

# JIS

**JAPANESE INDUSTRIAL STANDARD**

**Residual current operated  
circuit breakers**

 **JIS C 8371**—1992

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**Japanese Standards Association**

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

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1. Scope This Japanese Industrial Standard specifies current-operated type residual current circuit breakers for rated currents not exceeding 2500 A to be used for protection against earth fault of electric circuits for rated a.c. voltages not exceeding 600 V at a frequency 50 Hz or 60 Hz (hereafter referred to as "residual current operated circuit breakers" or "RCOCBs").

RCOCB's specified in this Standard include those given below. The requirements for RCOCB's of (1) to (3) below different from general technical requirements specified in this text are specified in Annexes 1 to 3 respectively.

- (1) RCOCB (which serves) also for induction motor protection
- (2) RCOCB for (branching in) household distribution board
- (3) Four-pole RCOCB

Remarks 1. The RCOCB referred to here means such a device that an earth detecting device, a tripping device, a switching mechanism, etc. are assembled in an enclosure of insulating materials, that the electric circuit under normal service can be switched manually or by means of an electrical operating device located outside the insulating enclosure and the electric circuit is automatically opened at an earth fault.

If the above earth detecting device, tripping device and switching mechanism are separated, this Standard applies to the assembled system of such devices.

2. In this Standard the units and numerical values in { } are based on the traditional unit system and are appended for information.
3. The Standards cited in this Standard are given in Attached Table 1.
4. The international standard corresponding this Standard is given below.

IEC 1008-1 (1990) Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCB's). Part 1: General rules



2. Definitions For the purpose of this Standard, the following principal definitions apply:

(1) Classification of RCOCB

- (a) current operated type RCOCB A RCOCB which automatically opens the circuit by detecting the earth-fault current with a zero-phase-sequence current transformer (including a differential transformer, hereafter the same applies).
- (b) plug-in type RCOCB A RCOCB which provides a plug-in connector on each or either of power supply side or load side.
- (c) high-speed type RCOCB A RCOCB whose breaking time at the rated residual operating current is not exceeding 0.1 s.
- (d) time-delay type RCOCB A RCOCB whose breaking time at the rated residual operating current is exceeding 0.1 s but not exceeding 2 s.
- (e) inverse-time type RCOCB A RCOCB in which the breaking time at the rated residual operating current is not exceeding 0.3 s, that at twice the rated residual operating current is not exceeding 0.15 s and those at five times the rated residual operating current and at 500 A are not exceeding 0.04 s.
- (f) high-sensitivity type RCOCB A RCOCB with a rated residual operating current not exceeding 30 mA.
- (g) medium-sensitivity type RCOCB A RCOCB with a rated residual operating current exceeding 30 mA but not exceeding 1000 mA.
- (h) low-sensitivity type RCOCB A RCOCB with a rated residual operating current exceeding 1000 mA but not exceeding 20 A.
- (i) interchangeable RCOCB A RCOCB with a rated current not exceeding 30 A of terminal connection system which has interchangeability at installation and replacement.
- (j) front-type RCOCB A RCOCB of such construction that the external wiring is connected to the terminals in the front of the apparatus.
- (k) rear-type RCOCB A RCOCB of such construction that the external wiring is connected to the terminals in the rear of the apparatus by means of rear stud terminals.
- (l) plug-in type RCOCB A RCOCB of such construction that disconnecting contacts are provided and the apparatus can be attached and detached without removing the external wiring.
- (m) flush-type RCOCB A RCOCB of such construction that major parts of apparatus are accommodated inside of the panel.
- (n) RCOCB also for induction motor protection A RCOCB which serves also for protection of an induction motor, and its rated current coincides with the full load current of the induction motor.

- (o) RCOCB for household distribution board This is generally called as safety breaker type RCOCB. This is mainly used at the entry into house and in branch circuits.
- (p) four-pole RCOCB A four-pole RCOCB which is equipped with a pole exclusively for the neutral line of a three-phase four-wire system.
- (q) RCOCB with protection for neutral line failure in single-phase three-wire system A RCOCB which has such a function that the apparatus opens the circuit when a neutral line failure occurs in a single-phase three-wire system, by detecting the unbalanced voltage (overvoltage) appearing across the voltage poles.

(2) General terms

- (a) main circuit The conductive path of a RCOCB for current carrying including the main contact.
- (b) control circuit The conductive path of a RCOCB intended for the closing or opening operation, or both, of the apparatus excluding the main circuit.
- (c) auxiliary circuit The conductive path of a RCOCB to be used for such functions as the signal corresponding to the operating state of apparatus and the interlock between RCOCB's, excluding the main circuit and control circuit.
- (d) pole An electrically insulated conducting path including the switching contacts in the main circuit.
- (e) open state (position) The state (position) of a RCOCB in which the predetermined clearance between open contacts in the main circuit of the RCOCB is secured.
- (f) closed state (position) The state (position) of a RCOCB in which the predetermined continuity of the main circuit of the RCOCB is secured.
- (g) tripped state (position) The state (position) of a RCOCB in which the RCOCB is opened due to actuation of the tripping mechanism.
- (h) earth fault Such a state that a hazardous voltage appears outside the electric path or equipment or hazardous current flows out due to bridging by arc or conductive material at abnormal decrease of the insulation between the electric path and the earth.
- (i) earth-fault current The current which flows out of the electric path due to earth fault and may cause such troubles as fire, electric shock of humans and animals, damage of electric path and equipment.
- (j) overcurrent This means a current which exceeds the rated current of a RCOCB and is the generic name of overload current and short-circuit current.


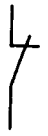

- (k) overload Such a running state that an overcurrent is flowing in a circuit not electrically damaged.
- (l) overload current The current which is flowing through a RCOCB under overload conditions.
- (m) inrush current The current exceeding the stationary current which flows instantaneously when an incandescent lamp is put into operation.
- (n) short-circuit current The overcurrent resulting from short circuit due to failure or incorrect connection.
- (o) prospective short-circuit current The short-circuit current that would flow in the circuit if each pole of the RCOCB were replaced by a conductor of negligible small impedance.
- (p) reference ambient temperature The ambient temperature employed as the reference for determination of the overcurrent tripping performances.
- (q) insulation distance This means the distance between parts to be insulated from each other and consists of clearance and creepage distance.
- (r) clearance The shortest distance between two insulated bare live parts.
- (s) creepage distance The shortest distance between two bare live parts along the surface of insulating material in contact with them.
- (t) arcing space The space necessary for insulation to avoid the trouble secondary affected by the exhaust gas of RCOCB at interruption of shorted circuit.

### (3) Components

- (a) main contact The contact provided in the main circuit of a RCOCB.
- (b) arcing contact The contact additionally provided to reduce arcing of the main contact by attracting the arc due to breaking or making the current.
- (c) conductive part The electrical path of a RCOCB intended for carrying current.
- (d) live part The part which directly becomes alive when a voltage is applied to a RCOCB.
- (e) terminal The conductive part provided to electrically connect a RCOCB with the external wiring.
- (f) release a device which opens a RCOCB by releasing the holding means of the switching mechanism.


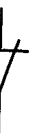

- (g) residual current release A release which carries out tripping action against the earth fault current.
- (h) overvoltage release A release which carries out action against the overvoltage appearing across the voltage pole and neutral pole.
- (i) test device A device by which the actuation of the residual current release is verified.
- (j) earth fault detector A device which detects the earth fault current.
- (k) overcurrent release A release which carries out tripping action against the overload current or short-circuit current.
- (l) overcurrent tripping element The unit element having a function of detecting overcurrent and provided on each pole of an overcurrent release.
- (m) replaceable overcurrent release An overcurrent release of such construction that the said release is unitized and a RCOCB of different rated current is available by changing the overcurrent release only.
- (n) sensitivity change-over system A system in which the rated residual operating current can be changed over.
- (o) adjustable rated current system A system in which the rated current is adjustable.
- (p) adjustable overcurrent tripping system A system in which the operating time or operating current of overcurrent trip is adjustable.
- (q) adjustable system This means that the operating time or operating current of overcurrent trip is adjustable by the user within the predetermined range to correspond with the service conditions.
- (r) auxiliary switch A switch which operates linked with the main circuit switching mechanism of a RCOCB. The contact of auxiliary switch shall be expressed by the symbols given in Table 1.

Table 1. Contacts of auxiliary switch

Symbol	Graphic symbol	State of auxiliary switch contacts
a		A contact which opens when the main contact opens and closes when the main contact closes.
b		A contact which closes when the main contact opens and opens when the main contact closes.
c		A contact combination consisting of "a" contact and "b" contact with a common contact and terminal for both.

- (s) alarm switch The switch which operates only when the RCOCB breaks the current due to operation of its release. The contact of alarm switch shall be expressed by the symbols given in Table 2.

Table 2. Contacts of alarm switch

Symbol	Graphic symbol	State of alarm switch contacts
a		A contact which closes when the main contact opens due to operation of release of the RCOCB.
b		A contact which opens when the main contact opens due to operation of release of the RCOCB.
c		A contact combination consisting of "a" contact and "b" contact with a common contact and terminal for both.

(4) Operation and actuation

- (a) closing operation An operation by which the main contact of a RCOCB is transferred from the open position to the closed position.
- (b) opening operation An operation by which the main contact of a RCOCB is transferred from the closed position to the open position.
- (c) reset operation An operation by which the apparatus is brought from the tripped state to the state immediately before reclosing.
- (d) test operation An operation to verify the actuation of residual current release by pushing the test button so that the main contact is transferred from the closed position to the open position.
- (e) manual operation An operating system in which the closing, opening and/or resetting operation can be made only by manual procedure.
- (f) electrical operation An operating system in which the operating force necessary for closing, opening, tripping and/or resetting is fed from electric energy by means of a motor, electromagnetic, solenoid, etc.
- (g) trip free This means that a RCOCB can be tripped by the tripping operation even if the apparatus is in closing operation or the closing command is maintained.
- (h) residual current trip The automatic tripping operation which opens a RCOCB by releasing the switching mechanism when the earth-fault current flows through the RCOCB.
- (i) overvoltage trip The automatic tripping operation which opens a RCOCB by releasing the switching mechanism when an overvoltage appears across the voltage pole and the neutral pole.
- (j) overcurrent trip The automatic tripping operation which opens a RCOCB by releasing the switching mechanism when an overcurrent flows through the RCOCB.
- (k) long time-delay trip The overcurrent tripping operation in which the operating time becomes shorter when the overcurrent increases.
- (l) instantaneous trip The overcurrent tripping operation which trips the RCOCB without intentional time delay when a relatively large overcurrent such as short-circuit current flows.
- (m) voltage trip The operation to trip a RCOCB by applying the voltage to the voltage release.
- (n) undervoltage trip The operation to trip a RCOCB when the voltage operating voltage of undervoltage release drops below the specified value.

(5) Ratings and characteristics

- (a) rated voltage ( $U_e$ ) This is the voltage to be used as the reference for switching performances, breaking performances and dielectric withstanding voltage performances under specified conditions.
  - (b) rated voltage of operating circuit ( $U_s$ ) This means the rated voltage to be applied to the electrical operating device. This is called rated closing operation voltage for closing, rated opening operation voltage for opening and rated tripping operation voltage for tripping.
  - (c) power-frequency recovery voltage The voltage at power frequency which appears across terminals of poles of a RCOCB after the breaking.
  - (d) rated current ( $I_n$ ) The current which can be continuously passed through an apparatus without exceeding the specified temperature rise limit.
  - (e) rated breaking capacity ( $I_{cn}$ ) This means the limit of current which can be broken under specified conditions and it is expressed by the r.m.s. value of symmetrical component of the prospective short-circuit current at  $\frac{1}{2}$  cycle after occurrence of short-circuit.
  - (f) residual operating current ( $I_{\Delta}$ ) The current at which the RCOCB trips when a current is passed through one pole of the main circuit, while the RCOCB is closed, and the current is gradually increased.
  - (g) rated residual operating current ( $I_{\Delta n}$ ) The earth fault current on primary side of the zero-phase-sequence transformer at which the RCOCB trips without fail under the prescribed conditions<sup>(1)</sup>.
- Note <sup>(1)</sup> The prescribed conditions referred here mean that the voltage is in the range 80 % to 110 % of the rated value under the standard service conditions.
- (h) rated residual non-operating current The earth fault current on primary side of the zero-phase-sequence transformer existence of which does not cause trip of the RCOCB under the prescribed conditions<sup>(1)</sup>.
  - (i) rated short-time current ( $I_{cw}$ ) This means the current which can be passed through a RCOCB, for the specified duration under the specified conditions without causing any abnormality. It is expressed in r.m.s. value of the symmetrical component.
  - (j) break time (by residual current) The time from the instant when an earth fault current exceeding the rated residual operating current appears to the instant when the circuit is completely interrupted.

- (k) limiting non-actuation This means that a RCOCB of time-delay type does not trip when the specified current is passed through one pole of the RCOCB under closed state for a short time. The maximum time of non-actuation in the above procedure is called the limiting non-actuating time.
- (l) operating overvoltage The overvoltage that causes trip of the RCOCB, when the said voltage is applied across the voltage pole and the neutral pole.
- (m) rated operating overvoltage The overvoltage that causes trip of the RCOCB without fail when it is applied across the voltage pole and the neutral pole under the prescribed conditions.
- (n) rated non-operating overvoltage The overvoltage that does not cause trip of the RCOCB when it is applied across the voltage pole and the neutral pole under the prescribed conditions.
- (o) actuating time at rated (operating) overvoltage The upper limit value of the period from the instant when a voltage equal to the rated operating overvoltage occurs to the instant when the RCOCB interrupts the circuit.
- (p) opening time The time measured from the instant when tripping command is given to the release of a RCOCB under closed state to the instant when the arcing contacts (main contacts if there is no arcing contact) have separated in all poles.
- (q) closing time The time measured from the instant when the electrical closing operation device of a RCOCB under open state is energized to the instant when the arcing contacts (main contacts if there is no arcing contact) come in contact in all poles.
- (r) arcing time The time measured from the instant when the first arcing contact (main contact if there is no arcing contact) separates to the instant when the currents are broken in all poles.
- (s) total break time (in case of overcurrent) The time measured from the instant when the tripping command is given to the release of a RCOCB under closed state to the instant of arc extinction in all poles. It is equal to the sum of the opening time and the arcing time.
- (t) instantaneous tripping time The time for the reference of instantaneous tripping.
- (u) continuous rating The rating at which the temperature rise at each part does not exceed the specified value when the voltage or current so rated is applied to the device continuously until the temperature rise stabilizes.
- (v) operating duty A sequence of closing operation, opening operation and/or closing operation followed by opening operation which is assigned to a RCOCB under the prescribed conditions.





#### 4.4 Classification according to sensitivity

- (1) High sensitivity type
- (2) Medium sensitivity type
- (3) Low sensitivity type

#### 4.5 Classification according to connection system with power supply and load, and mounting system

- (1) Terminal connection system
  - (a) Front type
  - (b) Rear type
  - (c) Plug-in type
  - (d) Flush type
- (2) Plug-in connection system
  - (a) Surface type
  - (b) Flush type

#### 4.6 Classification according to overcurrent trip

- (1) Long time-delay tripping type
- (2) Long time-delay and instantaneous tripping type
- (3) Instantaneous tripping type

### 5. Ratings

5.1 Rated current The rated current shall have the values given in Table 3.

Table 3. Rated currents

Unit: A											
Rated current ( $I_n$ )											
3	5	6	10	(13)	15	(16)	20	(25)	30	(32)	40
50	60	(63)	75	(80)	100	125	150	175	200	225	250
300	350	400	500	600	700	800	1 000	1 200	1 400	1 600	1 800
2 000	2 500										

Remarks 1. The rated current shall be not more than 15 A for RCOCB of plug-in type.

2. The values in parentheses are applicable for apparatus exclusively for earth fault protection.

5.2 Rated voltage of main circuit The rated voltage of main circuit shall have the values given in Table 4.

Table 4. Rated voltages of main circuit  
Unit: V

Rated voltages of main circuit ( $U_e$ )						
100	200	100/200( <sup>2</sup> )	230	240(265)	400	415(460)

Note (<sup>2</sup>) This means that the distribution voltage between the voltage lines is 200 V and the distribution voltage between the voltage line and the earthed neutral line is 100 V in the circuit where a RCOCB for single-phase three-wire circuit is connected.

- Remarks 1. The rated voltage shall be 100 V for RCOCB's of plug-in type.
2. The values in parentheses are those partly used in distribution systems of 60 Hz.

5.3 Rated voltage of operating circuit The rated voltages of operating circuit shall be as shown in Table 5.

Table 5. Rated voltages of operating circuit  
Unit: V

Classifi- cation	Rated voltages of operating circuit ( $U_e$ )						
AC	24	100	200	230	240	400	415
DC	24		48		100		200

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

5.5 Rated residual operating current The rated residual operating current shall have the values given in Table 6.

Table 6. Rated residual operating current

Classification	Rated residual operating current ( $I_{\Delta n}$ )						Application
High-sensitivity type (mA)	5	6	10	15	30		High-speed type Time-delay type Inverse-time type
Medium-sensitivity type (mA)	50	100	200	300	500	1000	High-speed type Time-delay type
Low-sensitivity type (A)	3	5	10	20			High-speed type Time-delay type

Remarks: The current shall be not more than 15 mA for RCOCB's of plug-in type.

5.6 Rated residual non-operating current This shall be not less than 50 % of the rated residual operating current.

5.7 Rated operating overvoltage The rated operating overvoltage shall be 135 V.

5.8 Rated non-operating overvoltage The rated non-operating overvoltage shall be not less than 120 V.

5.9 Rated actuating time at operating overvoltage The rated actuating time at operating overvoltage shall be within 1 s.

5.10 Rated breaking capacity The standard values of rated breaking capacity are as shown in Table 7.

Table 7. Rated breaking capacity

Unit: A

Rated breaking capacity ( $I_{cn}$ )	
1000 <sup>(3)</sup>	30000
1500	35000
2500	42000
5000	50000
7500	65000
10000	85000
14000	100000
18000	125000
22000	150000
25000	200000

Note <sup>(3)</sup> This applies to the RCOCB also for induction motor protection specified in Annex 1 and the RCOCB of single-phase two-wire system and two poles (2P2E).

5.11 Reference ambient temperature The reference ambient temperature shall be either of 25°C or 40°C.

The ambient temperature at long time-delay tripping test shall be the reference ambient temperature in general, but if the test is carried out at a room temperature different from the reference ambient temperature correction of current or time to the reference ambient temperature shall be made by using the temperature correction curve guaranteed by the manufacturer.

5.12 Rated short-time current The standard values of rated short-time current shall be not less than the values given in Table 8.

Table 8. Rated short-time current

Unit: A

Rated current ( $I_n$ )	Rated short-time current ( $I_{cw}$ ) <sup>(4)</sup>
$I_n \leq 30$	1000 <sup>(5)</sup> 1500
$30 < I_n \leq 100$	2500
$100 < I_n \leq 225$	5000
$225 < I_n \leq 600$	7500
$600 < I_n \leq 1000$	10000
$1000 < I_n \leq 1600$	14000
$1600 < I_n \leq 2000$	18000
$2000 < I_n$	22000

Notes <sup>(4)</sup> This is the r.m.s. value of a.c. component 1/2 cycle after occurrence of short circuit.

<sup>(5)</sup> This is applicable for RCOCB's of plug-in type.

## 6. Performances

### 6.1 Operating property

6.1.1 Manual operating property When the RCOCB is tested in accordance with 8.3.1, the operation shall be smooth and sure switching operation shall be observed.

6.1.2 Electrical operating property The electrical operating property shall comply with the following requirements:

- (1) Closing operation When the RCOCB with electrical closing device is tested in accordance with 8.3.2 (1), the closing shall be performed without any trouble.

- (2) Opening operation When the RCOCB with electric opening and resetting device is tested in accordance with 8.3.2 (2), the opening and resetting shall be performed without any trouble.
- (3) Voltage trip When the RCOCB with voltage release is tested in accordance with 8.3.2 (3), the tripping shall be performed without any trouble.
- (4) Undervoltage trip When the RCOCB with undervoltage release is tested in accordance with 8.3.2 (4), the following requirements shall be satisfied:
  - (a) The RCOCB shall be capable of being closed at a voltage not less than 85 % of the rated voltage of operating circuit.
  - (b) The RCOCB in closed state shall not be tripped at a voltage exceeding 70 % of the rated voltage of operating circuit.
  - (c) The tripping shall be performed at a voltage in the range 20 % to 70 % of the rated voltage of operating circuit.
  - (d) When the closing operation of the RCOCB is carried out at a voltage less than 20 % of the rated voltage of operating circuit, the closed state shall not be maintained.
  - (e) When the RCOCB is closed at 110 % of the rated voltage of operating circuit and then the voltage is removed, the tripping shall be performed without any trouble.

6.1.3 Trip free When the tripping mechanism of a RCOCB is tested in accordance with 8.3.3 (1) and (2), the tripping shall be performed firmly.

6.1.4 Switching action The apparatus employing an a.c. electromagnetic switch as the breaking part shall comply with the performances shown in 5.3 (switching action) of JIS C 8325.

## 6.2 Robustness of terminal

6.2.1 Tensile strength When the test is carried out as specified in 8.4 (1), no abnormality such as coming out of conductor shall occur.

6.2.2 Clamping of wire When the test is carried out as specified in 8.4 (2), no loosening of terminal, break of screw, damage of slit and screw thread or damage of washer and clamping plate shall take place.

6.2.3 Flexion strength When a RCOCB which is connecting the lead wire directly is tested in accordance with 8.4 (3), no abnormalities such as loosening of terminal, coming out of conductor shall occur.

## 6.3 Residual current trip

6.3.1 Residual operating current When the test is carried out as specified in 8.5.1, the value of residual operating current shall exceed the value of rated non-operating current but not exceed the value of the rated residual operating current.

6.3.2 Actuation time of tripping by residual operating current When the test is carried out as specified in 8.5.2, the actuation time shall comply with the requirements of Table 9. 1934

Table 9. Actuation time of tripping by residual operating current

Unit: s

High-speed type	Time-delay type	Inverse-time type			
		Rated residual operating current	Twice rated residual operating current	Five times rated residual operating current	500 A
Within 0.1	Over 0.1 but within 2	Within 0.3	Within 0.15	Within 0.04	Within 0.04

6.3.3 Limiting non-actuation The RCOCB of time-delay type shall not operate when tested in accordance with 8.5.3.

6.4 Residual operating current at ambient temperature change and power supply voltage fluctuation When the test is carried out as specified in 8.6, the value of residual operating current shall exceed the value of rated residual non-operating current but not exceed the value of rated residual operating current.

6.5 Non-actuation at ambient temperature change and power supply voltage fluctuation The specimen shall not operate when tested in accordance with 8.7.

6.6 Balance of zero-phase-sequence transformer The specimen shall not operate when tested in accordance with 8.8.

6.7 Actuation of test device When the test is carried out as specified in 8.9, the tripping operation shall be performed without any trouble.

#### 6.8 Overvoltage trip

6.8.1 Operating overvoltage When the RCOCB with protection for neutral line failure in single-phase three-wire system is tested in accordance with 8.10.1, the value of operating voltage shall exceed the rated non-operating overvoltage and not exceed the rated operating overvoltage.

6.8.2 Actuating time at overvoltage When the RCOCB with protection for neutral line failure in single-phase three-wire system is tested in accordance with 8.10.2, the specimen shall show a value within the value of rated actuating time at overvoltage.

6.9 Operating overvoltage at ambient temperature change and power supply voltage fluctuation When the RCOCB with protection for neutral line failure in single-phase three-wire system is tested in accordance with 8.11, the value of operating voltage shall exceed the value of rated non-operating overvoltage and not exceed the value of rated operating overvoltage.

6.10 Non-operating overvoltage at ambient temperature change and power supply voltage fluctuation The RCOCB with protection for neutral line failure in single-phase three-wire system shall not operate when tested in accordance with 8.12.

6.11 Maximum overvoltage trip The RCOCB with protection for neutral line failure in single-phase three-wire system shall operate within the rated overvoltage actuating time when tested in accordance with 8.13.

6.12 Current carrying and long time-delay trip These performances are applied to RCOCB's employing molded-case circuit-breaker as the breaking part.

- (1) Trip at 200 % current The overcurrent release shall operate within the operating time specified in Table 10, when tested in accordance with 8.14.2.
- (2) Trip at 125 % current The overcurrent release shall operate within the operating time specified in Table 10, when tested in accordance with 8.14.3.
- (3) Carrying 100 % current The overcurrent release shall not operate when tested in accordance with 8.14.4.

Table 10. Operating time of overcurrent release

Rated current( $I_n$ ) A	Operating time min	
	200 % of rated current	125 % of rated current
$I_n \leq 30$	Within 2	Within 60
$30 < I_n \leq 50$	Within 4	
$50 < I_n \leq 100$	Within 6	Within 120
$100 < I_n \leq 225$	Within 8	
$225 < I_n \leq 400$	Within 10	
$400 < I_n \leq 600$	Within 12	
$600 < I_n \leq 800$	Within 14	
$800 < I_n \leq 1000$	Within 16	
$1000 < I_n \leq 1200$	Within 18	
$1200 < I_n \leq 1600$	Within 20	
$1600 < I_n \leq 2000$	Within 22	
$2000 < I_n$	Within 24	



6.13 Instantaneous trip When the RCOCB employing molded-case circuit-breaker of rated current exceeding 100 A as the breaking part is tested in accordance with 8.15, it shall not operate at carrying current of the lower limit value guaranteed by the manufacturer.

It shall operate at an opening time (instantaneous trip time) not exceeding 0.1 s at carrying current of the upper limit value.

6.14 Actuation characteristics of overload protective device The RCOCB which provides overload protective function and is employing an a.c. electromagnetic switch as the breaking part shall comply with the performances shown in 5.6 (actuation characteristics of overload protecting device) of JIS C 8325.

6.15 Making and breaking of overload current When the test is carried out as specified in 8.16, the specimen shall be free from remarkable damage, burning and welding of contacts, and other electrical and mechanical troubles.

6.16 Inrush current The RCOCB of rated voltage 100 V or 100/200 V, and rated current not exceeding 50 A providing overcurrent protective function shall not open automatically and shall not show welding of the contacts when tested in accordance with 8.17.

6.17 Temperature rise When the test is carried out as specified in 8.18, the temperature rise at each part of the RCOCB shall not exceed the appropriate value given in Table 11, the temperature rise of insulation of main circuit current coil shall not exceed the appropriate value by thermoelectric thermometer method given in Table 12, and the temperature rise of insulation of undervoltage trip coil shall not exceed the appropriate value by resistance method given in Table 12.

Table 11. Temperature rise limit of each part of RCOCB

Unit: °C

Position and structural material		Temperature rise limit (thermo-electric thermometer method)
Contacts	Silver, silver plating <sup>(6)</sup> and silver alloys	- <sup>(7)</sup>
	Others	40
Joint <sup>(8)</sup>	Silver, silver plating and silver alloys	- <sup>(7)</sup>
	Between tin, solder or nickel plated parts one to another	60 <sup>(9)</sup>
	Others	40
Insulation	Synthetic resin products	- <sup>(10)</sup>
Terminals		60 <sup>(11)</sup>
Blade and blade receptacle of RCOCB of plug-in type		30
Filling compound		- <sup>(12)</sup>
Manually operated parts	Insulating material	35 <sup>(13)</sup>

- Notes (6) This is applicable to main contacts of RCOCB having arcing contacts.
- (7) This shall be the temperature rise not detrimental to the contacts, supporting conductor thereof or the insulating material adjacent to the joint. However, the temperature rise limit of RCOCB's of rated voltage not exceeding 300 V and rated current not exceeding 100 A shall be 100°C.
- (8) This means the intermediate joint to the terminal of RCOCB of front type, rear type, flush type and plug-in type and does not include the joint inside the RCOCB.
- (9) This is applicable for the joint clamped by screw only.
- (10) This shall be the temperature rise not detrimental to each synthetic resin.
- (11) The temperature rise limit shall be 65°C when the test is carried out with a copper bar connected.
- (12) This shall not flow out at temperatures not exceeding 75°C.
- (13) The measurement point of the temperature rise of manually operated part shall be almost the center of the part projecting from the enclosure surface.

Remarks: The limit of reference ambient temperature is 40°C.

Table 12. Temperature rise limit of coil insulation

Unit: °C

Classification		Temperature rise limit	
		Thermoelectric thermometer method	Resistance method
Class of coil insulation	Class Y insulation	50	70
	Class A insulation	65	85
	Class E insulation	80	100
	Class B insulation	90	110
	Class F insulation	115	135
	Class H insulation	140	160
Single-layer winding of enameled wire		90	-
Double-layer winding of enameled wire		80	-

Remarks: The limit of reference ambient temperature is 40°C.

6.18 Mechanical and electrical endurance (to switching) The specimen shall be free from electrical and mechanical troubles when subjected to the test of 8.19.

6.19 Insulation resistance When the test is carried out as specified in 8.20, the insulation resistance of each part shall be not less than 5 M $\Omega$ . However, in the case of 8.20 (2)(a), the above value is not applicable.

6.20 Dielectric withstand voltage When the test is carried out as specified in 8.21, each part shall withstand the test voltage for the prescribed time.

6.21 Short-circuit current breaking The RCOCB employing molded-case circuit-breaker as the breaking part shall satisfy the items (1) to (4) given below when tested in accordance with 8.22 (1) to (6), and it shall also satisfy the items (5) to (9) when checked in accordance with 8.22 (7) after the above test.

- (1) No trouble shall appear electrically or mechanically.
- (2) The specimen shall not damage the insulating covering of the connecting wires ( $W_1$  and  $W_2$  shown in Fig. 4).
- (3) The inspection fuse shall not cause fusion.
- (4) The RCOCB of rated voltage not exceeding 300 V and rated current not exceeding 100 A shall not ignite the shirting.
- (5) The insulation resistance of each part shall be not less than 0.5 M $\Omega$ . However, in the case of 8.20 (2)(a), this value is not applicable.
- (6) Each part shall withstand the test voltage for 1 min.
- (7) The overcurrent tripping action shall be performed within the operating time by 200 % of the rated current given in Table 10.
- (8) The specimen shall be capable of making and breaking the rated current under the rated voltage without any practical trouble.
- (9) The specimen shall satisfy the residual current specified in 6.3.1.
- (10) The specimen with protection for neutral line failure in single-phase three-wire system shall satisfy the tripping performance at operating overvoltage specified in 6.8.1.

6.22 Short-time current The RCOCB without overcurrent release shall not cause trouble electrically or mechanically when tested in accordance with 8.23.

It shall also satisfy the residual operating current specified in 6.3.1 after the above test.

6.23 Protection of cord When the RCOCB of rated current not exceeding 30 A ensuring protection of cord is tested at the cord protective current guaranteed by the manufacturer in accordance with 8.24, the insulating covering of cord shall not melt and the conductor of cord shall not break by melting.

6.24 Robustness of enclosure of insulating material When the enclosure of thermoplastic insulating material which supports the live part of RCOCB of rated current not exceeding 125 A is tested in accordance with 8.25, the diameter of dent caused by the steel ball shall not exceed 2 mm.

6.25 Resistance to ammonia gas When the test is carried out as specified in 8.26, no damage nor crack shall appear on the terminal screws or other brass components.

6.26 Resistance to corrosion When the test is carried out as specified in 8.27, the components of iron and steel used for the mechanism of a RCOCB shall not produce corrosion on the surface. However, corrosion at sharp edge and yellowish film which can be removed by rabbing are not considered as generation of corrosion.

The metal coated steel sheet component used for the parts other than the mechanism which is so concluded that generation of some rust on its cut face by press will not influence its function under normal service conditions is excluded.

6.27 Resistance to damp heat When the test is carried out as specified in 8.28, the requirements stated in 6.3.1, 6.19, 6.20, 6.12 (1) and 6.8.1 shall be satisfied.

6.28 Vibration When the test is carried out as specified in 8.29, the specimen shall show no abnormality at each part and shall not operate during the voltage application test.

After this test, the requirements stated in 6.3.1, 6.8.1 and 6.12 (1) shall be satisfied.

6.29 Impact acceleration When the test is carried out as specified in 8.30, the specimen shall show no abnormality at each part and shall not operate in the test with the test current being passed.

After this test, the requirements stated in 6.3.1, 6.8.1 and 6.12 (1) shall be satisfied.

6.30 Robustness against free fall When the RCOCB of plug-in type (portable type only) is tested in accordance with 8.31, no dangerous damage detrimental to service shall be found.

After this test, the requirements stated in 6.3.1, 6.19 and 6.20 shall be satisfied.

Remarks: Damages such as bending of blade and cracking of enclosure are not treated as the dangerous damage detrimental to service referred to here.

6.31 Retention force This requirement applies to the blade receiver of RCOCB of plug-in type. When the test is carried out as specified in 8.32, the specimen shall comply with the performances shown in 4.1 (retaining force) of JIS C 8303.

6.32 Make and break by plug and receptacle This item applies to the blade receiver of RCOCB of plug-in type. When the test is carried out as specified in 8.33, the specimen shall comply with the performances shown in 4.4 (make and break) of JIS C 8303.

6.33 Strength of blade mount This item applies to the blade mount of RCOCB of plug-in type. When the test is carried out as specified in 8.34, the specimen shall comply with the performances shown in 4.9 (strength of blade fixing part) of JIS C 8303.

6.34 Strength of cord anchorage The RCOCB of plug-in type equipped with cord shall comply with the performances shown in 4.11 (strength of cord anchorage) of JIS C 8303, when tested in accordance with 8.35.

6.35 Strength of cord outlet The RCOCB of plug-in type equipped with cord shall comply with the performances shown in 4.12 (strength of cord outlet) of JIS C 8303, when tested in accordance with 8.36.

6.36 Strength of lead wire for overvoltage detection When the RCOCB with protection for neutral line failure in single-phase three-wire system is tested in accordance with 8.37, there shall be no slipping at the joint of power supply wire and internal terminal and no abnormality shall be found.

6.37 Breaking of heavy earth-fault current When the test is carried out as specified in 8.38, the specimen shall not produce remarkable damage or welding of contacts or other electrical and mechanical trouble.

After this test, the specimen shall satisfy the requirement 6.3.1 and the RCOCB with protection for neutral line failure in single-phase three-wire system shall satisfy 6.8.1.

6.38 Lightning impulse withstand voltage When the test is carried out as specified in 8.39, no trouble shall be observed at any part.

6.39 Non-actuation by lightning impulse The specimen shall not operate when tested in accordance with 8.39 and 8.40. However, this performance is not applied to RCOCB with a rated residual operating current not exceeding 10 mA and such marking that the apparatus has no performance of non-actuation by lightning impulse.

6.40 Aging of electronic components When the test is carried out as specified in 8.41, the specimen shall satisfy the requirements stated in 6.3.1, 6.8.1 and 6.12 (1).

6.41 Cyclic heating of main circuit wire connecting terminal When the test is carried out as specified in 8.42, the temperature rise at 150th cycle shall not exceed the temperature rise at 25th cycle plus 8°C.

The temperature rise of terminals when the rated current is passed after completion of 150th cycle shall not exceed the appropriate value of Table 11.

6.42 Non-actuation by radiated electromagnetic wave The specimen shall not operate when tested in accordance with 8.43.

6.43 Tripping under superposition of higher harmonic current When the test is carried out as specified in 8.44, the value of residual current shall exceed the value of rated residual non-operating current but shall not exceed the rated residual operating current.

6.44 Tripping under superposition of high frequency current When the test is carried out as specified in 8.45, the value of residual current shall exceed the value of rated residual non-operating current but shall not exceed the rated residual operating current.

## 7. Construction

7.1 Construction in general RCOCB's shall be robustly constructed from materials of good quality and less secular change, shall ensure that smooth and safe operation, perfect electrical contact and easy connection with wires, and shall comply with the following requirements:

- (1) Electronic components used in electronic circuits shall be those of high reliability such as those for communication industry.
- (2) RCOCB's shall not cause any abnormality in their function during normal service and endurance test, and shall not generate excess noise or radio waves which interfere other waves.
- (3) The enclosure, cover of terminal part, and manually operated part of a RCOCB shall be of insulating materials. However, those parts which are not likely to be accessed by human hand are exempted from the above requirement.
- (4) In a plug-in type RCOCB, the blade shall comply with 5. (construction, dimension and material) of JIS C 8303 and the receptacle shall be capable of receiving the plugs conforming to 5. of JIS C 8303 without any difficulty.
- (5) Iron or steel (excluding stainless steel) shall be treated rust proof by plating, painting, oil quenching or other appropriate means. Such materials used for the part where rust is not likely to cause danger need not fulfill the above requirement.
- (6) Electrical insulations shall be capable of withstanding the temperature of the parts in contact with or adjacent to them, shall be less hygroscopic, and their part which is likely to be reached by arc shall be arc resistant.
- (7) The trip mechanism or the like shall be so constructed that no dust is likely to enter.
- (8) Plug-in type RCOCB's shall be so constructed that they can be surely fixed by the aid of attachment when they are mounted on a structure or in a switch box.
- (9) In a RCOCB in which earth fault detecting device, tripping device, switching mechanism, etc. are used in combination, terminal marks for connecting such components shall be marked.

- (10) When the terminals for earth side pole and neutral pole are limited, such a fact shall be indelibly marked. In this case the neutral line terminal shall be marked with "N" or "For neutral line", but may be "W" for plug-in type ones. In the RCOCB for single-phase three-wire system the central terminal shall be the neutral line terminal.
- (11) The power supply side and load side shall be identified. If there is no trouble when either of power supply or load is connected to the terminal such a case is an exception.
- (12) The live part shall not be touched by the test finger shown in Attached Fig. 1 under normal service conditions. The force applied to the test finger shall be 30 N{3.1 kgf}.

The live part which is exposed during service such as the terminal is excluded.

**7.2 Current carrying part** The current carrying parts of RCOCB's shall comply with the following requirements:

- (1) The materials for current carrying parts shall be copper, copper alloys, stainless steel, iron which is so plated that it will be accepted by the test specified in 8.27 or materials having electrical, thermal and mechanical stabilities at least equivalent thereto.
- (2) Each joint shall withstand the mechanical stress caused electrically and mechanically under normal service state.

**7.3 Operating mechanism** The operating mechanism of a RCOCB shall comply with the following requirements:

- (1) In a multi-pole RCOCB, each pole shall be opened and closed simultaneously. However, RCOCB of three-phase four-wire system in which the neutral pole is closed earlier than other poles and opened later than other poles is an exception.
- (2) The RCOCB shall be trip free and shall be so sealed that incorrect setting of tripping mechanism and interference to automatic tripping are impossible.
- (3) The overcurrent adjustable type apparatus shall satisfy the tripping characteristic specified in Table 10.
- (4) The rated current adjustable type apparatus shall comply with the following requirements:
  - (a) The apparatus shall satisfy the tripping characteristic shown in Table 10 in correlation with the marked rated current.
  - (b) The apparatus shall not be capable of being set to intermediate positions other than marked positions of rated current.

- (c) The apparatus shall be so constructed that the readjustment of rated current setting by the user is impossible after the applicable rated current setting has been done, or such means as sealing to prevent the readjustment shall be employed.
- (5) RCOCB's employing a.c. electromagnetic switch as the breaking part shall comply with JIS C 8325.
- (6) Sealing shall be performed so as to prevent the incorrect setting of residual operating current or the interruption of trip operation. Any sealing shall be clearly verified when the seal has been broken or replaced. However, for the RCOCB with sensibility adjusting mechanism, such mechanism that the rated residual operating currents nominated by the manufacturer can be changed over by the user is allowed. Even in this case, the mechanism shall be so designed that the changeover from the high sensitivity type to other type can not be performed.
- (7) A test button of automatic reset type shall be provided to verify the sure operation of trip mechanism caused by residual current. In this test system, the test current shall not exceed 2.5 times the rated residual operating current at rated voltage. When a RCOCB provides not less than 2 rated voltages or sensitivity changeover, the test current shall not exceed 2.5 times the largest rated residual operating current at the lowest rated voltage.
- The test button shall not be damaged when a pressing force of 100 N{10.2 kgf} is applied for 1 min.
- (8) The test button shall bear an indication of its purpose ("T" when abbreviation is used), and the color of test button shall be green for the RCOCB provided with residual current protection only, or red for the RCOCB provided with additional integral overload protection.
- When a residual current indicator is provided, the color of indicator shall be yellow or white.
- The above colors shall not be used for knobs, or other parts operated by a man.
- (9) The screws or nuts mounted on operating parts shall be equipped with locking means so as not to become loose by vibration.
- (10) For distribution boards mainly used in household, the closing operation of residual current tripping mechanism of a RCOCB with a rated current not exceeding 60 A and a rated breaking capacity not exceeding 5000 A (at 100/200 V) shall be made simply by a single operation. If the closing operation can not be done by a single operation due to unavoidable reason, the operating procedure shall be marked.
- (11) The RCOCB with protection for neutral line failure in single-phase three-wire system shall not operate at an instantaneous overvoltage.



7.4 Indication of open state and closed state In a RCOCB, open and closed states shall be clearly indicated by using "OFF·ON" or "○·|".

7.5 Terminals Terminals shall be so constructed that the necessary contact pressure at connection of wires or bars is continuously maintained, and the terminals in main circuit shall comply with the following requirements:

- (1) The terminal shall be so constructed that the screws do not work loose. When the screw penetrates metal part, the number of engaging threads shall be at least two for screws of nominal diameter less than 8 mm, and the engaging length shall be at least 40 % of the nominal diameter for screws of nominal diameter not less than 8 mm. For terminal screws of nominal diameter not less than 8 mm, if a part of internal threads of the terminal frame is partially threaded, the length of effectively engaged full thread shall be at least 25 % of the nominal diameter and the sum of full thread length and partial thread length shall be at least 55 % of the nominal diameter under service state.

The length of engagement, if the screw does not penetrate, shall be at least the major diameter of external thread.

- (2) Terminals which require copper terminal to be soldered or bending of wire end into ring form at the time of connecting wire shall not be used. For RCOCB's of a rated current not exceeding 20 A which are so constructed that the wire is surely positioned under the washer by means of a conical spring washer or that a large fillister head machine screw is used and come out of wire is prevented by bending a part of terminal plate, the bending of wire end into ring form is allowed.
- (3) The terminal shall be so constructed that it can surely clamp the wire or copper bar specified in Table 13 and the terminal screw has at least the nominal diameter shown in the said table.

The terminal which exclusively serves for connection of crimp-type terminals or copper bars shall be clamped in accordance with the method specified by the manufacturer.

Table 13. Nominal diameter of terminal screw and connectable wires  
Unit: mm<sup>2</sup>

Rated current $I_n$ (A)	Nominal diameter of terminal screw (mm)		Range of sizes of 600 V p.v.c. insulated wire
	Fixed with one screw	Fixed with two screws	
$I_n \leq 15$	3.5	3 <sup>(14)</sup> or 3.5	ø1.6 to ø2.6 mm or 2.0 to 5.5
15 < $I_n \leq 20$	4	3.5	ø1.6 to ø2.6 mm or 2.0 to 5.5
20 < $I_n \leq 30$	4.5	4	ø2.0 to ø3.2 mm or 3.5 to 8
30 < $I_n \leq 40$	6 or 5 <sup>(15)</sup>	5	5.5 to 14
40 < $I_n \leq 50$	6 or 5 <sup>(15)</sup>	5	8 to 22
50 < $I_n \leq 60$	6	5	8 to 22
60 < $I_n \leq 75$	8 or 6 <sup>(15)</sup>	6	14 to 38
75 < $I_n \leq 100$	8	6	22 to 60
100 < $I_n \leq 125$	8	6	38 to 60
125 < $I_n \leq 150$	8	6	38 to 60
150 < $I_n \leq 175$	8	6	60 to 100
175 < $I_n \leq 200$	8	6	60 to 100
200 < $I_n \leq 225$	8	6	100 to 150
225 < $I_n \leq 250$	8	6	100 to 150 <sup>(16)</sup>
250 < $I_n \leq 300$	8	6	100 to 200 <sup>(16)</sup>
300 < $I_n \leq 350$	10	8	150 to 250 <sup>(16)</sup>
350 < $I_n \leq 400$	10	8	2 x (60 to 100) <sup>(16)</sup>
400 < $I_n \leq 500$	12	10	2 x (100 to 150) <sup>(16)</sup>
500 < $I_n \leq 600$	12	10	2 x (100 to 200) <sup>(16)</sup>
700 $\leq I_n$	-		-( <sup>17</sup> )

Notes (<sup>14</sup>) This is applicable for terminals which are connected with cords or which are built into a machinery and apparatus.

(<sup>15</sup>) This is applicable for terminals which are employing large fillister head machine screws (including the equivalent), which are equipped with saddle plate and which are intended for connection with crimp-type terminals and copper bars.

- (<sup>16</sup>) The terminal may be so constructed that it is capable of connecting the copper bar having a cross-sectional area almost equal to that of the appropriate 600 V p.v.c. insulated wire.
- (<sup>17</sup>) This means that the terminal shall be capable of connecting a copper bar of a current density 1 A/mm<sup>2</sup> to 2 A/mm<sup>2</sup>.
- (4) The screwless terminal shall comply with 4.11 (screwless terminal) of JIS C 8304.
- (5) The terminal screw shall not also serve as a mounting means of the component. If the component does not work loose at attaching and detaching the wire, such a case is an exception.
- (6) For RCOCB of rated current not exceeding 100 A, excluding those of plug-in type, a hole of 4 mm diameter shall be provided on the cover of terminal part for measurement of the insulation resistance. As for the distance between the above hole and the terminal part, the creepage distance shall be 6 mm or more and the clearance shall be 4 mm or more.
- (7) When studs of rear connection are used, the size of current carrying part shall, as a rule, have the appropriate value shown in Table 14 or over.

Table 14. Nominal diameter of stud thread  
Unit: mm

Rated current $I_n$ (A)	Nominal diameter of stud thread( <sup>18</sup> )
$I_n \leq 30$	5
$30 < I_n \leq 60$	6
$60 < I_n \leq 100$	8
$100 < I_n \leq 1200$	—( <sup>17</sup> )

Note (<sup>18</sup>) In the case of a bar stud or thread less round stud, the stud shall have a cross-sectional area which results in a current density not exceeding 2 A/mm<sup>2</sup>.

**7.6 Insulation distances** The insulation distances of RCOCB's with a rated voltage not exceeding 300 V and a rated current not exceeding 100 A shall show the respective values shown in Table 15 or over, when measured in accordance with 3. (3) of JIS C 8306.

Table 15. Insulation distances

Unit: mm

Part		Clearance		Creepage distance	
		$I_n < 15 \text{ A}$	$15 \text{ A} \leq I_n \leq 100 \text{ A}$	$I_n < 15 \text{ A}$	$15 \text{ A} \leq I_n \leq 100 \text{ A}$
Between live parts of different polarity	Terminal part	3	4	3	6
	Fixed part other than terminal part where adhesion of metal powder is difficult	1.5	4	1.5	6
	Other parts	3	4	3	6
Between live parts and dead metallic parts liable to be earthed or surface of accessible non-metallic parts	Terminal part	3	4	3	6
	Fixed part other than terminal part where adhesion of metal powder is difficult	1.5	4	1.5	6
	Other parts	3	4	3	6

- Remarks 1. The clearance means the distance measured while a force of 30 N {3.1 kgf} is applied on the outer surface of apparatus and a force of 2 N {0.2 kgf} is applied in the inside to minimize the distance.
2. In a RCOCB to be mounted on the structure (including distribution boards) which has a gap not exceeding 0.3 mm at its butt joint of enclosure, excluding the mounting surface, the insulation distance between live parts and surface of accessible non-metallic parts may be made 1.5 mm or more.
3. In a RCOCB with a rated current not less than 15 A and of such construction that the cover or enclosure can not be opened by the user, the creepage distance may be made 4 mm or more at the portions other than the terminal part.
4. For the clearance and creepage distance between live parts of different polarity (excluding those between the main circuit and the circuit stated below) in the electronic circuit, control circuit, auxiliary circuit and exciting coil (excluding the overcurrent trip coil) of a RCOCB whose rated current  $I_n$  shows  $15 \text{ A} \leq I_n \leq 100 \text{ A}$ , the column of  $I_n 15 \text{ A}$  shall apply.

7.7 Structure and marking of overvoltage detecting lead wire The structure and marking of overvoltage detecting lead wire in a RCOCB with protection for neutral line failure in single-phase three-wire system shall comply with the following requirements:

- (1) The color of overvoltage detecting lead wire shall be white, and the cross-sectional area of the conductor shall be not less than  $0.5 \text{ mm}^2$ .
- (2) The mark "N" shall be marked on an easily visible place near the outlet of overvoltage detecting lead wire.

7.8 Dimensions The external dimensions and mounting dimensions of RCOCB's of interchangeable type shall be as shown in Attached Fig. 2.

## 8. Test methods

8.1 Test conditions Unless otherwise specified for investigation of performances, the tests shall be carried out under the standard test conditions stated below.

For a RCOCB in which the rated current, and/or instantaneous tripping time or operating time at overcurrent are adjustable, the test shall be carried out at the maximum currents or the maximum overcurrent operating on the items not especially specified.

The tightening torques of terminal screws of the RCOCB shall be as specified in Table 16 and the wires to be connected to the RCOCB shall be as specified in Table 17.

- |                                   |   |
|-----------------------------------|---|
| (1) Ambient temperature           | $5^{\circ}\text{C}$ to $35^{\circ}\text{C}$ |
| (2) Relative humidity             | 45 % to 85 %                                |
| (3) External magnetic field       | 80 A/m max. (at rated frequency)            |
| (4) Mounting angle                | Correct position $\pm 5^{\circ}\text{C}$    |
| (5) Frequency                     | Rated frequency $\pm 2 \%$                  |
| (6) Distortion factor of waveform | Within 5 %                                  |

Table 16. Tightening torque relating with nominal diameter of screw  
Unit: N·m{kgf·m}

Nominal diameter of screw (mm)	Tightening torque	
	I <sup>(19)</sup>	II <sup>(20)</sup>
3	0.5{0.051}	—
3.5	0.8{0.082}	—
4	1.2{0.122}	—
4.5	1.8{0.184}	—
5	2.0{0.204}	2.0{0.204}
6	2.5{0.255}	3.0{0.306}
8	3.5{0.357}	6.0{0.612}
10	—	10.0{1.02 }
12	—	14.0{1.43 }

Notes <sup>(19)</sup> This is applicable to screws tightened with a driver or the like.

<sup>(20)</sup> This is applicable to screws tightened by means other than drivers.

Table 17. Kind and size of connecting wires

Unit: mm<sup>2</sup>

Rated current (A)	Size of 600 V p.v.c. insulated wire	Rated current (A)	Size of 600 V p.v.c. insulated wire
$I_n \leq 15$	$\phi$ 1.6 mm	$400 < I_n \leq 500$	$2 \times 150^{(21)}$
$15 < I_n \leq 20$	$\phi$ 2 mm	$500 < I_n \leq 600$	$2 \times 200^{(21)}$
$20 < I_n \leq 30$	5.5	$600 < I_n \leq 1\,600$	Carry out the test with copper bars at a current density from 1.5 A/mm <sup>2</sup> to 1.8 A/mm <sup>2</sup> ( <sup>22</sup> )( <sup>23</sup> ) connected.
$30 < I_n \leq 40$	8		
$40 < I_n \leq 50$	14		
$50 < I_n \leq 60$	14		
$60 < I_n \leq 75$	22		
$75 < I_n \leq 100$	38		
$100 < I_n \leq 125$	60	$1\,600 < I_n \leq 2\,500$	Carry out the test with copper bars at a current density from 1.0 A/mm <sup>2</sup> to 1.3 A/mm <sup>2</sup> ( <sup>22</sup> )( <sup>23</sup> ) connected.
$125 < I_n \leq 150$	60		
$150 < I_n \leq 175$	100		
$175 < I_n \leq 200$	100		
$200 < I_n \leq 225$	150		
$225 < I_n \leq 250$	150		
$250 < I_n \leq 300$	200	—	—
$300 < I_n \leq 350$	250	—	
$350 < I_n \leq 400$	$2 \times 100$	—	

Notes <sup>(21)</sup> The test may be made with copper bars at a current density from 1.5 A/mm<sup>2</sup> to 1.8 A/mm<sup>2</sup> connected.

<sup>(22)</sup> When two copper bars are connected to a terminal of RCOCB, the two bars shall be connected with the terminal placed between the bars.

<sup>(23)</sup> The cross-sectional area, surface conditions and condition of joint of connecting copper bars used in the tests of 8.14 and 8.18 shall be clearly stated in the test report.

8.2 Construction test In the construction test, examine the matters specified in 7., 11. and 12.

### 8.3 Operating property test

8.3.1 Manual operating property test In the manual operating property test, carry out opening and closing manually and examine the actuating states.

8.3.2 Electrical operating property test Carry out the electrical operating property test on RCOCB's with electrical operating device as stated below.

In the case of a.c., carry out the test at the rated frequency.

- (1) Closing operation property test Carry out the closing operation property test on RCOCB's with electrical closing operation device, at 85 %, 100 % and 110 % of the rated voltage of operating circuit.
- (2) Opening operation property test Carry out the opening operation property test on RCOCB's with electrical opening operation device, at 85 %, 100 % and 110 % of the rated voltage of operating circuit.
- (3) Voltage trip test Carry out the voltage trip test on RCOCB's with voltage release at 85 %, 100 % and 110 % of the rated voltage of operating circuit in the case of a.c., and at 75 %, 100 % and 125 % of the rated voltage of operating circuit in the case of d.c.
- (4) Undervoltage trip test Carry out the undervoltage test on RCOCB's with undervoltage release in the following sequence:
  - (a) Carry out the closing operation at 85 % of the rated voltage of operating circuit.
  - (b) Reduce the test voltage to 71 % of the rated voltage of operating circuit.
  - (c) Reduce the test voltage until the undervoltage release operates. In this procedure, reduce the test voltage down to 20 % of the rated voltage of operating circuit at the maximum.

- (d) Carry out the closing operation at 20 % of the rated voltage of operating circuit.
- (e) Close the specimen at 110 % of the rated voltage of operating circuit and then remove the voltage.

### 8.3.3 Trip free test

- (1) Carry out such a test three times that the RCOCB is closed, the operating handle is held at closed position and a current of  $1.5 I_{\Delta n}$  is passed through one pole under the said state.
- (2) Carry out such a test three times that the testing circuit is so set up that a current of  $1.5 I_{\Delta n}$  flows through one pole when the RCOCB is closed, and the closing operation is carried out by moving the handle of the RCOCB from its open position gradually by spending a time not less than about 1 s.

8.4 Terminal robustness test In the terminal robustness test, carry out connection of the wires specified in JIS C 3307 or copper bars having the smallest and largest cross-sectional areas of conductor shown in Table 13, by tightening them using a tool suitable for the terminal, as stated below.

- (1) Carry out the tightening at a torque equal to 2/3 of the appropriate tightening torque given in Table 16.

Apply the tensile force specified in Table 18 to each conductor. Apply the tensile force in the axial direction of the conductor statically for 1 min.

- (2) Tighten the terminal screw at the torque specified in Table 16. After the above procedures, loosen the terminal and carry out visual check.

Table 18. Tensile force to be applied to conductor

Unit: N{kgf}

Nominal diameter of terminal screw (mm)	Tensile force
3.5max.	60 { 6.1 }
4	80 { 8.2 }
4.5	85 { 8.7 }
5	90 { 9.2 }
6	100 { 10.2 }
8	120 { 12.2 }
10	140 { 14.3 }
12	160 { 16.3 }



- (3) Carry out the test in accordance with 13.1.1 (3) (twisting test) of JIS C 8306, for RCOCB with directly connected lead wires.

## 8.5 Residual current trip

**8.5.1 Residual operating current test** Pass a current through one pole of the specimen under closed state while the rated voltage is applied to but no load current is passed through the specimen, gradually increase the current and measure the value of residual operating current when the RCOCB operates.

The number of measurements shall be once when the residual operating current is decided by electronic circuit, and 5 times for by other systems.

**8.5.2 Break time (by residual current) test** Measure the operating time when a current of the value specified in Table 19 is suddenly applied to one pole of the specimen under closed state while the rated voltage is applied to but no load current is passed through the specimen.

The number of measurements shall be five.

Table 19. Test conditions for residual current trip

Classification	Test current
High speed type	Rated residual operating current
Time-delay type	Rated residual operating current
Inverse-time type	Rated residual operating current
	Twice rated residual operating current
	Five times rated residual operating current
	500 A

**8.5.3 Limiting non-actuating time test** Apply this test to RCOCB's of time-delay type. Suddenly apply a current of 10 A or 20 times the rated residual operating current whichever is the larger, to one pole of the specimen under closed state while the rated voltage is applied to but no load current is passed through the specimen, and continue this current for the limiting non-actuating time (0.1 s at the minimum).

**8.6 Test for residual operating current at ambient temperature change and power supply voltage fluctuation** Do not pass the load current, adjust the ambient temperature to three points i.e. -10°C, 20°C and 50°C, set the power supply voltage to 80 %, 100 % and 110 % of the rated voltage at each point, and carry out the test similar to 8.5.1 at each of the combined point.

**8.7 Test for non-actuation at ambient temperature change and power supply voltage fluctuation** Do not pass the load current, adjust the ambient temperature to three points i.e. -10°C, 20°C and 50°C, set the power supply voltage to 80 %, 100 % and 110 % of the rated voltage at each point, carry out the tests similar to 8.5.1, obtain the combination of ambient temperature and power supply voltage where the residual operating current becomes the smallest, and suddenly apply the rated residual non-operating current to one pole of the specimen under closed state.

**8.8 Balance test** Connect the resistance load, apply the rated voltage to the specimen under closed state, and pass the test current specified in Table 20 to the main circuit three times each for about 1 s (the operating time for RCOCB of time-delay type with a marked operating time exceeding 1 s) at intervals of about 10 s.

In the test of a four-pole RCOCB, two poles i.e. the neutral pole and each pole are combined as a pair and carry out the test twice on each pair in the single-phase circuit, and then carry out the test on the voltage poles similar to the three-pole one. When the three-pole one is tested in the single-phase circuit, the test may be carried out by combining two poles so that the number of tests on each pole becomes four.

The test may be carried out on RCOCB's having overcurrent protective mechanism, with the overcurrent protective mechanism treated not to operate.

Table 20. Conditions for balance test

Unit: A

Classification	Rated current $I_n$	Test current
Single-phase apparatus	$I_n \leq 600$	$6 \times \text{rated current (150 min.)}$
	$600 < I_n$	$(\text{Rated current} - 600) \times 2 + 3600$
Three-phase apparatus	$I_n \leq 50$	$8 \times \text{rated current (150 min.)}$
	$50 < I_n \leq 600$	$6 \times \text{rated current (400 min.)}$
	$600 < I_n$	$(\text{Rated current} - 600) \times 2 + 3600$

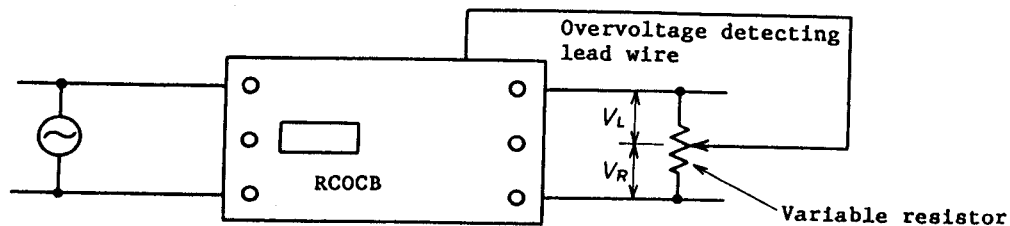
**8.9 Test of test device** Apply 80 % of the rated voltage, do not pass the load current, and operate the specimen by operating the test button repeatedly 25 times at intervals of 5 s in each of the states prescribed below.

- (1) Such state that the earth-fault current is not passed.
- (2) Such state that the rated residual non-operating current is passed through each pole.

#### 8.10 Overvoltage trip test

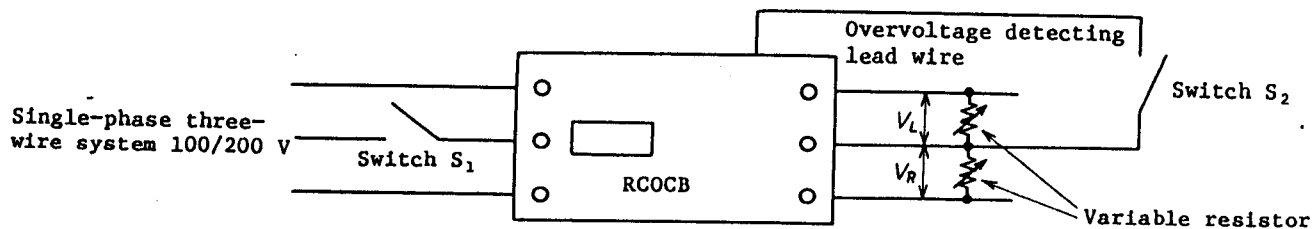
**8.10.1 Operating overvoltage test** In the operating overvoltage test, use the circuit shown in Fig. 1, apply the rated voltage across the supply side terminals of the RCOCB while the contacts of the RCOCB are closed, change  $V_L$  and  $V_R$  by means of the variable resistor and measure the voltage when the RCOCB operates in the above procedures.

Fig. 1. Operating overvoltage test circuit



8.10.2 Test for actuating time at overvoltage In the test for actuating time at overvoltage, use the circuit shown in Fig. 2, set the value of resistor so that the values of  $V_L$  and  $V_R$  become equal to the value of rated operating voltage under such conditions that the rated voltage is applied to the specimen while switch  $S_2$  and switch  $S_1$  are opened. Close switch  $S_1$ , close switch  $S_2$ , then open switch  $S_1$  and measure the time until the instant when the RCOCB operates from the instant of opening switch  $S_1$ .

Fig. 2. Test circuit for actuating time at overvoltage

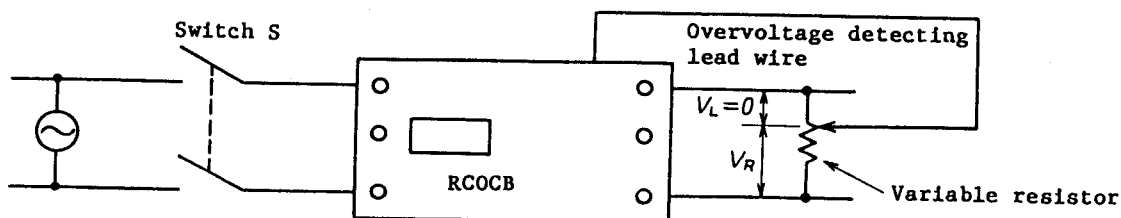


8.11 Test for operating overvoltage at ambient temperature change and power supply voltage fluctuation In the test for operating overvoltage at ambient temperature change and power supply voltage fluctuation, adjust the ambient temperature to three points i.e.  $-10^{\circ}\text{C}$ ,  $20^{\circ}\text{C}$  and  $50^{\circ}\text{C}$ , set the power supply voltage to 80 %, 100 % and 110 % of the rated voltage at each point and carry out the test in accordance with 8.10.1 at each of the combined points.

8.12 Test for non-operating overvoltage at ambient temperature change and power supply voltage fluctuation In the test for non-operating overvoltage at ambient temperature change and power supply voltage fluctuation, obtain the combination of ambient temperature and power supply voltage where the operating overvoltage becomes the smallest in the test of 8.11, and suddenly apply the rated non-operating overvoltage under the conditions obtained above.

8.13 Maximum overvoltage trip test In the maximum overvoltage trip test, use the circuit shown in Fig. 3, and measure the operating time when 1.1 times the rated voltage is applied by means of switch  $S$  to the RCOCB.

Fig. 3. Test circuit for maximum operating overvoltage



#### 8.14 Current passing and long time-delay trip test

**8.14.1 Test conditions** The reference ambient temperature at the tests shall be 25°C or 40°C. When the test is carried out at a temperature other than those specified above carry out the correction of current or time by using the temperature compensation curve ensured by the manufacturer. Set the RCOCB of adjustable rated current type to the largest value, intermediate value and smallest value of rated current setting, connect the wire corresponding to the set value, and then carry out the measurements.

Set the RCOCB of adjustable long time-delay trip time to the largest value, and then carry out the measurements.

**8.14.2 Test for trip at 200 % current** In the test for trip at 200 % current, pass 200 % of the rated current through the RCOCB, and measure the time until the specimen operates automatically. Carry out this test by passing the current through each pole equipped with overcurrent tripping element.

**8.14.3 Test for trip at 125 % current** In the test for trip at 125 % current, pass 125 % of the rated current through the RCOCB, and measure the time until the specimen operates automatically. Carry out this test by passing the current through each pole equipped with overcurrent tripping element at the same time.

**8.14.4 Test for carrying of 100 % current** In the test for carrying 100 % current, continuously pass the rated current through the RCOCB until the temperature rise at each part stabilizes.

This test may be carried out at the same time with the temperature test when carried out at the reference ambient temperature or the specimen does not require the current compensation. For the three-pole RCOCB for single-phase three-wire system, carry out this test by passing the current simultaneously through each pole equipped with overcurrent tripping element.

**8.15 Instantaneous trip test** In the instantaneous trip test, carry out the test by passing currents equal to the lower limit value and upper limit value of the instantaneous tripping current setting guaranteed by the manufacturer through the RCOCB. Verify that no tripping operation is performed by passing a current corresponding to the lower limit value for 0.1 s.

Measure the opening time by passing a current corresponding to the upper limit value. In this procedure pass the test current through each pole by turn. The test current shall not include transient d.c. component.

Carry out the test at the largest setting and smallest setting of current if the instantaneous tripping current is adjustable.

**8.16 Overload making and breaking test** Carry out the overload making and breaking test under the conditions stated below.

- (1) As for the test circuit conditions, operating system, and the number and rate of make/break cycles, carry out the test as specified in Table 21 for RCOCB's without overcurrent release, as specified in Table 22 for RCOCB's with overcurrent release employing molded case circuit breaker as its breaking part, and as specified in 7.8 (making current test) and 7.9 (breaking current test) of JIS C 8325 for RCOCB's with overcurrent release employing electromagnetic switch as the breaking part.
- (2) Carry out the test of two-pole RCOCB by means of a single-phase a.c., with the two poles connected in series. Carry out the test of three-pole RCOCB for three-phase three-wire system by means of a three-phase power supply of three-phase balanced load.
- (3) Carry out the test of three-pole RCOCB for single-phase three-wire system not employing molded case circuit breaker as the breaking part in a single-phase circuit with two poles i.e. the neutral pole and each voltage pole combined as a pair by turn, and then in the circuit for three-wire system with balanced load. Carry out the test of three-pole RCOCB for single-phase three-wire system employing molded case circuit breaker as the breaking part in the circuit of single-phase three-wire system with balanced load.
- (4) Carry out the test of two-pole RCOCB for single-phase two-wire system (for neutral point earthed electric lines) in a single-phase a.c. circuit whose power supply is earthed at the neutral by connecting the specimen in the same way as stated in (2).
- (5) Carry out the test of four-pole RCOCB for three-phase four-wire system not employing molded case circuit breaker as the breaking part in a single-phase circuit with two poles i.e. the neutral pole and each voltage pole combined as a pair by turn, and then in the three-phase circuit for three-phase four-wire system with balanced load.

Carry out the test of four-pole RCOCB for three-phase four-wire system employing molded case circuit breaker as the breaking part in the circuit for three-phase balanced load.

Table 21. Overload making and breaking test conditions for RCOCB without overcurrent release

Test voltage ( <sup>24</sup> )	Test current ( <sup>24</sup> )	Power factor	Supply voltage fluctuation	Classification	Number of make/break cycles ( <sup>25</sup> )		Rest time s
					Between voltage poles or between neutral pole and each voltage pole (single-phase load)	Single-phase three-wire system Three-phase three-wire system Three-phase four-wire system (balanced load)	
1.1 times rated voltage	1.5 times rated current	0.75 to 0.8	5 % max.	Single-phase two-wire system two poles	100	-	10
				Three-phase three-wire system three poles	-	100	
				Single-phase three-wire system three poles	For each pair 50 In total 100	50	
				Three-phase four-wire system four poles	For each pair 30 In total 90	70	

Notes (<sup>24</sup>) The tolerances on test voltage and test current are as follows:

Test voltage:  $\pm 5$  % of the specified voltage

Test current:  $+5_0$  % of the specified current

(<sup>25</sup>) One making and breaking operation is counted as one cycle.

Remarks: The duration of current in one cycle shall be about 1 s.

Table 22. Overload making and breaking test conditions for RCOCB which also serves as molded-case circuit-breaker

Rated current $I_n$ A	Circuit conditions			Operating system and number of make/break cycles <sup>(27)</sup>			Rate of make and break (cycles/hour) ( <sup>(27)</sup> )( <sup>(30)</sup> )
	Test voltage ( <sup>(26)</sup> )	Test current ( <sup>(26)</sup> )	Power factor	Supply voltage fluctuation	Manual making Manual breaking ( <sup>(28)</sup> )	Manual making Automatic breaking <sup>(29)</sup>	Total
$I_n \leq 100$	1.1 times rated voltage ( $U_e$ )	$6 I_n$ (150 A min.)	0.45 to 0.5	15 % max.	35	15	50
$100 < I_n \leq 225$					20	5	25
$225 < I_n \leq 600$		(Rated current (A) - 600 A) $\times$ 2 + 3600 A	30 % max.		25	-	60
$600 < I_n \leq 1200$					10	-	30
$1200 < I_n \leq 2500$					10	-	20

Notes (<sup>(26)</sup>) The tolerances on test voltage and test current are as follows:

Test voltage:  $\pm 5\%$  of the specified voltage

Test current:  $\begin{smallmatrix} +5 \\ 0 \end{smallmatrix} \%$  of the specified current

(<sup>(27)</sup>) One making and breaking operation is counted as one cycle.

The manual making and manual breaking operations may be made by using the electrical operating device.

(<sup>(28)</sup>) The manual breaking may be carried out by means of test button trip, voltage trip, undervoltage trip or overcurrent trip.

(<sup>(29)</sup>) The automatic breaking shall be carried out by means of overcurrent trip.

For RCOCB's exceeding 225 A, all make/break cycles may be performed by manual making and manual breaking.

(<sup>(30)</sup>) If it is impossible to operate at this rate, the rate may be reduced to a rate at which the RCOCB can be reset.

8.17 Inrush current test In the inrush current test, burn incandescent lamps at the room temperature under the following conditions:

- (1) Employ incandescent lamps of 200 W at 100 V as the standard, and the number of lamps shall be such that the lamps under burning state can pass 100 % of the rated current of the RCOCB. If necessary 1 to 2 lamps may be smaller than 200 W.
- (2) The voltage of the test circuit shall be 100 V to 105 V, and the supply capacity shall be such that the voltage drop at the supply terminal of the RCOCB does not exceed 5 % when the current is passed through the RCOCB by employing incandescent lamps as the load.
- (3) In this test, subject the specimen continuously three cycles of such sequence of operations that the circuit is closed for 2 s and then opened for 2 min for cooling.

8.18 Temperature test In the temperature test, connect the wire or copper bar specified in Table 17 of a length not less than 1.5 m to each terminal or between the terminals of the RCOCB of terminal connection type, to each terminal of the RCOCB of plug-in type by using the plug and receptacle complying with JIS C 8303, tighten the terminal with 2/3 of the tightening torque specified in Table 16, apply the rated voltage to the input part of the earth-fault detector and continuously pass the rated current through the main circuit until the temperature of each part stabilizes. Then measure the temperature rise at each part shown in Tables 11 and 12.

Carry out the above test on the RCOCB which has been so treated that the breaker does not perform the residual current trip operation.

8.19 Mechanical and electrical endurance test Carry out the mechanical and electrical endurance test under the following conditions:

- (1) Connect the wire specified in Table 17 to each terminal of the RCOCB of terminal connection type or to each terminal of the RCOCB of plug-in type by using the plug and receptacle complying with JIS C 8303, and then subject the specimen to the switching test under the conditions shown in Table 23.
- (2) For the 1000 cycles in the test without current, apply the voltage only and trip the specimen by the test button.
- (3) For the specimen without operating handle, carry out the tripping by means of the test button in every test.
- (4) For RCOCB's with alarm switch, voltage release or undervoltage release, trip the specimen by the voltage release or undervoltage release in the switching test with current for the cycles equal to 10 % of the total switching cycles shown in Table 23.



- (5) Carry out the test on the specimen with auxiliary switch or electrical operating device with such accessory attached. Carry out the switching by means of the electrical operation at rated voltage of operating circuit for the specimen with electrical operating device. If the operating motor or solenoid has a short-time rating, the rate of switching may be reduced to the extent at which the said device is endurable.
- (6) For the specimen with auxiliary switch and/or alarm switch, apply the highest rated voltage of such switch and let the switch make and break the rated current at the said voltage, during the endurance test to switching with current stated in (4) or (5) above.
- (7) The allowable limits of the test voltage and the test current in the test with current shall be as follows:
  - (a) The test voltage shall be 1.1 times the rated voltage  $\pm 5\%$ .
  - (b) The test current shall be the rated current  $^{+5}_{0}\%$ .

Table 23. Mechanical and electrical endurance test conditions

Test voltage	Test current	Power factor	Supply voltage fluctuation	Rated current $I_n$ A	Classification	Rate of switching cycles/minute ( <sup>31</sup> )	Number of switching cycles		
							With current		Without current
							Between voltage poles or between neutral pole and each voltage pole (single-phase load)	Single-phase three-wire system Three-phase three-wire system Three-phase four-wire system (balanced load)	
1.1 times rated voltage	Rated current	0.75 to 0.85	5 % max.	$I_n \leq 100$	Single-phase two-wire system	6	6000 (2000)	-	4000 (2000)
					Three-phase three-wire system Three poles	6	-	6000	4000
					Single-phase three-wire system Three poles	6	For each pair 2000 (1000) In total 4000 (2000)	4000 (1000)	2000 (1000)
									10000 (4000)

Table 23. (Continued)

Test voltage	Test current	Power factor	Supply voltage fluctuation	Rated current $I_n$ A	Classification	Rate of switching cycles/minute ( <sup>31</sup> )	Number of switching cycles			
							With current		Without current	Total
							Between voltage poles or between neutral pole and each voltage pole (single-phase load)	Single-phase three-wire system Three-phase three-wire system Three-phase four-wire system (balanced load)		
1.1 times rated voltage	Rated current to 0.85	0.75 to 0.85	5 % max.	$100 < I_n \leq 225$	Single-phase two-wire system	5	4000	-	4000	8000
					Three-phase three-wire system Three poles	5	-	4000	4000	8000
					Single-phase three-wire system Three poles	5	For each pair 1500 In total 3000	2500	2500	8000

Table 23. (Continued)

Test voltage	Test current	Power factor	Supply voltage fluctuation	Rated current $I_n$ A	Classification	Rate of switching cycles/minute ( <sup>31</sup> )	Number of switching cycles			
							With current		Without current	Total
							Between voltage poles or between neutral pole and each voltage pole (single-phase load)	Single-phase three-wire system Three-phase three-wire system Three-phase four-wire system (balanced load)		
1.1 times rated voltage	Rated current	0.75 to 0.85	5 % max.	$225 < I_n \leq 600$	Single-phase two-wire system	4	1000	-	5000	6000
					Three-phase three-wire system Three poles	4	-	1000	5000	6000
					Single-phase three-wire system Three poles	4	For each pair 500 In total 1000	500	4500	6000

Table 23. (Continued)

Test voltage	Test current	Power factor	Supply voltage fluctuation	Rated current $I_n$ A	Classification	Rate of switching cycles/minute <sup>(31)</sup>	Number of switching cycles		
							With current	Without current	Total
1.1 times rated voltage	Rated current	0.75 to 0.85	5 % max.	600 < $I_n \leq 800$	Single-phase two-wire system	2	Between voltage poles or between neutral pole and each voltage pole (single-phase load)	Single-phase three-wire system Three-phase three-wire system Three-phase four-wire system (balanced load)	4000
					Three-phase three-wire system Three poles	2	-	500	
					Three-phase three-wire system Three poles	1	-	500	
				800 < $I_n \leq 1000$	Three-phase three-wire system Three poles				3000

Table 23. (Continued)

Test voltage	Test current	Power factor	Supply voltage fluctuation	Rated current $I_n$ A	Classification	Rate of switching cycles/minute <sup>(31)</sup>	Number of switching cycles		
							With current		Without current
							Between voltage poles or between neutral pole and each voltage pole (single-phase load)	Single-phase three-wire system Three-phase three-wire system Three-phase four-wire system (balanced load)	
1.1 times rated voltage	Rated current	0.75 to 0.85	5 % max.	$1000 < I_n$	Three-phase three-wire system Three poles	1	-	500	2000
									2500

Note (<sup>31</sup>) One opening and closing operation is counted as one cycle. The rate of switching may be increased subject to agreement between the purchaser and supplier to shorten the duration of test.  
Maintain the closed state for 1.5 s to 2.0 s.

Remarks: The numerical values in parentheses are applicable for RCOCB's exclusively for earth-fault protection for household and similar uses. In the test without current, the first 1000 cycles are operated manually, the next 500 cycles are performed by the test button with the rated voltage applied, and the further 500 cycles are performed by passing the rated residual current.

The manually operated 1000 cycles in the test without current of three-pole RCOCB for single-phase three-wire system are omitted.

**8.20 Insulation resistance test** In the insulation resistance test, measure the insulation resistance of each part of the RCOCB stated below with a 500 V insulation resistance tester. Carry out the test of RCOCB with protection for neutral line failure in single-phase three-wire system with the overvoltage detecting lead wire connected to the neutral pole terminal on load side.

- (1) Between terminals under open or tripped state. However, the part between terminals connected with electronic circuits (including electronic components for earth-fault detection and the circuits for overvoltage protective elements) is excepted.
- (2) Between terminals of different polarity under closed state. However, for RCOCB's with earth-fault detecting electronic component and/or electronic overcurrent release carry out the test under the states described below.
  - (a) Such a state that the electronic circuits (including earth-fault detecting electronic components and the circuits for overvoltage protective elements) are being connected.
  - (b) Such a state that the electronic circuits (including earth-fault detecting electronic components and the circuits for overvoltage protective elements) are electrically opened.
- (3) Between conductive parts and enclosure (accessible parts by a man) under open state and closed state. The enclosure (accessible parts by a man) dealt with here means the parts capable of coming in contact with the test finger excluding the mounting face (rear face of RCOCB), the surface on which the wires are connected and the side surface equipped with an arc discharging hole.

The surface on which the operating handle is provided is considered as the enclosure.

- (4) Between conductive parts and mounting metal plate for test under open state and closed state.
- (5) For the RCOCB equipped with accessories, between conductive parts of RCOCB together with the earthed metals and the auxiliary circuit or control circuit of accessories (circuits which are normally not connected with the main circuit) under open state and closed state.

**8.21 Dielectric withstand voltage test** Carry out the dielectric withstand voltage test under the conditions stated below.

- (1) Test voltage The voltage to be applied to each part of the RCOCB shall have the appropriate value shown in Table 24.

Table 24. Dielectric withstand voltage test conditions

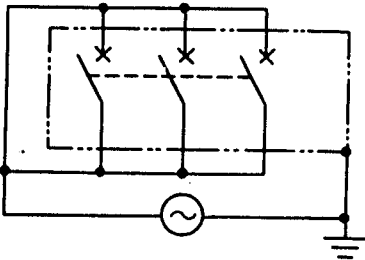
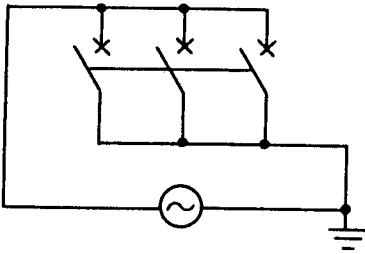
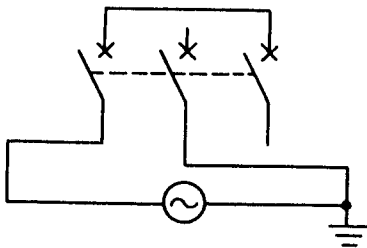
Unit: V

Main circuit		Auxiliary circuit or control circuit	
Rated voltage $U_e$	Test voltage (r.m.s. value of a.c. component)	Rated voltage of operating circuit $U_s$	Test voltage (r.m.s. value of a.c. component)
$U_e \leq 300$	2000	$U_s \leq 60$	1000
$300 < U_e \leq 600$	2500	$60 < U_s \leq 600$	$2 U_s + 1000 (1500 \text{ min.})$

- (2) Voltage application position The position to which the test voltage is applied shall be as described below. Carry out the test on the RCOCB with protection for neutral failure in single-phase three-wire system with the overvoltage detecting lead wire opened.
- (a) Apply the voltage to the main circuit as specified in Table 25.
- (b) For auxiliary circuits or control circuits, apply the voltage between the auxiliary circuits or control circuits and the earthed metals. However, the dielectric withstand voltage test of the operating motor of the electrical operating device may be carried out in accordance with JIS C 4004 separately from the RCOCB.
- (3) Test frequency The frequency of a.c. test voltage shall fall within the range of 45 Hz to 62 Hz.
- (4) Capacity of testing transformer The testing transformer shall have a capacity not less than 500 VA.
- (5) Duration of voltage application At first apply a voltage not exceeding  $1/2$  of the test voltage, increase the voltage to the test voltage as quickly as possible within the extent that the instantaneous voltage can be read by a voltmeter, and apply the test voltage attained continuously for 1 min. If the test is performed on many products, application of 120 % of the test voltage for 1 s from the beginning may substitute for the above test.



Table 25. Voltage application positions and states of RCOCB

Positions in main circuit to which test voltage is applied	States of RCOCB	
Between conductive parts of main circuit and enclosure (parts accessible by a man), mounting metal plate and auxiliary circuit or control circuit of accessories		Open and closed
Between supply side terminals and load side terminals		Open or tripped
<p>① Between poles of different polarity at each of left-center, right-center and left-right</p> <p>② Test is made with earth-fault detecting electronic components and circuits for overvoltage protective elements are electrically opened.</p>	 <p>The figure shows the case of left-center</p>	Closed

Remarks: The test voltage may be applied between supply side terminal in each pole pair.

8.22 Short-circuit test Carry out this test on RCOCB's employing molded-case circuit-breaker in the test circuit shown in Fig. 4, under the conditions prescribed below. Carry out the test on specimen with adjustable instantaneous trip current setting at the largest setting value.

(1) Circuit conditions

- (a) Current measurement Measure the current which flows when the RCOCB connecting wires  $W_1$ ,  $W_2$  and the RCOCB E are short-circuited with conductors or wires of possible low impedance (prospective short-circuit current).

- (b) Test current The test current shall be not less than 100 % of the rated breaking capacity and be measured with an oscillograph. As for the test current, draw envelopes of the crest values of a.c. component, and take  $\frac{1}{2\sqrt{2}}$  times the peak to peak amplitude of the envelopes  $\frac{1}{2}$  cycle after occurrence of the short circuit as the r.m.s. value of a.c. component. In the case of three phases, take the average value of the r.m.s. values of a.c. components in every phase as the r.m.s. value of a.c. component in the test circuit.
- (c) Circuit constants The test voltage shall be 1.1 times the rated voltage, the tolerances shall be  $\pm 5\%$  and the power factor shall be as shown in Table 26.

Table 26. Circuit constants for short-circuit test and short-time test

Rated breaking capacity or rated short time current I A	Power factor	Magnification $n$ ( <sup>32</sup> )
$I \leq 2500$	0.85 to 0.9	1.42
$2500 < I \leq 5000$	0.65 to 0.7	1.53
$5000 < I \leq 10000$	0.45 to 0.5	1.7
$10000 < I \leq 20000$	0.25 to 0.3	2.0
$20000 < I \leq 50000$	0.2 to 0.25	2.1
$50000 < I$	0.15 to 0.2	2.2

Note (<sup>32</sup>) The ratio of the maximum crest value to the r.m.s. value of symmetrical component.

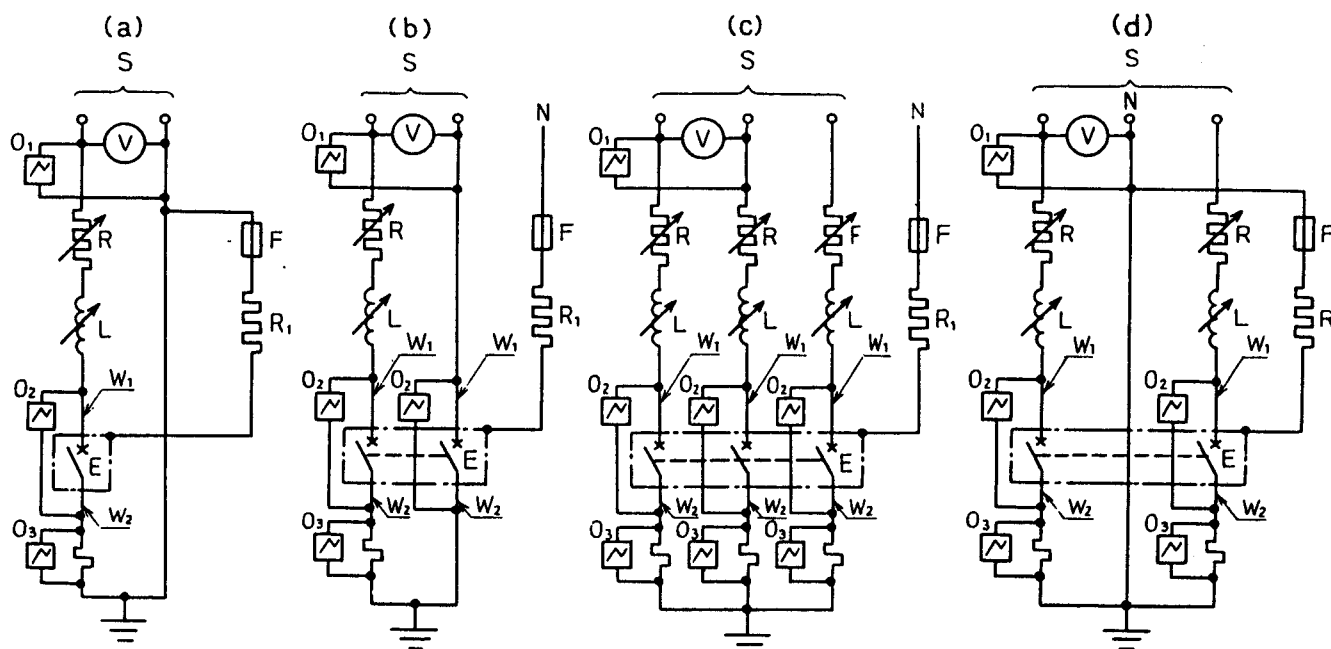
- (d) Power-frequency recovery voltage The average value of the power-frequency recovery voltages on every phase shall be not less than 100 % of the test voltage.
- (2) Operating duty As for the operating duty, 0-t-CO is counted as one cycle. Here, "0" means that the shorted circuit is closed by means of closing switch of the test circuit and let the RCOCB to break the current. The "CO" means closing of the shorted circuit by the RCOCB under test immediately followed by opening of the circuit due to tripping of the RCOCB. The "t" is the time interval between "0" test and "CO" test, and shall be the minimum time which allows reset of the RCOCB. It is not necessary to shorten "t" below 2 min in any case.

(3) Duration of test voltage application Apply the test voltage for at least 0.1 s after completion of the breaking.

(4) Test method

- (a) Carry out the test of RCOCB's with rated voltage 100/200 V of two poles for single-phase two-wire system (for neutral line earthed electric lines) and of three poles for single-phase three-wire system in the circuit of Fig. 4 (a) (between voltage line and neutral line of neutral line earthed power supply), once on each pole equipped with an overcurrent tripping element, and then once in the circuit of Fig. 4 (d) (in the case of three-pole specimen, one pole being connected with the neutral line). In the test on each pole, the test current shall be 5000 A for specimens whose rated breaking capacity is exceeding 5000 A.
- (b) Carry out the test of other two-pole RCOCB's in the circuit of Fig. 4 (a), once on each pole equipped with an overcurrent tripping element, and then once in the circuit of Fig. 4 (b). In the test on each pole, the test current shall be 5000 A for specimens whose rated breaking capacity is exceeding 5000A, and the test voltage shall be 265 V for specimens whose rated voltage is exceeding 240 V.
- (c) Carry out the test of three-pole RCOCB other than those stated in (a) in the circuit of Fig. 4 (a) once on each pole, and then once in the circuit of Fig. 4 (c). In the test on each pole, the test current shall be 5000 A for specimens whose rated breaking capacity is exceeding 5000 A, and the test voltage shall be 265 V for specimens whose rated voltage is exceeding 240 V.
- (d) The test on each pole of multi-pole RCOCB stated in (a) to (c) may be carried out on a separate specimen. For RCOCB's whose rated current is exceeding 600 A, the test on each pole may be omitted.

Fig. 4. Configuration of short-circuit test circuit



R : resistor for circuit adjustment<sup>(33)</sup>

L : reactor for circuit adjustment<sup>(34)</sup>

E : specimen

O<sub>1</sub> : voltage recording element of test voltage measuring oscillograph

O<sub>2</sub> : voltage recording element of arc voltage measuring oscillograph <sup>(35)</sup>

O<sub>3</sub> : current recording element of oscillograph<sup>(36)</sup>

W<sub>1</sub>, W<sub>2</sub> : connecting wires for specimen<sup>(37)</sup>

R<sub>1</sub> : current limiting resistor for inspection fuse<sup>(38)</sup>

F : inspection fuse<sup>(39)</sup>

S : (power) supply<sup>(40)</sup>

N : to be connected to neutral point<sup>(41)</sup>

Notes <sup>(33)</sup> This may be located on primary side of power supply.

<sup>(34)</sup> This may be located on primary side of power supply.  
A parallel resistor which shunts 0.6 % of the total current may be connected when an air-core reactor is used.

<sup>(35)</sup> The measurement resistance shall be  $100^{+20}_0 \Omega$  per 1 V of phase voltage.

<sup>(36)</sup> This may be located on power supply side of the specimen E.

- (<sup>37</sup>) W<sub>1</sub> and W<sub>2</sub> shall be the wire or copper bar of a length not exceeding 1.5 m with the cross-sectional area shown in Table 17, and the sum of the length of W<sub>1</sub> and length of W<sub>2</sub> shall be 1.5 m. The size does not necessarily exceed 500 mm<sup>2</sup> unless the insulating covering of W<sub>1</sub> and W<sub>2</sub> is damaged.
- (<sup>38</sup>) A resistor which reduces the estimated fault current to about 100 A to protect the inspection fuse.
- (<sup>39</sup>) A fuse consisting of a copper wire of  $\phi 0.1$  mm with a length 50 mm or more.
- (<sup>40</sup>) In this figure, the circuit closing switch is omitted, this switch may be located on either of primary or secondary side of power supply transformer.
- (<sup>41</sup>) When one line of power supply S in the circuit of (b) is the neutral line, connect the inspection fuse F to the neutral line on the power supply side of the specimen.

Remarks: The portion shown by  indicates the metal box, mounting metal plate and metal plate for verification of arcing space.

- (5) Installation of shirting Place the shirting (plain woven cotton cloth without sizing consisting of  $72 \pm 4$  warps of yarn number count 30 and of  $69 \pm 4$  wefts of yarn number count 36 per 25.4 mm as its density) in front of the opening for operating knob during the short-circuit test of RCOCB's of a rated voltage not exceeding 300 V and a rated current not exceeding 100 A. Place the shirting at a position 20 mm from the end of knob as illustrated in Fig. 5, and the size shall be not less than the opening for operating knob.
- (6) Verification of arcing space During the short-circuit test, for verification of arcing space, arrange the metal plates as illustrated in Fig. 5 or Fig. 6, connect them electrically with the mounting metal plate and with the limiting resistance R<sub>1</sub> and inspection fuse F [see Fig. 4, Fig. 5 (3) and Fig. 6 (3)].

Here, the dimension L and dimension S shall be the values guaranteed by the manufacturer. The top and front shall consist of steel plate of 1 mm or more thick without perforation, and the sides shall consist of wire netting or perforated steel plate with a rate of opening exceeding 40 % but not exceeding 70 %. The top shall be confronting to the arc discharge hole, the length shall be not less than the sum of the width of the RCOCB plus twice the dimension S and the width shall be not less than the depth of RCOCB. If there is some trouble to install the connecting conductors for testing, insulate the connecting conductors and cover specimen with the top metal plate to a point not exceeding 20 mm from the conductor.

Fig. 5. Verification of arcing space (when  $I_{cn} \leq 10000$  A)

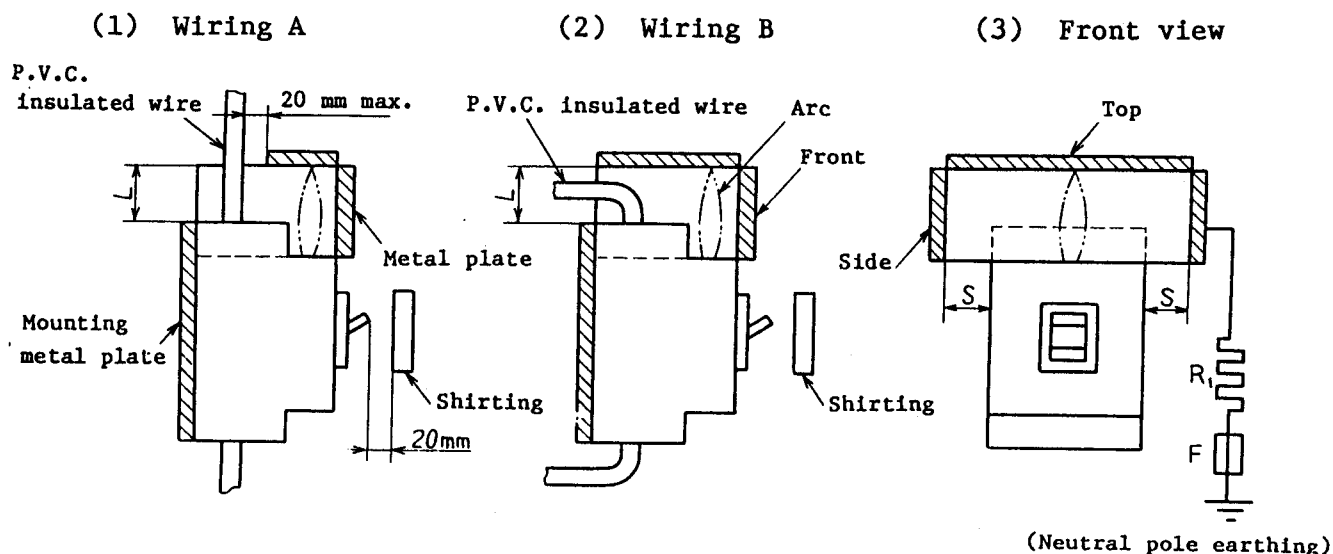
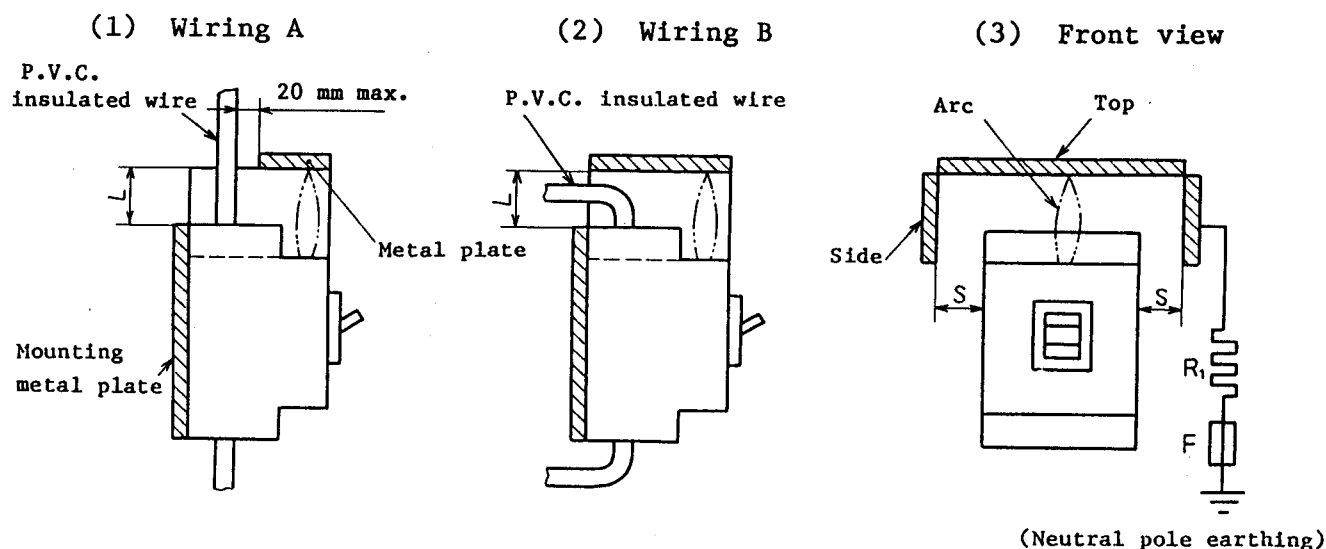


Fig. 6. Verification of arcing space (when  $I_{cn} > 10000$  A)



(7) Verification after short-circuit test

- (a) Insulation resistance Measure the insulation resistances in accordance with 8.20, 15 min after the short-circuit test.
- (b) Dielectric withstand voltage Carry out the dielectric withstand voltage test in accordance with 8.21 after the test of (a). In this verification the test voltage shall be twice the rated voltage (1000 V at the minimum) for main circuits and twice the rated voltage of operating circuit (1000 V at the minimum) for the auxiliary circuits or control circuits and the duration of application shall be 1 min.
- (c) Trip After the test of (b), pass 250 % of the rated current through each pole, and measure the time until the specimen operates automatically.

- (d) Trip by residual current After the test of (c), carry out the residual operating current test in accordance with 8.5.1.
- (e) Trip by operating overvoltage After the test of (d), carry out the operating overvoltage test in accordance with 8.10.1.

**8.23 Short-time current test** Connect the wire specified in Table 17 of a length within 1.5 m to each terminal of the RCOCB of terminal connection type, to each terminal of the RCOCB of plug-in type by means of the plug and receptacle complying with JIS C 8303, apply 1.1 times the rated voltage and pass the test current equal to the rated short-time current and of the characteristics shown in Table 26 twice each for about 0.02 s at an interval of 2 min, through the specimen under closed state. In this procedure, carry out the first closing and opening (or breaking) operations by the switch located on the power supply side of the RCOCB, and the second closing with the RCOCB.

When three-pole or four-pole specimen is tested in single-phase circuit, the test may be made by combining two poles so that number of tests on each pole becomes two. After completion of this test, carry out the residual operating current test in accordance with 8.5.1.

**8.24 Cord protection test** In the cord protection test, use the short-circuit test circuit shown in Fig. 4, connect the wire specified in JIS C 3306 of the size specified in Table 27 to the load side terminal in series, and carry out breaking once by means of "0" operation. Carry out the test in single-phase circuit for specimens of two poles, and of three poles for single-phase three-wire system, in three-phase circuit for three-pole specimens. Expose the conductor by removing the covering from the cord to a point 10 mm from the end of terminal as illustrated in Fig. 7.

Fig. 7. Connecting method of cord in cord protection test

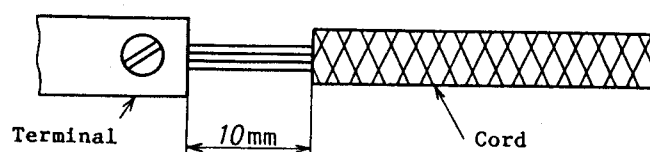


Table 27. Wires for cord protection test

Rated current $I_n$ A	Size of test cord $\text{mm}^2$	Length of cord <sup>(42)</sup> m	
		Single phase	Three phases
$I_n \leq 5$	0.5	1	Insert a cord of 0.5 to each phase
$5 < I_n \leq 20$	0.75		
$20 < I_n \leq 30$	1.25		

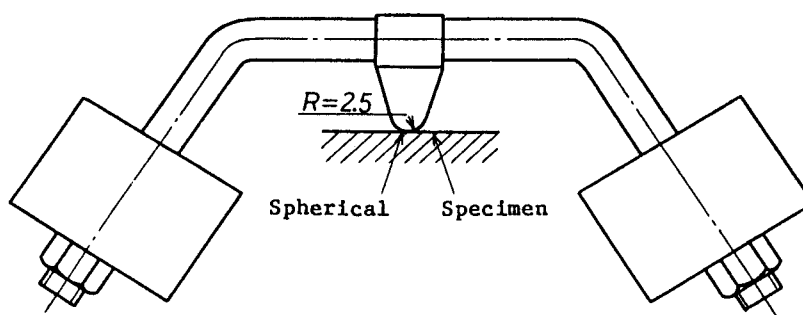
Note <sup>(42)</sup> This means the length of conductor.

**8.25 Robustness test of enclosure of insulating material** Carry out the robustness of enclosure of insulating material by means of the test apparatus shown in Fig. 8. Place the surface of the portion to be tested horizontally and push it by a steel ball of 5 mm diameter with a force of 20 N{2.04 kgf}. Carry out the test under the following conditions:

- (1) Carry out the test in a thermostatic chamber at  $125 \pm 2^\circ\text{C}$  for the enclosure parts of RCOCB necessary for fixing the conductive parts or earthing conductor parts to the prescribed positions.
- (2) Carry out the test in a thermostatic chamber at  $70 \pm 2^\circ\text{C}$  or the temperature rise of the specimen in question obtained in the test of 8.18 plus  $40 \pm 2^\circ\text{C}$  whichever is the higher, for the enclosure parts of RCOCB not necessary for fixing the conductive parts or earthing conductor parts (including the parts only in contact with such conductive parts). After 1 h, remove the steel ball from the specimen, cool the specimen by immersing it into water so that it becomes almost the room temperature within 10 s, and then measure the diameter of dent produced by the steel ball.

Fig. 8. Robustness test apparatus for enclosure of insulating material

Unit: mm



**8.26 Test for resistance to ammonia gas** Carry out the test for resistance to ammonia gas as follows:

- (1) Connect the wire specified in Table 17 of 10 cm long to each terminal by tightening the screw at the tightening torque specified in Table 16, and remove the terminal cover, if provided. Place the specimen so prepared in the desiccator specified in JIS R 3503 of nominal size 240 mm containing the test liquid of 1 l in the bottom so that the specimen does not come in contact with the test liquid and the face on which operating knob is located is facing to the test liquid, and maintain such a state for 72 h. The room temperature under which the desiccator is allowed to stand shall be  $20 \pm 2^\circ\text{C}$ . During this test do not diffuse the ammonia gas by opening the lid of desiccator or by similar operation. The test may be carried out on the components of brass only if the test conditions are considered as the same. After the above procedures take out the specimen and test it in accordance with 8.4.



- (2) Place the RCOCB of plug-in type, as it stands, in the desiccator specified in JIS R 3503 of nominal size 240 mm containing the test liquid of 1 l in the bottom so that the specimen does not come in contact with the test liquid and that the face on which the test button is mounted is facing the liquid surface and maintain such a state for 72 h. The room temperature under which the desiccator is allowed to stand shall be  $20 \pm 2^{\circ}\text{C}$ . During the test, do not diffuse the ammonia gas by opening the lid of desiccator or by similar operation. After the above procedures, take out the specimen and test it in accordance with 6. (retention force test) of JIS C 8306.
- (3) Prepare the test liquid for use in the test of (1) in the following way. Dissolve 107 g of the extra grade ammonium chloride specified in JIS K 8116 into distilled water of about 700 ml, add the liquid prepared by dissolving 50 g to 70 g of the extra grade sodium hydroxide specified in JIS K 8576 into distilled water of about 250 ml to the above solution, so that the hydrogen ion concentration (in pH) reaches 10 at total amount of about 1 l.

8.27 Test for resistance to corrosion Carry out the test for resistance to corrosion on the components of iron and steel used for the mechanism parts of RCOCB's in the following sequence:

- (1) Remove the grease completely from the specimen. However, this treatment may be omitted for the springs and the sliding parts protected from corrosion by means of grease or the like.
- (2) Immerse the specimen into 10 % aqueous solution of the ammonium chloride specified in JIS K 8116 at  $20 \pm 5^{\circ}\text{C}$  for 10 min. Take it out of the solution, shake off water drops completely without drying, and then allow it to stand in a vessel containing saturated water vapor at  $20 \pm 5^{\circ}\text{C}$  for 10 min.
- (3) Dry the specimen in a thermostatic chamber at  $100 \pm 5^{\circ}\text{C}$  for 10 min.

8.28 Test for resistance to damp heat (cyclic) Carry out the test for resistance to damp heat as stated below.

- (1) Apply the rated voltage to and pass the rated current through the RCOCB and subject the RCOCB under such conditions to 28 damp heat cycles repeatedly, the damp heat cycle shown in Fig. 9 being one cycle. This test may be carried out with the residual current trip blocked.

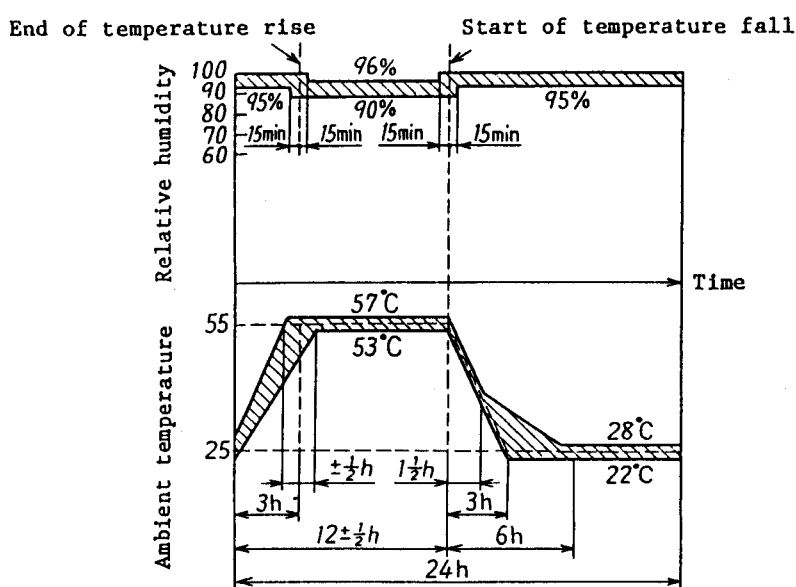
The test may be carried out on the specimen of a rated current exceeding 225 A, with the rated voltage only applied.

The specimen having an overcurrent protective mechanism other than an electronic overcurrent protective mechanism may be tested while operation of the overcurrent protective mechanism is blocked.

- (2) Cut off the voltage and current after the test of (1), and allow the specimen to stand under ordinary temperature and ordinary humidity for at least 4 h. Successively apply the rated voltage, allow the specimen to stand at  $-10^{\circ}\text{C}$  for 16 h, cut off the power supply and then allow the specimen to stand at ordinary temperature for 4 h.
- (3) Carry out the test of 8.5.1 immediately after the test of (2). Carry out the tests of 8.20 and 8.21 after completion of this test.

Further, subject the specimen with electronic overcurrent protective mechanism to the test of 8.14.2 and the specimen with protection for neutral line failure in single-phase three-wire system to the test of 8.10.1.

Fig. 9. Damp heat (cyclic) test conditions



Remarks: The hatched portions show the ranges within which the temperature and humidity shall be maintained.

**8.29 Vibration test** In the vibration test, mount the RCOCB as in normal service state, carry out the vibration test in each of the directions up and down, left and right, and front and rear in accordance with 4.2 (constant frequency endurance test) of JIS C 0911 under the test conditions of Table 28, and then carry out the test of 8.5.1.

Carry out the test with voltage application on the specimen under closed state.

Further, subject the specimen with overcurrent release to the test of 8.14.2 and the specimen with protection for neutral line failure in single-phase three-wire system to the test of 8.10.1.

Table 28. Vibration test conditions

Classification of test	Vibration conditions			Application condition
	Vibration acceleration $\text{m/s}^2$	Vibration frequency Hz	Duration of test h	
Test without voltage	19.6	16.7	1	-
Test with voltage application			0.5	Rated frequency Rated voltage

8.30 Impact acceleration test In the impact acceleration test, mount the RCOCB as in normal service state, bring it to its closed state, apply the rated voltage, and pass the test current shown in Table 29 through one pole. Carry out the impact test on the specimen above stated in the up and down directions and the direction which brings the front upwards each three times in accordance with 5. (test method 2) of JIS C 0912 at the impact acceleration specified in Table 29, and then carry out the test of 8.5.1.

Further, subject the specimen with overcurrent release to the test of 8.14.2, and the specimen with protection for neutral line failure in single-phase three-wire system to the test of 8.10.1.

Table 29. Impact acceleration test conditions

Rated current A	Test current	Impact acceleration <sup>(43)</sup> $\text{m/s}^2(\text{G})$
Not exceeding 30	Rated non-operating current	147 (15)
	Without current	490 (50)
Exceeding 30	Rated non-operating current	98 (10)
	Without current	294 (30)

Note (43) The impact acceleration waveform shall be close to sine wave and the duration of impact shall be  $10 \pm 5$  ms.

Remarks: G is acceleration of gravity which is  $9.8 \text{ m/s}^2$ .

8.31 Free fall test This test applies to RCOCB's of plug-in type (portable type only). Put one specimen in the rotary drum shown in Attached Fig. 12 (tumbling barrel tester) of JIS C 8306, and let the specimen fall three times at a rate of 5 revolutions per minute. After completion of this test, carry out the tests of 8.5.1, 8.20 and 8.21.

8.32 Retention force test This test applies to the blade receiver of RCOCB's of plug-in type. Carry out this test in accordance with 6.2 (retention force test) of JIS C 8303.

8.33 Make and break test of plug and receptacle This test applies to the blade receiver of RCOCB's of plug-in type. Carry out this test in accordance with 6.5 (make and break test) of JIS C 8303.

8.34 Strength test of blade mount This test applies to the blade mount of RCOCB's of plug-in type. Carry out this test in accordance with 6.10 (strength test for blade fitting part) of JIS C 8303.

8.35 Strength test of cord anchorage This test applies to RCOCB's of plug-in type equipped with cord. Carry out this test in accordance with 6.12 (strength test of cord anchorage) of JIS C 8303.

8.36 Strength test of cord outlet This test applies to RCOCB's of plug-in type equipped with cord. Carry out this test in accordance with 6.13 (strength test of cord outlet) of JIS C 8303.

8.37 Strength test of lead wire for overvoltage detection Carry out the strength test of lead wire for overvoltage detection as follows:

- (1) Apply a tension of 30 N{3.06 kgf} to the wire outwards from the RCOCB for 10 s.
- (2) Grip the lead wire at a point 5 cm from the appliance body and push it towards inside of the RCOCB at a force of 30 N{3.06 kgf}.

8.38 Breaking test of heavy earth-fault current Apply 1.1 times the rated voltage (1.1 times the voltage between neutral pole and other pole for the specimen having a pole to be connected with neutral line of single-phase three-wire system or three-phase four-wire system), and pass the test current through one pole of the specimen in closed state under the conditions specified in Table 30 to operate the specimen. Carry out the above tests on each pole. After completion of this test, carry out the tests of 8.5.1 and 8.10.1. This test is not applied to RCOCB's with overcurrent release.

Table 30. Heavy earth-fault current breaking test conditions

Test current	Number of tests	Rated current $I_n$ A	Rest time s	Voltage fluctuation %
10 times rated current	Two for each pole	$I_n \leq 100$	10	15 max.
		$100 < I_n \leq 225$	30	
		$225 < I_n \leq 500$		30 max.

Remarks: The power factor shall have the value shown in Table 26 corresponding to the test current.

8.39 Lightning impulse withstand voltage test Apply the lightning impulse voltage shown in Table 31, in positive polarity and negative polarity, each three times at intervals of 1 min to the following portions:

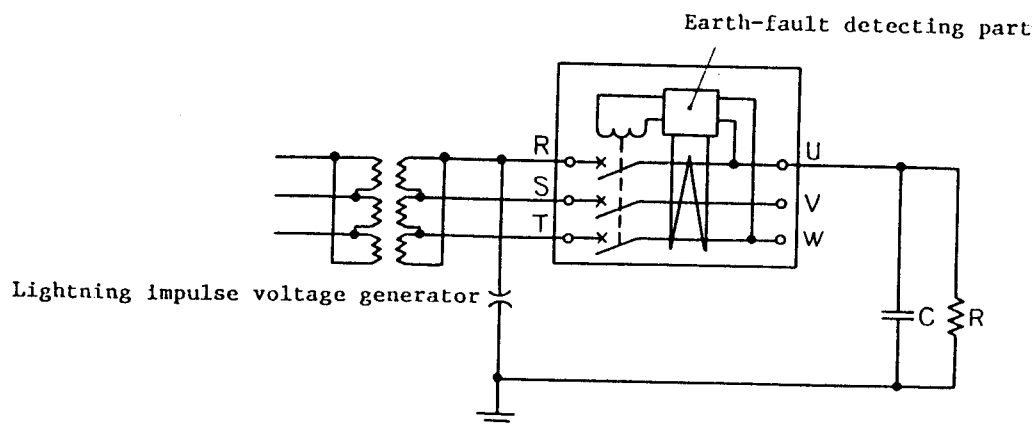
- (1) Between terminals of different polarity in closed position
- (2) Between every live part (connected together) and enclosure

Table 31. Lightning impulse withstand voltage test conditions

Test voltage (peak value)	Waveform	
	Front time	Time to half value
7 kV $\pm$ 3 %	1.2 $\mu$ s $\pm$ 30 %	50 $\mu$ s $\pm$ 20 %

8.40 Test for non-actuation by lightning impulse Apply the rated voltage to the test circuit of Fig. 10, and apply the lightning impulse voltage shown in Table 31 to the specimen at closed state, in positive polarity and negative polarity each three times at intervals of 1 min.

Fig. 10. Test circuit for non-actuation by lightning impulse



C: Capacitor 0.03  $\mu$ F      R: Resistor 0.1 M $\Omega$

8.41 Aging test of electronic components Carry out the aging test of electronic components as follows:

An example of the test circuit diagram is shown in Attached Fig. 3 for informative reference.

- (1) Apply 1.1 times the rated voltage to and pass the rated current through the RCOCB, and maintain the breaker at an ambient temperature  $40 \pm 2^\circ\text{C}$  for 168 h. In this procedure the specimen with a rated current exceeding 225 A may be tested without passing the rated current.

The test may be performed with the overcurrent protective mechanism blocked for specimens having an overcurrent protective mechanism other than electronic overcurrent protective mechanism.

- (2) After the test of (1), cut off the voltage and the current, and allow the specimen to stand at ordinary temperature for 4 h.

- (3) After the test of (2), carry out the test of 8.5.1. After completion of this test, carry out the test of 8.14.2 on the specimen with electronic overcurrent protective mechanism, and carry out the test of 8.10.1 on the specimen with protection for neutral failure in single-phase three-wire system.

#### 8.42 Cyclic heating test of main circuit wire connecting terminal

Maintain the specimen in still air at an ambient temperature 15°C to 30°C and test it as stated below. Do not carry out changeover of current passing and resting by the RCOCB.

- (1) The conditions of heating cycles shall be as given in Table 32.
- (2) Connect the wire specified in Table 17 of a length not more than 1 m at a tightening torque  $\frac{2}{3}$  of that specified in Table 16 to each terminal of the RCOCB of terminal connection type, or to each terminal of the RCOCB of plug-in type by using the plug and receptacles complying with JIS C 8303.
- (3) Measure the temperature rise at the 25th cycle and that at the 150th cycle.
- (4) After completion of the duration of rest at 150th, pass the rated current until the temperature of the terminal stabilizes, and measure the temperature rise.

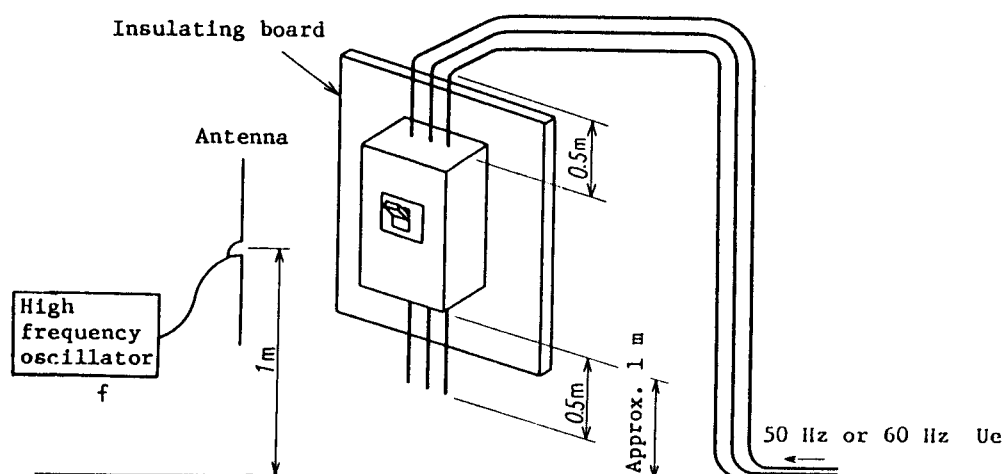
Table 32. Conditions for cyclic heating test of main circuit wire connecting terminal

Test voltage	Test current	Duration of current	Duration of rest	Number of cycles
Rated voltage	1.25 times rated current <sup>(44)</sup>	1 h	1 h	150

Note (44) For RCOCB providing overcurrent protective mechanism, the test current may be reduced to 100 % of the rated current.

8.43 Test for non-actuation by radiated electromagnetic wave In the circuit shown in Fig. 11, apply the rated voltage to the RCOCB under closed state, and subject the specimen so prepared to the radiated electromagnetic waves of the conditions given in Table 33 for 2 s.

Fig. 11. Test for non-actuation by radiated electromagnetic wave



Remarks: Carry out the test for non-actuation by radiated electromagnetic wave in a place shielded from external radio waves.

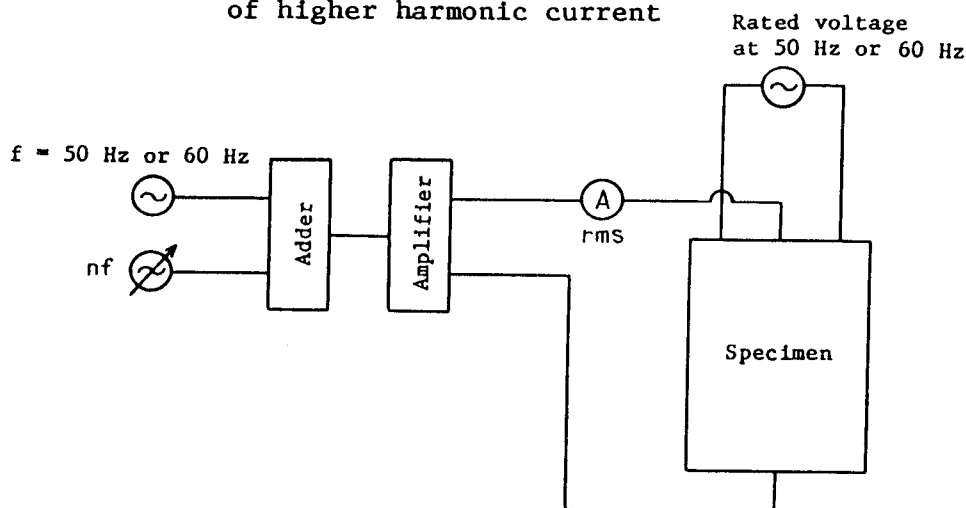
Table 33. Test conditions for non-actuation by radiated electromagnetic wave

Frequency (MHz)	Electric field strength in vicinity of specimen
27	130 dB (3.16 V/m)
144	130 dB (3.16 V/m)
430	140 dB (10 V/m)
900	146 dB (20 V/m)

Remarks: Assume  $1 \mu\text{V/m} = 0 \text{ dB}$

8.44 Tripping test under superposition of higher-harmonic current In the circuit shown in Fig. 12, apply the rated voltage at a frequency 50 Hz or 60 Hz, do not pass the load current, pass a current on which higher harmonic current is superposed in positive-phase-sequence and negative-phase-sequence so that the distortion factor becomes 10 % through one pole of the RCOCB in closed position, gradually increase this current and measure the residual operating current at the instant when the RCOCB operates. Carry out the test on each of third-harmonic superposition and fifth-harmonic superposition.

Fig. 12. Test circuit for tripping under superposition of higher harmonic current



8.45 Tripping test under superposition of high-frequency current In the circuit shown in Fig. 13, apply the rated voltage at a frequency 50 Hz or 60 Hz, do not pass the load current, pass a current at power frequency through one pole of the RCOCB in closed state, pass the high-frequency currents (the  $I_{RF}$  shown in Fig. 13) shown in Table 34 through another pole, increase the current at power frequency gradually, and measure the residual operating current at the instant when the RCOCB operates.

Fig. 13. Test circuit of tripping under superposition of high-frequency current

Rated voltage at 50 Hz or 60 Hz

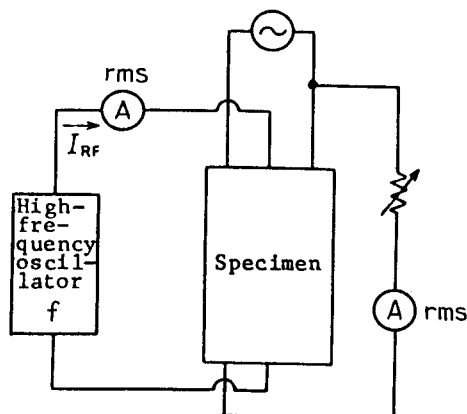


Table 34. Conditions for superposition of high-frequency currents

Frequency of $I_{RF}$ kHz	Value of $I_{RF}$
1	0.1 times rated residual operating current
3	0.26 times rated residual operating current
30	2.0 times rated residual operating current

Remarks: The maximum of  $I_{RF}$  shall be 2 A.



## 9. Inspection

9.1 Kinds of inspection The kinds of inspection shall be as follows:

- (1) Type inspection This is the inspection carried out to decide whether the quality of the product satisfies the quality items shown in the design or not and the purpose of this inspection is to decide the adequacy of quality for a type of the products.
- (2) Acceptance inspection This is the inspection carried out to decide whether the quality items necessary for acceptance of the products which have been already passed the type inspection are satisfying the relevant provisions or not, and the purpose is to decide the acceptance.

## 9.2 Type inspection

- (1) The type inspection shall be carried out for the items shown in Table 35.

Table 35. Inspection items in type test

Inspection item		Test method
7., 11., 12.	Construction, marking, matters to be clearly stated	8.2
6.1	Operating property	8.3
6.2	Robustness of terminals	8.4
6.3	Residual current trip	8.5
6.4	Residual operating current at ambient temperature change and power supply voltage fluctuation	8.6
6.5	Non-actuation at ambient temperature change and power supply voltage fluctuation	8.7
6.6	Balance of zero-phase-sequence transformer	8.8
6.7	Actuation of test device	8.9
6.8	Overvoltage trip	8.10
6.9	Operating overvoltage at ambient temperature change and power supply voltage fluctuation	8.11
6.10	Non-operating overvoltage at ambient temperature change and power supply voltage fluctuation	8.12
6.11	Maximum overvoltage trip	8.13
6.12	Current carrying and long time-delay trip	8.14

Table 35. (Continued)

Inspection item		Test method
6.13	Instantaneous trip	8.15
6.14	Actuation characteristics of overload protective device	JIS C 8325 5.6
6.15	Making and breaking of overload	8.16
6.16	Inrush current	8.17
6.17	Temperature rise	8.18
6.18	Mechanical and electrical endurance (to switching)	8.19
6.19	Insulation resistance	8.20
6.20	Dielectric withstand voltage	8.21
6.21	Short-circuit current breaking	8.22
6.22	Short-time current	8.23
6.23	Protection of cord	8.24
6.24	Robustness of enclosure of insulating material	8.25
6.25	Resistance to ammonia gas	8.26
6.26	Resistance to corrosion	8.27
6.27	Resistance to damp heat	8.28
6.28	Vibration	8.29
6.29	Impact acceleration	8.30
6.30	Robustness against free fall	8.31
6.31	Retention force	8.32
6.32	Make and break by plug and receptacle	8.33
6.33	Strength of blade mount	8.34
6.34	Strength of cord anchorage	8.35
6.35	Strength of cord outlet	8.36
6.36	Strength of lead wire for overvoltage detection	8.37
6.37	Breaking of heavy earth-fault current	8.38

Table 35. (Continued)

Inspection item		Test method
6.38	Lightning impulse withstand voltage	8.39
6.39	Non-actuation by lightning impulse	8.40
6.40	Aging of electronic components	8.41
6.41	Cyclic heating of main circuit wire connecting terminal	8.42
6.42	Non-actuation by radiated electromagnetic wave	8.43
6.43	Tripping under superposition of higher-harmonic current	8.44
6.44	Tripping under superposition of high-frequency current	8.45

- (2) In the type inspection, the RCOCB's shall be mounted in the normal position, the test shall be carried out on the same specimen under clean and new states for each class of type inspection shown in Table 36 for the inspection items shown in the same table in the given sequence and the results shall comply with the provisions of 6.

For the performances stated in 6.12, 6.15, 6.17, 6.21 and 6.23, the inspection shall be carried out with the specimen mounted to vertical plane.

In the inspection class I, the test may be carried out on the separate specimen for each inspection item.

In the inspection classes II to XI, the test may be carried out on the same specimen by optionally combining the inspection items.

During the test, the contacting parts shall not be cleaned and the conditions of the test device shall not be altered.

Table 36. Classification of type inspection

Class of type inspection	Inspection item	Test method	Application
I (Construction, material)	7., 11., 12. Construction, marking, matters to be clearly stated	8.2	
	6.1 Operating property	8.3	
	6.2 Robustness of terminals	8.4	
	6.24 Robustness of enclosure of insulating material	8.25	RCOCB of $U_e \leq 300$ V, $I_n \leq 100$ A
	6.25 Resistance to ammonia gas	8.26	
	6.26 Resistance to corrosion	8.27	
	6.30 Robustness against free fall	8.31	Plug-in type (portable one)
	6.31 Retention force	8.32	Plug-in type
	6.32 Make and break by plug and receptacle	8.33	Plug-in type
	6.33 Strength of blade mount	8.34	Plug-in type
	6.34 Strength of cord anchorage	8.35	Plug-in type with cord
	6.35 Strength of cord outlet	8.36	Plug-in type with cord
	6.36 Strength of lead wire for overvoltage detection	8.37	With protection for neutral line failure in single-phase three-wire system
	6.41 Cyclic heating of main circuit wire connecting terminal	8.42	

Table 36. (Continued)

Class of type inspection	Inspection item	Test method	Application
II (Residual current tripping)	6.3 Residual current trip	8.5	Carry out test for all residual operating currents capable of being set if it is sensitivity change-over system
	6.4 Residual operating current at ambient temperature change and power supply voltage fluctuation	8.6	
	6.5 Non-actuation at ambient temperature change and power supply voltage fluctuation	8.7	
	6.6 Balance of zero-phase-sequence transformer	8.8	
	6.7 Actuation of test device	8.9	
III (Overvoltage tripping)	6.8 Overvoltage trip	8.10	With protection for neutral line failure in single-phase three-wire system
	6.9 Operating overvoltage at ambient temperature change and power supply voltage fluctuation	8.11	
	6.10 Non-operating overvoltage at ambient temperature change and power supply voltage fluctuation	8.12	
	6.11 Maximum overvoltage trip	8.13	
IV (Resistance to damp heat)	6.19 Insulation resistance	8.20	
	6.20 Dielectric withstand voltage	8.21	
	6.12 (1) Trip at 200 % current	8.14.2	Carry out test on RCOCB with electronic over-current protective mechanism

Table 36. (Continued)

Class of type inspection	Inspection item	Test method	Application
	6.3.1 Residual operating current	8.5.1	
	6.8.1 Operating overvoltage	8.10.1	With protection for neutral line failure in single-phase three-wire system
	6.27 Resistance to damp heat	8.28	
	- Verification after test	8.9(1)	
V (Endurance in field)	6.19 Insulation resistance	8.20	
	6.20 Dielectric withstand voltage	8.21	
	6.3.1 Residual operating current	8.5.1	
	6.8.1 Operating overvoltage	8.10.1	With protection for neutral line failure in single-phase three-wire system
	6.12 Current carrying and long time-delay trip	8.14	RCOCB also serves as molded-case circuit breaker
	6.13 Instantaneous trip	8.15	RCOCB also serves as molded-case circuit breaker with $I_n > 100$ A
	6.14 Actuation characteristics of overload protective device	JIS C 8325, 5.6	RCOCB employing electromagnetic switch for breaking part
	6.15 Making and breaking of overload	8.16	
	6.16 Inrush current	8.17	$U_c = 100$ V or 100/200 V, $I_n \leq 50$ A
	6.17 Temperature rise	8.18	
	6.18 Mechanical and electrical endurance (to switching)	8.19	
	- Verification after test	8.2, 8.3, 8.5.1, 8.10.1, 8.14.2, 8.21	

Table 36. (Continued)

Class of type inspection	Inspection item	Test method	Application
VI (Short-circuit current breaking)	6.3.1 Residual operating current	8.5.1	
	6.8.1 Operating overvoltage	8.10.1	With protection for neutral line failure in single-phase three-wire system
	6.12 (1) Trip at 200 % current	8.14.2	RCOCB also serves as molded-case circuit breaker
	6.21 Short-circuit current breaking	8.22	
	6.23 Protection of cord	8.24	RCOCB with $I_n \leq 30$ A, and protected cord
VII (Heavy earth-fault current breaking)	6.3.1 Residual operating current	8.5.1	
	6.8.1 Operating overvoltage	8.10.1	With protection for neutral line failure in single-phase three-wire system
	6.37 Breaking of heavy earth-fault current	8.38	Without overcurrent release
VIII (Short-time current)	6.3.1 Residual operating current	8.5.1	Without overcurrent release
	6.22 Short-time current	8.23	
IX (Vibration)	6.3.1 Residual operating current	8.5.1	
	6.8.1 Operating overvoltage	8.10.1	With protection for neutral line failure in single-phase three-wire system
	6.12 (1) Trip at 200 % current	8.14.2	With overcurrent release
	6.28 Vibration	8.29	

Table 36. (Continued)

Class of type inspection	Inspection item	Test method	Application
X (Impact acceleration)	6.3.1 Residual operating current	8.5.1	
	6.8.1 Operating overvoltage	8.10.1	With protection for neutral line failure in single-phase three-wire system
	6.12 (1) Trip at 200 % current	8.14.2	With overcurrent release
	6.29 Impact acceleration	8.30	
XI (Noise, surging and aging)	6.3.1 Residual operating current	8.5.1	
	6.42 Non-actuation by radiated electro-magnetic wave	8.43	
	6.43 Tripping under superposition of higher-harmonic current	8.44	
	6.44 Tripping under superposition of high-frequency current	8.45	
	6.38 Lightning impulse withstand voltage	8.39	
	6.39 Non-actuation by lightning impulse	8.40	
	6.40 Aging of electronic components	8.41	
	6.3.1 Residual operating current	8.5.1	

- (3) The test sample sizes in the type inspection shall be as shown in Table 37, the inspection of class I shall be carried out on one specimen, each of the inspections of classes II to XI shall be carried out on three specimens and the product is accepted when all the specimens pass the inspections. However, in the inspections of classes II to XI, when two specimens out of three are accepted, addition of specimens is allowed, the test is carried out again on three specimens and the products are regarded as acceptable if all the specimens pass the reinspection.



For RCOCB which has several rated residual operating currents referring to one rated current, the test shall be carried out under such states that one specimen out of three is set to the maximum of rated residual operating current, one specimen is set to the minimum of rated residual current, and the remaining one to either of the maximum or the minimum optionally.

Table 37. Test sample size

Class of type inspection	Sample size	Acceptance number	Additional (reinspection) sample size
I	1	1	Not permitted
II to XI	3	2	3

9.3 Acceptance inspection The acceptance inspection shall be carried out for the items shown in Table 38 on the one test specimen.

However, all or a part such as residual operating current of the items may be omitted subject to agreement between the purchaser and supplier.

Table 38. Acceptance inspection items

Inspection item	Test method
7., 11., 12. Construction, marking, matters to be clearly stated	8.2
6.1 Operating property	8.3
6.7 Actuation of test device	8.9
6.12 (1) Trip at 200 % current	8.14.2
6.19 Insulation resistance	8.20
6.20 Dielectric withstand voltage	8.21
6.3.1 Residual operating current	8.5.1
6.8.1 Operating overvoltage	8.10.1

10. Designation of products The product shall be designated by the name, purpose of protection, electrical system and number of poles, rated voltage, rated current, rated breaking capacity (RCOCB also serves as molded-case circuit-breaker), rated residual operating current, and breaking time (by residual current).

Example 1. Current operated type RCOCB (or ELCB), exclusively for earth-fault protection, single-phase two-wire system, two poles (or 2 P),  $U_c$  100 V/200 V,  $I_n$  20 A,  $I_{\Delta n}$  30 mA, 0.1 s

Example 2. Current operated type RCOCB (or ELCB), for earth-fault and short-circuit protection (also serves as molded-case circuit-breaker), three-phase three-wire system, three poles (or 3P),  $U_c$  200 V exclusive,  $I_n$  30 A,  $I_{cn}$  35000 A (or 35 kA),  $I_{\Delta n}$  30 mA, 0.1 s

## 11. Marking

11.1 Body of RCOCB The following items shall be indelibly marked at an easily visible place on the surface of each RCOCB:

- (1) Name (for interchangeable type according to JIS, the fact shall be marked)
- (2) Classification by purpose of protection (this shall be marked in such cases that the RCOCB serves also for overload protection, for overload and short-circuit protection and for induction motor protection. RCOCB which serves also for overload and short-circuit protection may be marked as RCOCB which also serves as molded-case circuit breaker)
- (3) Rated voltage (if two voltages mark 100 V - 200 V for example)
- (4) Rated frequency (mark 50 Hz or 60 Hz if exclusive)
- (5) Rated current(<sup>45</sup>)
- (6) Rated residual operating current
- (7) Break time (by residual current)
- (8) Limiting non-actuation time (mark for time-delay type)
- (9) Rated residual non-operating current (may be omitted when this is 50 % of rated residual operating current)
- (10) Number of poles and electric line system or their abbreviation (e.g. 3 P, 3 $\phi$  3W, mark number of elements for two-pole one-element system)
- (11) Reference ambient temperature(<sup>46</sup>)
- (12) Rated short-time current(<sup>47</sup>) [rated breaking capacity (rated breaking current) for RCOCB which also serves as molded-case circuit-breaker]
- (13) Guaranteed value of cord protection(<sup>48</sup>) (Guaranteed value at guaranteed voltage)

- (14) Manufacturer's name or abbreviation
- (15) Year and month of manufacture or their abbreviation
- (16) Rated voltage to earth (mark, if necessary)
- (17) Protective function for neutral line failure in single-phase three-wire system (if RCOCB has function to open the circuit at the time of neutral line failure in single-phase three-wire system, mark it as "with protection for neutral line failure in single-phase three-wire system")
- (18) RCOCB of a rated residual operating current not exceeding 10 mA without lightning impulse non-actuation function shall be marked with such facts.
- (19) Explanation for operation of test button [for example, mark "verify that this RCOCB is brought to open position (or OFF) by pushing the test button"]

Notes (<sup>45</sup>) This shall be also marked on the release, if it is replaceable.

(<sup>46</sup>) In the case of 40°C this may be omitted.

(<sup>47</sup>) If the breaking capacity differs according to the rated voltage, the behavior due to them shall be marked.

(<sup>48</sup>) This shall be marked only for RCOCB in which cord protection is guaranteed.

Remarks: The marking of the item (4) on main body may be omitted.

11.2 Markings on accessories The following markings shall be carried out, if the following accessories are attached to the RCOCB:

(1) Auxiliary switch and alarm switch

- (a) Rated voltage of switch
- (b) Terminal marks

(2) Voltage release and overvoltage release

- (a) Rated voltage of operating circuit
- (b) Frequency (ones exclusively used at 50 Hz or 60 Hz only)
- (c) Rated time of short-time rated one (for continuous rated one, such a marking is not necessary)
- (d) Terminal marks

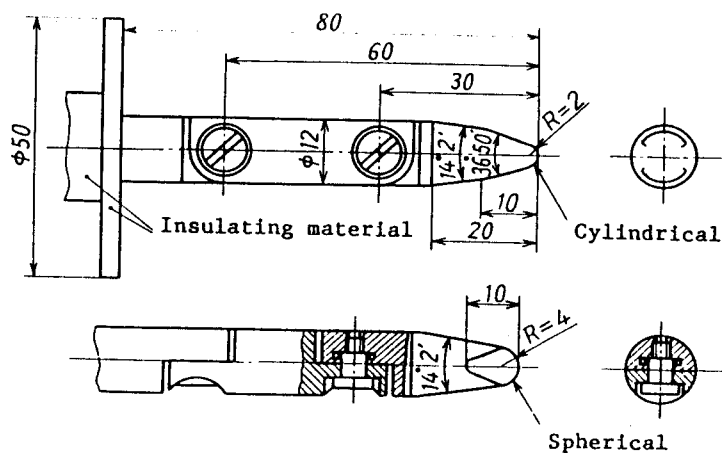
(3) Electrical operating device

- (a) Rated voltage of operating circuit
- (b) Frequency (ones exclusively used at 50 Hz or 60 Hz only)
- (c) Terminal marks

12. Matters to be clearly stated When the marking of rated frequency is omitted according to the Remarks of 11.1, it shall be clearly stated in the instruction manual, catalog or other technical data.

Attached Fig. 1. Test finger (example)

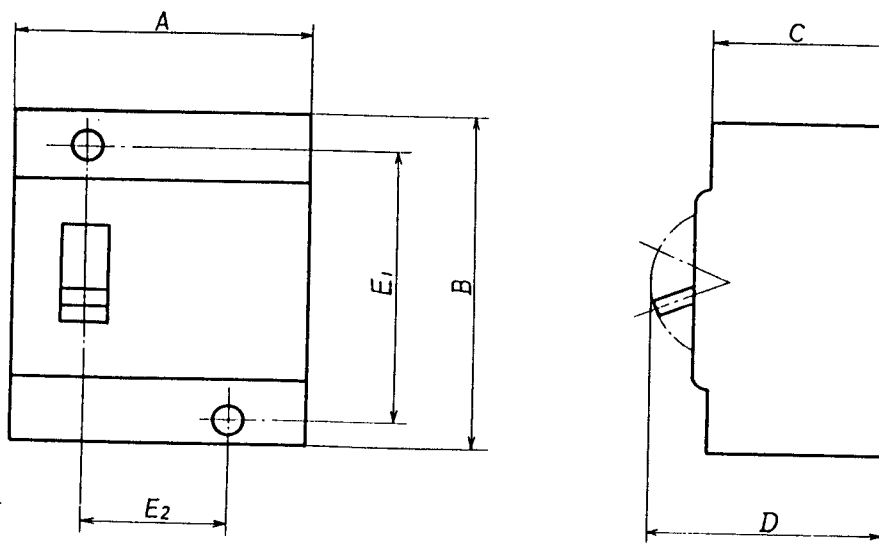
Unit: mm



Remarks 1. Tolerances on angle are  $\pm 5'$ .

2. Tolerances on dimension are  $-0.05^0$  mm, for a dimension less than 25 mm, and are  $\pm 0.2$  mm for a dimensions not less than 25 mm.

Attached Fig. 2. External dimensions and mounting dimensions of RCOCB of interchangeable type

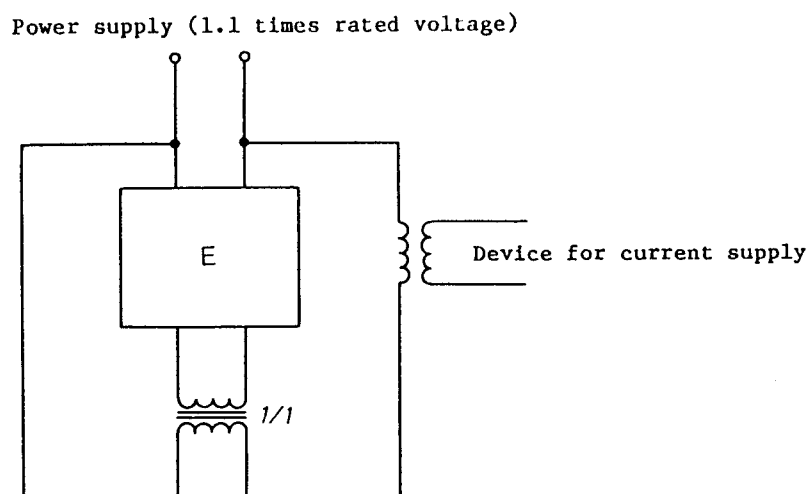


Unit: mm

Kind of RCOCB	External dimensions				Mounting dimensions	
	A	B	C	D	E <sub>1</sub>	E <sub>2</sub>
Two-pole type	68 $\pm$ 1	70 $\pm$ 1	40 $\pm$ 1	65 max.	60 $\pm$ 0.5	34 $\pm$ 0.5
Three-pole horizontal type	90 $\pm$ 1	80 $\pm$ 1	40 $\pm$ 1	65 max.	70 $\pm$ 0.5	56 $\pm$ 0.5

Remarks: In the three-pole RCOCB of single-phase three-wire system equipped with protection for neutral line failure which belongs three-pole horizontal RCOCB of interchangeable type and is used for a household distribution board, the terminal of neutral pole shall be so constructed that the wire is clamped by two pressing screws.

Attached Fig. 3. Test circuit diagram for aging of electronic components (Example)



E: RCOCB to be tested

Attached Table 1. Cited Standards

- JIS C 0911 Vibration testing procedure for electric machines and equipment
- JIS C 0912 Shock testing procedure for electric machines and equipment
- JIS C 3306 Polyvinyl chloride insulated flexible cords
- JIS C 3307 600 V grade polyvinyl chloride insulated wires
- JIS C 4004 General rules for rotating electrical machines
- JIS C 8303 Plugs and receptacles for domestic and similar general use
- JIS C 8304 Small switches for indoor use
- JIS C 8306 Testing methods for wiring devices
- JIS C 8325 AC electromagnetic switches
- JIS K 8116 Ammonium chloride
- JIS K 8576 Sodium hydroxide
- JIS R 3503 Glass apparatus for chemical analysis

Annex 1. Residual current operated circuit breaker which also serves for protection of induction motor

1. Scope This annex specifies RCOCB's which also serve as the overload and short-circuit protection of lines of a.c. 600 V or less at a frequency 50 Hz or 60 Hz, and the overload protection of single-phase or three-phase induction motors connected to the above lines.

For matters not specified in this annex, the provisions stated in this text shall apply.

2. Rated current The rated current shall be determined by taking the full-load current of the induction motor into consideration, and no standard values are specified.

3. Operating mechanism In a long time-delay release, the current setting may be designed adjustable so that the setting of rated current to match the different full load current behavior of each motor is possible.

In the adjustable current setting device, adjustable current scales are provided and the tripping characteristic given in Table 10 in this text shall be satisfied at each set value of current in the adjustable range.

4. Current carrying and long time-delay trip

4.1 Trip at 200 % current The overcurrent release shall operate automatically within the appropriate time shown in Annex 1 Table 1, when tested in accordance with 8.14.2 of this text.

Annex 1 Table 1. Operating time of overcurrent release

Rated current ( $I_n$ ) A	Operating time min	
	200 % of rated current	125 % of rated current
$I_n \leq 30$	Within 2 (within 3)	Within 60
$30 < I_n \leq 50$	Within 4 (within 5)	Within 60
$50 < I_n \leq 100$	Within 6	Within 120
$100 < I_n \leq 225$	Within 8	Within 120

Remarks: The values in parentheses are applicable only for such a case that wires of an ampacity not less than 1.25 times the rated current of motor is used in the branch circuit exclusively for the motor, in accordance with the installation for branch circuit to motor or the like number 6 (b) in article 186 of the Technical Standard for Electrical Facilities.

4.2 Trip at 125 % current The overcurrent release shall operate automatically within the appropriate time shown in Annex 1 Table 1, when tested in accordance with 8.14.3 of this text.

4.3 Carrying 100 % current The overcurrent release shall not operate when tested in accordance with 8.14.4 of this text.

4.4 Trip at 600 % current The overcurrent release shall operate automatically at a time 2 s or more but within 30 s from overcurrent when tested in accordance with 5.1.

## 5. Test method

5.1 Test for trip at 600 % current Carry out the test for trip at 600 % current, by passing 600 % of the rated current or set current through every pole at the same time.



Annex 2. Residual current operated circuit breakers  
for household distribution boards

1. Scope This annex specifies RCOCB's of a rated current not exceeding 30 A which are mainly used for the branch circuits of household distribution boards to be installed in the vicinity of service entrance of indoor lines at a frequency 50 Hz or 60 Hz and of 100 V single-phase two-wire system or 100/200 V single-phase three-wire system.

For matters not specified in this annex, the provisions stated in this text shall apply.

2. Ratings

2.1 Rated currents Table 1. The rated currents shall be as shown in Annex 2

Annex 2 Table 1. Rated currents		
Unit: A		
Rated current ( $I_n$ )		
15	20	30

2.2 Rated voltages Table 2. The rated voltages shall be as shown in Annex 2

Annex 2 Table 2. Rated voltages	
Unit: V	
Rated voltage ( $U_c$ )	
100	100/200

2.3 Rated breaking capacities In general, the rated breaking capacities shall be as given in Annex 2 Table 3.

Annex 2 Table 3. Rated breaking capacities		
Unit: A		
Rated breaking capacities ( $I_{cn}$ )		
(1000)	1500	2500

Remarks: The value in parentheses shall not be used as far as possible.

3. Number of poles and number of tripping elements The number of poles and number of tripping elements shall be as given in Annex 2 Table 4.

Annex 2 Table 4. Number of poles and number of tripping elements

Number of poles	Rated voltage ( $U_c$ ) V	Number of tripping elements
Two	100	1
	100/200	2

4. Reference temperature for operation The reference temperature for operation shall be either 25°C or 40°C.

#### 5. Performances

5.1 Dielectric withstand voltage The RCOCB shall satisfy the provision of 6.20 in this text, when tested in accordance with 7.2.

5.2 Short-circuit current breaking The RCOCB shall satisfy the provision of 6.21 in this text, when tested in accordance with 7.3.

6. Construction in general The construction of RCOCB's shall comply with the following requirements:

- (1) The earth side terminal of RCOCB equipped with one overcurrent tripping element shall be indelibly marked with such fact.

The earth side terminal shall be marked with "N".

- (2) The overcurrent tripping element of a RCOCB equipped with one overcurrent tripping element shall be mounted on voltage line side.
- (3) The enclosure, cover of terminal part and the parts operated by a man shall be of insulating materials. However, the parts not easily accessed by a man are exempted from the above requirement.
- (4) The hole of 4 mm diameter for measurement of insulation resistance shall be provided on the cover of terminal part. Between the hole and the terminal part, there shall be a creepage distance of 6 mm or more and a clearance of 4 mm or more.
- (5) The opening and closing operation shall be made by a single operation without requiring reset operation.

#### 7. Test methods

7.1 Construction test In the construction test, examine the matters specified in 6 and 8 of this Annex, and 7 and 12 of this text.

7.2 Dielectric withstand voltage test Carry out the dielectric withstand voltage test as follows:

- (1) Test voltage The voltage to be applied to various parts of RCOCB shall be 1500 V (r.m.s. value of a.c. component).
- (2) Positions of voltage application As specified in 8.21 (2) of this text.

7.3 Short circuit test Carry out the short circuit test under the conditions given below.

- (1) Circuit conditions As specified in 8.22 (1) of this text.
- (2) Operating duty As specified in 8.22 (2) of this text.
- (3) Duration of test voltage application As specified in 8.22 (3) of this text.
- (4) Test method Carry out the test in the circuit of Fig. 4 (a) in this text, once on each pole having the tripping element. Then carry out the test once in the circuit of Fig. 4 (b) in this text on two-pole one-element RCOCB, and in the circuit of Fig. 4 (d) in this text on two-pole two-element RCOCB.

8. Marking The number of overcurrent tripping elements shall be marked, in addition to compliance with the provisions of 11. in this text.

### Annex 3. Four-pole residual current operated circuit breaker

1. Scope This annex specifies four-pole RCOCB's equipped with an exclusive pole for connection with neutral line (hereafter referred to as the "neutral pole") which are used for protection of three-phase four-wire lines of a.c. 600 V or less at a frequency 50 Hz or 60 Hz.

For matters not specified in this annex, the provisions stated in this text shall apply.

#### 2. Performances

2.1 Current carrying and long time-delay trip When the test is carried out as specified in 4.2, the results shall comply with 6.12 of this text.

2.2 Making and breaking of overload current When the test is carried out as specified in 4.3, the results shall comply with 6.15 of this text.

2.3 Temperature rise When the test is carried out as specified in 4.4, the results shall comply with 6.17 of this text.

2.4 Mechanical and electrical endurance (to switching) When the test is carried out as specified in 4.5, the results shall comply with 6.18 of this text.

2.5 Short-circuit current breaking When the test is carried out as specified in 4.6, the results shall comply with 6.21 of this text.

#### 3. Construction

3.1 Behavior of neutral pole The correlationship of neutral pole with other three poles at opening and closing shall be either of those given below.

- (1) They open and close at the same time
- (2) The neutral pole contacts earlier in closing and opens later in opening.

3.2 Marking of neutral pole The neutral pole shall be marked with such fact that this is the neutral pole with indelible way.

3.3 Number of tripping elements The number of tripping elements shall be 3, the tripping element is not necessarily provided on neutral pole.

3.4 Current carrying part of neutral pole This part shall have a continuous current carrying capacity equal to the rated current on the other three poles.

However, for RCOCB's of a rated current exceeding 200 A, the continuous current carrying capacity may be reduced to 50 % or more (200 A at the minimum) of the rated current on other three poles.

3.5 Size of neutral-pole terminal The terminal shall have the same size as those of other three poles.

#### 4. Test methods

4.1 Construction test In the construction test, examine the matters specified in 3 of this Annex, and 7, 11 and 12 of this text.

4.2 Current carrying and long time-delay trip test Follow 8.14 of this text. For RCOCB's having no release on the neutral pole, current is not necessarily passed through the neutral pole.

4.3 Overload current making and breaking test Carry out the test in accordance with the following requirements:

- (1) The test circuit conditions, operating system, number of switching cycles, and rate of switching shall be as specified in Table 23 of this text.
- (2) Carry out the test on three poles excluding neutral pole as if the specimen were a three-pole RCOCB.

4.4 Temperature test Carry out the test as follows:

- (1) Carry out the test as specified in 8.18 of this text.
- (2) Carry out the test on three poles excluding neutral pole, as if the specimen were a three-pole RCOCB.
- (3) Connect the neutral pole with the adjacent pole in series, and carry out the additional test at a current equal to the continuous current carrying capacity of the neutral pole.

If the continuous current carrying capacity of the neutral pole is equal to the rated current on the other three poles, the four poles may be tested simultaneously in the test of (2).

4.5 Mechanical and electrical endurance test Carry out the test as follows:

- (1) Carry out the test as specified in 8.19 of this text.
- (2) Carry out the test on three poles excluding neutral pole as if the specimen were a three-pole RCOCB.
- (3) Connect the neutral pole with the adjacent pole in series, and carry out the switching with current only, under a single-phase power supply at a voltage equal to  $\frac{1}{\sqrt{3}}$  of the test voltage at three phases as the additional test. The test current shall be a current equal to the continuous current carrying capacity of the neutral pole. This test may be carried out on a separate specimen.

4.6 Short-circuit test Carry out the short-circuit test as follows:

- (1) Carry out the test as specified in 8.22 of this text.
- (2) Carry out the test on three poles excluding neutral pole as if the specimen were a three-pole RCOCB.
- (3) Connect the neutral pole with the adjacent pole in series, and carry out the test once in the circuit of Fig. 4 (b) in this text. The test voltage shall be  $\frac{1}{\sqrt{3}}$  of the test voltage at three phases and the test current shall be a current equal to the rated breaking capacity. This test may be carried out on a separate specimen.

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