

JIS

JAPANESE INDUSTRIAL STANDARD

**Circuit-breakers for
equipment**

JIS C 4610—1990

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In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

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Circuit-Breakers for Equipment

C 4610-1990

1. Scope

This Japanese Industrial Standard specifies circuit-breakers for equipment with a rated voltage not exceeding 300 V a.c. (at 50 Hz or 60 Hz) or 65 V d.c. and a rated current not exceeding 50 A which are installed in an electrical equipment and used for protection of the electrical equipment (hereafter referred to as "circuit breakers").

- Remarks 1. The circuit-breaker referred here means an apparatus consisting of switching mechanism, main contacts, auxiliary contacts, release, etc., specifically designed for the protection of electrical equipment, capable of making and carrying currents and of breaking the current automatically under specified abnormal conditions. It is traditionally called circuit protectors.
2. "Installed in an electrical equipment" stated in the above includes such a case that the circuit-breaker for equipment is installed in an external circuit exclusively used for the internal circuit which is the subject of protection of the equipment when the installation in the equipment body is impossible due to construction of the electrical equipment.
3. Applicable Standards are given below.
- JIS C 0704-Insulation Test for Control Gear
- JIS C 2809-Flat Quick-connect Terminals
- JIS C 3307-600 V Grade Polyvinyl Chloride Insulated Wires
- JIS C 3316-600 V Grade Polyvinyl Chloride Insulated Wires for Electrical Apparatus
- JIS K 8116-Ammonium Chloride
- JIS K 8459-Carbon Tetrachloride
4. The units and numerical values given in { } in this Standard are based on the traditional unit system and are currently the criteria in force.

2. Definitions

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

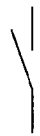
(1) General Terms

- (a) main circuit All the conductive parts of a circuit-breaker which compose the circuit intended to be closed and opened.

- (b) control circuit The circuit which receives signals from outside of the circuit-breaker and controls the energy for operation of the circuit-breaker.
- (c) auxiliary circuit The generic name of circuits in a circuit-breaker excluding the main circuit, operating circuit and control circuit.
- (d) pole This means the switching part of each line in the main circuit of a circuit-breaker. This is named single-pole, two-pole, three-pole or multiple-pole according to the number of lines capable of being switched simultaneously.
- (e) protected pole A pole provided with an overcurrent tripping element.
- (f) unprotected pole A pole without an overcurrent tripping element. Generally other functions are same as the protected pole.
- (g) open state (open position) The state (position) in which the predetermined clearance between open contacts in the main circuit of the circuit-breaker is secured.
- (h) closed state (closed position) The state (position) in which the continuity of the main circuit is secured under the prescribed conditions.
- (i) tripped state (tripped position) The state (position) in which the circuit-breaker stays as opened due to operation of the release mechanism.
- (j) overcurrent This means any current exceeding the rated current of the circuit breaker and is a generic name of overload currents and short-circuit currents.
- (k) overload The operating condition of equipment under which an overcurrent flows through the circuit-breaker.
- (l) overload current An overcurrent which flows through the circuit-breaker under overload conditions.
- (m) short-circuit current An overcurrent which flows through the shorted circuit, when a circuit is shorted by a fault, or by misconnection of wires or intentionally.
- (n) prospective current (intrinsic current) The current that would flow in the circuit, if each pole of the circuit-breaker were replaced by a conductor of negligible impedance.
- (o) reference operating temperature The ambient temperature used for determination of overcurrent release performance.
- (p) type inspection The inspection carried out to decide whether the quality of products satisfies the quality items specified in the design or not.

- (q) acceptance inspection The inspection carried out to decide whether the quality items necessary at the acceptance of the product of the same design and manufacture as that already passed the type inspection are satisfactory or not.
 - (r) insulation distance The distance between the parts to be insulated each other. It consists of clearance and creepage distance.
 - (s) clearance The shortest distance in air between two bare live parts insulated each other.
 - (t) creepage distance The shortest distance between two bare live parts along an insulating material in contact with them.
 - (u) cold state Such a state that no current is passed through the circuit-breaker (the apparatus is cooled to room temperature)
- (2) Terms for Constructional Elements
- (a) main contact A contact provided in the main circuit of a circuit-breaker.
 - (b) conductive part The electric circuits of a circuit-breaker through which currents flow.
 - (c) live part The part which is charged when a voltage is applied to a circuit-breaker.
 - (d) release A device which causes a circuit-breaker to open.
 - (e) thermal-magnetic overcurrent release An overcurrent release consisting of a thermal element which causes time-delay tripping for an overload current, and a electromagnet which causes instantaneous tripping for a short-circuit current.
 - (f) hydraulic-magnetic overcurrent release An overcurrent release consisting of an electromagnet with oil dash pot which causes time-delay tripping for an overload current and instantaneous tripping for a short-circuit current.
 - (g) thermal overcurrent release An overcurrent release in which the tripping element for overload and short-circuit currents consists of a thermal element only.
 - (h) magnetic overcurrent release An overcurrent release in which the tripping element for overload and short-circuit currents consists of a electromagnet only.
 - (i) Auxiliary switch A switch which is operated linked with the main-circuit switching mechanism of a circuit-breaker. The contacts of an auxiliary switch shall be indicated by the symbols given in Table 1.

Table 1. Contact of Auxiliary Switch

Symbol	Graphical symbol	State of contact of auxiliary switch
a		A contact which is open when the main contacts of the circuit-breaker open and closed when they are closed.
b		A contact which is closed when the main contacts of the circuit-breaker are open and open when they are closed.
c		A combination of a-contact and b-contact having a common contact and terminal.

- (j) **alarm switch** A switch which operates only when breaking is done due to operation of the release of the circuit-breaker. The contacts shall be indicated by the symbols given in Table 2.

Table 2. Contact of Alarm Switch

Symbol	Graphical symbol	State of contact of alarm switch.
a		A contact which is closed when the main contacts open due to operation of release of the circuit-breaker.
b		A contact which is open when the main contacts open due to operation of release of the circuit-breaker.
c		A combination of a-contact and b-contact having a common contact and terminal.

- (k) terminal A conductive part which is provided for electrical connection of the circuit-breaker with the external wiring.
 - (l) pillar terminal A terminal of such construction that the conductor is inserted into a hole or cavity, where it is clamped under the shank of the screw(s) for connection. The clamping may be made by directly applying the clamping force by the shank of the screw or through an intermediate clamping element.
 - (m) screw terminal A terminal of such construction that the conductor is clamped under the head of the screw for connection. The clamping pressure may be applied directly by the head of the screw or through a washer, a clamping plate, an antispread device, etc.
 - (n) stud terminal A terminal of such construction that the conductor is clamped under a nut for connection. The clamping pressure may be applied directly by the nut or through a washer, a clamping plate, an antispread device, etc.
 - (o) lug terminal A screw or stud terminal of such construction that a cable lug or a conductor bar is clamped by means of a screw or nut for connection.
 - (p) flat quick-connect terminal A female terminal which allows easy insertion and withdrawal of male tab without use of tools.
 - (q) male tab A flat male tab which is inserted into the tab receptacle.
 - (r) tab forming a part of circuit-breaker A male tab which is permanently fixed to a circuit-breaker or attached as a component.
- (3) Terms for Operation and Motion
- (a) closing operation An operation by which the main contacts of a circuit-breaker are brought from the open position to the closed position.
 - (b) opening operation An operation by which the main contacts of a circuit-breaker are brought from the closed position to the open position.
 - (c) reset operation An operation by which the circuit-breaker in tripped state is brought to a state ready for closing again.
 - (d) trip-free Such function that the circuit-breaker can be tripped by the tripping operation even if it is under closing operation or the closing command is maintained and after completion of tripping the circuit-breaker does not maintain the closed state when closing operation is carried out if the tripping command is consecutively given.
 - (e) non-trip-free Such function that the circuit-breaker does not open when the tripping command is given during closing operation or the closing command is continued.

- (f) overcurrent trip An automatic tripping action which opens the circuit-breaker by releasing the switching mechanism when an overcurrent flows through the circuit-breaker.
- (g) time-delay trip (long-time-delay trip) An overcurrent trip by which the operation time is delayed almost inversely proportional to the value of the overcurrent.
- (h) instantaneous trip An overcurrent trip by which the circuit-breaker is opened without intentional time delay due to relatively large overcurrent such as the short-circuit current.
- (i) voltage trip The action to trip the circuit-breaker by applying the operation voltage to the release.
- (j) under-voltage trip The trip which is performed when the voltage of the release falls below a specified value.

(4) Terms for Ratings and Characteristics

- (a) rated operational voltage (U_e) The upper limit of operational voltage at which the switching performance and breaking performance are ensured under specified conditions.
- (b) rated insulation voltage (U_i) The voltage which is taken as the reference of the insulation design, and on which the insulation distances and the dielectric withstand voltage are based.
- (c) control voltage This is the voltage to be applied to the electrical control device, and means a closing control voltage, opening control voltage and tripping control voltage in the case of closing, opening and tripping respectively.
- (d) recovery voltage The voltage at the power frequency which appears across the terminals of a pole of a circuit-breaker immediately after the breaking of the current (r.m.s. value).
- (e) rated current (I_n) The current which does not cause a temperature exceeding the specified limit of temperature rise, when the current is passed continuously.
- (f) rated breaking capacity (I_{cn}) This is the limit of current that a circuit-breaker is capable of breaking under specified conditions, and means the a.c. component (r.m.s. value) of the prospective short-circuit current (intrinsic current) at $\frac{1}{2}$ cycle after initiation of short circuit in the case of a.c., and the maximum value of the prospective short-circuit current (intrinsic current) in the case of d.c.

- (g) tripping time The time interval from the instant at which the associated tripping current begins to flow in the main circuit to the completion of tripping operation.
- (h) conventional delay tripping time The time which serves as the reference of the time-delay tripping current.
- (i) conventional instant tripping time (t_i) The time which serves as the reference of the instantaneous tripping time.
- (j) opening time The interval of time from the instant when the tripping command is applied to the release of a circuit-breaker in closed position to the instant when the main contacts start to separate.
- (k) arcing time The interval of time from the instant when the main contacts separate to the instant when the current is interrupted in all the poles.
- (l) total breaking time The interval of time from the instant when the tripping command is applied to the release of a circuit-breaker in closed position to the instant of arc extinction in all the poles. It is equal to the sum of the opening time and the arcing time.
- (m) non-tripping current (I_{nt}) The current which the circuit-breaker is capable of carrying for the conventional delay tripping time without tripping.
- (n) time-delay tripping current (I_t) The current which causes the circuit-breaker to operate within the conventional delay tripping time.
- (o) instantaneous tripping current (I_i) The current which causes the circuit-breaker to operate automatically within the conventional instant tripping time.
- (p) instantaneous non-tripping current (I_{ni}) The current which does not cause the circuit-breaker to operate within the conventional instant tripping time.
- (q) operating duty A sequence of operations in which, closing and opening, and/or closing followed by opening are carried out at certain intervals of time.

3. Standard Conditions in Service

The standard conditions in service shall be as stated in (1) to (5) below, and circuit-breakers shall be used under these conditions unless otherwise specified.

- (1) The ambient temperature shall be within the range of -5 to 40°C. The average value over a period of 24 h shall not exceed 35°C.
- (2) The altitude shall not exceed 2000 m.
- (3) Relative humidity shall be within the range of 45 to 85 %.

- (4) The equipment shall not be subjected to abnormal vibration or shock.
- (5) Atmosphere where no excess water vapour, oil vapour, smog, dust, salt, corrosive substance, etc. exist.

4. Classification of Circuit-Breakers

4.1 Classification According to Method of Mounting Circuit-breakers shall be classified as given below according to the method of mounting.

- (1) Surface type
- (2) Flush type
- (3) Panel-mounting type
- (4) Rail-mounting type
- (5) Plug-in type

4.2 Classification According to Operation System Circuit-breakers shall be classified as given below according to the operation system.

- (1) R type Circuit-breakers for automatic interruption and non-automatic resetting which have manual closing mechanism but no manual opening mechanism.
- (2) M type Circuit-breakers for automatic interruption and non-automatic resetting, provided with manual operation mechanism designed for occasional manual switching, but not designed for frequent switching operations under normal conditions.
- (3) S type Circuit-breakers for automatic interruption and non-automatic resetting which can be used as a manual switch under normal load conditions.

4.3 Classification According to Mode of Tripping Circuit-breakers shall be classified as given below according to the mode of tripping.

- (1) Thermal type (TO)
- (2) Thermal-magnetic type (TM)
- (3) Magnetic type (MO)
- (4) Hydraulic-magnetic type (HM)

5. Ratings

5.1 Rated Voltages The rated voltages shall be as follows:

- (1) Rated operational voltage (U_e) The rated operational voltages shall be as given in Table 3.

Table 3. Rated Operational Voltage

Unit: V

	Rated operational voltage of circuit-breaker (U_e)							
A.C.	50	100	100/200	(110)	(110/220)	200	(220)	240 (265)
D.C.	12	24	48	60				

Remarks 1. The voltage is expressed by the line voltage for multiphase circuit.

2. The values in parentheses are established by considering 10 % allowance on nominal voltages.

- (2) Rated Insulation Voltage (U_i) The rated insulation voltages shall be as given in Table 4. In no case shall the maximum rated operational voltage exceed the rated insulation voltage.

Table 4. Rated Insulation Voltage

Unit: V

Rated insulation voltage of circuit-breaker (U_i)			
65	125	250	300

- 5.2 Rated Current (I_n) The rated currents shall be as given in Table 5.

Table 5. Rated Current

Unit: A

Rated current of circuit-breaker (I_n)									
0.05	0.1	0.3	0.5	0.75	1	2	3	5	7.5
10	15	20	25	30	40	50			

5.3 Conventional Delay Tripping Time The conventional delay tripping time shall be 60 min.

5.4 Conventional Instant Tripping Time (t_i) The conventional instant tripping time shall be 0.1 s.

5.5 Reference Operating Temperature The reference operating temperature shall be 40°C or 25°C.

5.6 Rated Frequency The rated frequency shall be 50 Hz, 60 Hz or 50/60 Hz.

5.7 Rated Breaking Capacity (I_{cn}) The rated breaking capacities shall be as given in Table 6.