B 7528 Mercury Filled Thermometers

JIS C 1601 Indicating Thermoelectric Thermometers

JIS C 1603 Indicating Resistance Thermometers

JIS C 4520 General Rules for Control Switches

JIS C 8370 Molded Case Circuit Breakers (MCCB)

JIS C 8371 Residual Current Operated Circuit Breakers

2. Definitions

For the purpose of this Standard, the following principal definitions shall apply:

(1) Terms concerning kind of circuit breakers

- (a) vacuum circuit breaker A circuit breaker which performs opening and closing of the electric line in high vacuum.
- (b) air circuit breaker A circuit breaker which performs opening and closing of the electric line in the atmosphere.
- (c) oil circuit breaker A circuit breaker which performs opening and closing of the electric line in an insulating oil.
- (d) d.c. high-speed circuit breaker An air circuit breaker which is able to break abnormal current in d.c. electric circuit, by separating the contacts at such a high speed, that current limiting action occurs generally.

- (e) field circuit breaker An air circuit breaker for field circuit having a discharge contact.

(2) Terms concerning rating

- (a) rated insulation voltage The voltage to which the design is referred to guarantee the dielectric withstand voltage under specified conditions.
- (b) rated operational voltage Upper limit of operational voltage which guarantees the breaking performance and switching performance under the specified conditions. The rated operational voltage shall not exceed the rated insulation voltage.
- (c) rated thermal current The limit of current which the circuit breaker can carry continuously without the temperature rise exceeding the specified value under the specified conditions.
- (d) rated frequency The frequency for which the circuit breaker is designed to satisfy the specified conditions.
- (e) rated making capacity This is the limit of current that a circuit breaker is capable of making under the specified conditions, and the wave is equal to the maximum prospective peak short-circuit current in the case of a.c. and the rated short-circuit breaking capacity in the case of d.c.
- (f) rated breaking capacity This is the limit of current that a circuit breaker is capable of breaking under the specified conditions, and means the symmetrical component (effective value) of prospective short-circuit current at $\frac{1}{2}$ cycle after initiation of short-circuit in the case of a.c., and the maximum prospective short-circuit current in the case of d.c.
- (g) rated short-time withstand current The rated short-time withstand current is the current that a circuit breaker can carry for 1 s without any abnormality under the specified conditions, and is expressed as the symmetrical component of a.c. at $\frac{1}{2}$ cycle after initiation of short-circuit in the case of a.c.
- (h) rated closing operation voltage This means the voltage for which the electrical power operated closing device of a circuit breaker is designed, and it is expressed by the terminal voltage when the maximum current is flowing during close operation.
- (i) rated closing control voltage This means the voltage for which the electrical closing control of a circuit breaker is designed, and it is expressed by the terminal voltage when the maximum current is flowing during closing control.
- (j) rated tripping control voltage This means the voltage for which the release of a circuit breaker is designed, and it is expressed by the terminal voltage when the maximum current is flowing during tripping control.

(3) Terms concerning construction

- (a) contact A component having a contact surface which is closed or opened by switching operation of a circuit breaker.
- (b) main contact A contact included in the main circuit of a circuit breaker, intended to carry the current of the main circuit, at its closed position.
- (c) arcing contact A contact which is specially provided for the purpose of avoiding arc generation on the main contact, by taking over the arc caused by breaking or making operation.
- (d) intermediate contact A contact the timing of which in switching operation is positioned between main contact and arcing contact, and which takes over the arc caused by breaking or making operation to avoid generation of arc on the main contact.
- (e) auxiliary switch A switch interlocked with the operating mechanism of the main circuit of a circuit breaker. The contacts of auxiliary switches are designated by the symbols shown in Table 1.

Table 1. Contacts of auxiliary switches

Symbol	Graphic symbol	State of auxiliary switch contacts
a		Opens when main contact of circuit breaker is opened and closes when it is closed.
b		Closes when main contact of circuit breaker is opened and opens when it is closed.
c		Contact "a" and contact "b" having a common terminal are assembled in one.

Remarks: The Figures are corresponding to the open position of main contact of a circuit breaker.

- (f) pole and number of poles The pole means the switching part for each line of electric circuit, and the breaker is called single-pole, two-pole, three-pole circuit breaker and so on, according to the number of lines which can be closed and opened simultaneously.

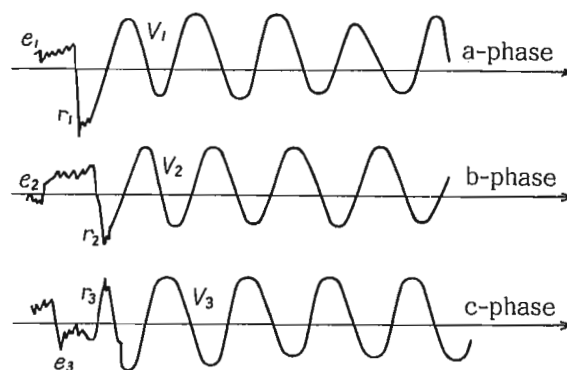
- (g) release A device which opens a circuit breaker.
- (h) trip-free mechanism A mechanism which can trip the circuit breaker, by its operation even closing command is being given, and also can keep the open position, after completion of tripping, even closing command is maintained successively to the operating mechanism.
- (i) anti-pumping device A device which prevents the re-closing after one cycle of operation "CO", as long as the circuit breaker is in the state of receiving closing command.
- (j) silver faced contact Contacts, in which both faces of conductive parts touching each other are silver filled or silver plated whose practical function is guaranteed.

(4) Terms concerning operation and test

- (a) open position The position at which a circuit breaker is perfectly opened.
- (b) closed position The position at which a circuit breaker is perfectly closed.
- (c) ambient temperature The temperature of air surrounding an entire circuit breaking device. (For example; if a circuit breaker is mounted in an enclosure or in a switch cubicle, the temperature of air outside of such enclosure.)
- (d) operating duty A series of operations in which closing, opening or closing-opening operations are made at a constant time intervals.
- (e) prospective short-circuit current The short-circuit current that would flow in the circuit, if each pole of the circuit breaker were replaced by a conductor of negligible impedance.
- (f) prospective peak short-circuit current The peak value of prospective short-circuit current during the transient period which follows initiation of the short-circuit.
- (g) maximum prospective peak short-circuit current The prospective peak short-circuit current when initiation of the current takes place at the instant which leads to the highest possible value.
- (h) critical breaking current A value of breaking current, not more than the rated short-circuit breaking capacity, at which the arcing time is longer than at the rated short-circuit breaking capacity, and that shows the maximum value.
- (i) supply voltage The voltage to be supplied to the circuit breaker at the time of short-circuit test. Unless otherwise specified, it shall be expressed as the line voltage (effective value in the case of a.c.).

- (j) power-frequency recovery voltage The voltage which appears across the terminals of a pole of a circuit breaker after the breaking of the current successively. In the case of a.c., it is expressed as the voltage (effective value) of power frequency (refer to Fig. 1).
- (k) transient recovery voltage The transient voltage which appears across the terminals of one pole immediately after breaking of the current, in the case of a.c. (refer to Fig. 1).

Fig. 1. Recovery voltages



e_1, e_2, e_3 : arc voltage

V_1, V_2, V_3 : circuit voltage (across terminals)

r_1, r_2, r_3 : transient recovery voltage

- (l) opening time The time from the instant when the release is energized to the instant when the arcing contacts (main contacts if there is no arcing contact) are just separated, in a circuit breaker at closed position.
- (m) arcing time Time interval from the instant of separation of arcing contacts (main contact if there is no arcing contacts) to the instant when the currents of all poles are just broken. In the case saying about certain pole especially, the time interval from the instant of separation of the arcing contacts (main contact if there is no arcing contact) of that pole to the instant when the current of that pole is just broken.
- (n) break-time The sum of the opening time and the arcing time.
- (o) make-time The time interval from the instant when the closing control of a circuit breaker in the open position is energized to the instant when the arcing contacts (main contacts if there is no arcing contact) are just closed.
- (p) short-circuit test The test to be carried out for determination of the breaking performance and making performance, etc. of a circuit breaker.
- (q) test frequency The frequency of voltage or current to be supplied when testing a circuit breaker.

- (r) short-circuit power-factor The cosine of phase difference angle between fundamental wave of a.c. component of short-circuit current and that of power frequency recovery voltage when that short-circuit is broken. The power factor in three-phase circuit is expressed as the average value of those obtained on every phase.
 - (s) deviation factor of waveform The percentage ratio of the maximum difference between a wave in question and the equivalent sine wave to the crest value of the equivalent sine wave, when the wave in question and its equivalent sine wave are placed in piles at a position where the largest difference between instantaneous values of the said both waves becomes minimum. The equivalent sine wave above-mentioned means the sine wave having the same effective value and frequency as those of the wave in question.
 - (t) closing operation test The test which is carried out to examine the closing performance of a circuit breaker at no-load.
 - (u) tripping test The test which is carried out to examine the tripping performance of a circuit breaker. The tests for voltage trip, overcurrent trip and under-voltage trip are carried out.
 - (v) continuous switching operation test The test which is carried out to examine the mechanical and electrical endurance of a circuit breaker.
- (5) Terms concerning tripping
- (a) overcurrent trip The operation which permits a circuit breaker to open when an overcurrent passes through the overcurrent release.
 - (b) direct overcurrent trip The operation which permits a circuit breaker to open by energizing the overcurrent release directly from the main circuit current of the circuit breaker.
 - (c) indirect overcurrent trip The operation which permits a circuit breaker to open by energizing the overcurrent release indirectly, via current transformer or shunt, from the main circuit current of the circuit breaker.
 - (d) characteristic of instantaneous release Tripping characteristics of a release which operates without any intentional time-delay.
 - (e) characteristic of time-delay release Tripping characteristic of a release which operates with intentional time-delay.
 - (f) voltage trip The operation which permits a circuit breaker to open by applying a voltage to the shunt release.
 - (g) under-voltage trip The operation which permits a circuit breaker to open when the voltage of under-voltage release becomes the specified value or below.
- (6) Terms concerning operation and control
- (a) operating device The mechanism to manage and transfer the energy which operates movable contact part of a circuit breaker directly.

- (b) operating device supply voltage The voltage to be applied to the terminals of solenoid, motor, etc. of the operating device.
- (c) operating device supply pressure The pneumatic pressure of compressed air to be applied to the operating device.
- (d) electrical operation system The operation system, in which the mechanical force directly necessary for closing or tripping a circuit breaker is given from the electric energy via motors, solenoids, etc. The system used for closing is called electrical closing operation system and that used for tripping is called electrical tripping operation system.
- (e) pneumatic operation system The operation system, in which the mechanical force directly necessary for closing or tripping a circuit breaker is given by the compressed air. The system used for closing is called pneumatic closing operation system and that used for tripping is called pneumatic tripping operation system.
- (f) spring operation system The operation system, in which the mechanical force directly necessary for closing or tripping a circuit breaker is given from the stored energy in the spring. The system used for closing is called spring closing operation system and that used for tripping is called spring tripping operation system.
- (g) power operation system Generic term of electric operation system, pneumatic operation system and spring operation system.
- (h) manual operation system The operation system in which the mechanical force directly necessary for closing a circuit breaker is given by human power or human power and spring force or the like.
- (i) dependent manual operation system The operation system in which the mechanical force directly necessary for closing a circuit breaker is given by human power.
- (j) independent manual operation system The operation system in which the storage of mechanical force directly necessary for closing a circuit breaker and successive closing action are given by a series of consecutive human power so that the closing speed and closing force are unrelated to the human power.
- (k) control device The device which receives the signal from outside of a circuit breaker, selects the signal, and then controls the energy for operating the circuit breaker. It consists of trip coils, electromagnetic contactors, pressure relays, electromagnetic valves, control relays, auxiliary contacts interlocked with main contact, etc.
- (l) control supply voltage The voltage to be applied to the control device of a circuit breaker and it is called as the closing control voltage and the tripping control voltage in the case of closing and tripping respectively.

- (m) control supply pressure The pressure of compressed air to be applied to the control device of a circuit breaker, and it is called as the closing control supply pressure and the tripping control supply pressure in the case of closing and tripping respectively.
- (n) electrical control system The control system in which the energy source which directly operates a circuit breaker is controlled by electrical means.
- (o) pneumatic control system The control system in which the energy source which directly operates a circuit breaker is controlled by pneumatic means.

3. Classification of circuit breakers

3.1 Classification by operation system

- (1) Dependent manual operation type circuit breaker
- (2) Independent manual operation type circuit breaker
- (3) Dependent power operation type circuit breaker
 - (a) Electrical operation type circuit breaker
 - (b) Spring operation type circuit breaker
 - (c) Pneumatic operation type circuit breaker

3.2 Classification by arc extinguishing media

- (1) Vacuum circuit breaker
- (2) Air circuit breaker
- (3) Oil circuit breaker

3.3 Classification by type

- (1) Number of poles
- (2) Kind of current (a.c. or d.c.), and in the case of a.c., number of phases and rated frequency.

4. Service conditions

4.1 Standard service condition The standard service conditions mean that all the service conditions given below are satisfied, and that circuit breakers shall be used under the conditions, unless otherwise specified.

- (1) Ambient temperature A temperature within the range of maximum +40°C to minimum -5°C. The average value over a period of 24 h, however, shall not exceed +35°C.

- (2) Altitude An altitude not exceeding 2000 m.

For a circuit breaker used in a place exceeding 2000 m, barometric correction may be considered in the temperature test and dielectric withstand voltage test.

- (3) Atmospheric conditions The surrounding air shall be pure, and the relative humidity shall not exceed 85 % at the maximum temperature of +40°C and not exceed 90 % at +20°C.
- (4) Condition of installation The circuit breaker shall be installed in accordance with the instruction of manufacture.

4.2 Special service condition Special service condition is the service condition when circuit breakers are used in one of the following places. In this case, this service condition shall be specified specially.

- (1) Where the ambient temperature and altitude are other than specified in 4.1.
- (2) Where the atmosphere is significantly affected by sea breeze.
- (3) Where it is usually very damp.
- (4) Where excessive steam or excessive oil vapour exists.
- (5) Where explosive, combustible or other harmful gases exist, and where there is possibility of attack of those gases.
- (6) Where excessive dust exists.
- (7) Where the circuit breaker receives abnormal vibration or impact.
- (8) Where special condition exists other than above-mentioned.

5. Ratings

5.1 Rated operational voltages The rated operational voltages shall be those given in Table 2.

5.2 Rated insulation voltages The rated insulation voltages shall be those given in Table 2.

Table 2. Rated operational voltages and rated insulation voltages

Unit: V

A.C. (effective value)		D.C.	
Rated operational voltage	Rated insulation voltage	Rated operational voltage	Rated insulation voltage
220	600	220	600
460		440	
550		750	750

5.3 Rated thermal currents The rated thermal currents shall be those given in Table 3.

Table 3. Rated thermal currents

Unit: A						
Rated thermal current						
200	300	400	600	800	1000	1200
1600	2000	2500	3000	4000	5000	6000
8000						

5.4 Rated frequency The rated frequency shall be 50 or 60 Hz or 50/60 Hz common use.

5.5 Rated breaking capacities The rated breaking capacities shall be those given in Table 4.

Table 4. Rated breaking capacities

Unit: kA			
Rated breaking capacities			
10	16	20	25
31.5	40	50	63
80	100	125	160
200			

5.6 Rated short-time withstand currents The rated short-time withstand current shall have the value equal to the rated breaking capacity of that circuit breaker.

5.7 Rated making capacity The rated making capacities of a.c. circuit breaker shall be those given in Table 5.

Table 5. Rated making capacities

Rated making capacity (n times rated breaking capacity) $n \times I_{cn}$	Standard power factor lagging	Rated breaking capacity I_{cn} kA
$1.7 \times I_{cn}$	0.5	10 or under
$2.0 \times I_{cn}$	0.3	Over 10 up to and incl. 20
$2.1 \times I_{cn}$	0.25	Over 20 up to and incl. 50
$2.2 \times I_{cn}$	0.2	Over 50 up to and incl. 80
$2.3 \times I_{cn}$	0.15	Over 80 up to and incl. 200

5.8 Standard operating duty The standard operating duty shall be as given in Table 6.

Table 6. Standard operating duty

Class of circuit breaker	Standard operating duty
A.C. breaker	O-1 min - CO-3 min - CO
D.C. breaker	O-1 min - CO

Remarks: O: breaking operation

CO: closing operation immediately followed by breaking operation.

5.9 Rated closing operation voltage, rated closing control voltage and rated tripping control voltage The rated closing operation voltage, rated closing control voltage and rated tripping control voltage shall be as given in Table 7.

Table 7. Rated closing operation voltage and others

Unit: V
Rated closing operation voltage
Rated closing control voltage
Rated tripping control voltage
100
200