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Residual current operated circuit breakers

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**In the event of any doubt arising,
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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.

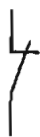
- (g) residual current release A release which carries out tripping action against the earth fault current.
- (h) overvoltage release A release which carries out action against the overvoltage appearing across the voltage pole and neutral pole.
- (i) test device A device by which the actuation of the 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 RCOB 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 RCOB. 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_{Δ}) 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⁽¹⁾.
- Note ⁽¹⁾ 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⁽¹⁾.
 - (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.

3. Standard service conditions Unless otherwise specified, RCOCB's shall be used under the standard service conditions stated below. As for the service under the conditions other than the standard service conditions, it is subjected to the agreement between the purchaser and supplier.

- (1) An ambient temperature range of -10°C to 40°C . Providing, the average value over 24 h shall not exceed 35°C .
- (2) An altitude not exceeding 2000 m
- (3) A relative humidity range of 45 % to 85 %
- (4) Where the RCOCB does not receive abnormal vibration or shock.
- (5) Atmosphere without existence of excess steam, oil vapor, smoke, dust, salt, corrosive substances, etc.

4. Classification RCOCB's are classified as follows:

4.1 Classification according to electrical system and number of poles

- | | |
|--------------------------------|---|
| (1) Single-phase 2-wire system | 2 poles (for earthed plug socket),
2 poles (for neutral earthed circuit) |
| (2) Single-phase 3-wire system | 3 poles |
| (3) Three-phase 3-wire system | 3 poles |
| (4) Three-phase 4-wire system | 4 poles |

4.2 Classification according to purpose of protection

- (1) Exclusively for earth fault protection
- (2) For earth fault and overload protection
- (3) For earth fault, overload and short-circuit protection
- (4) For earth fault and short-circuit protection
- (5) For also neutral line failure protection for single-phase 3-wire system
- (6) For also induction motor protection

4.3 Classification according to operating time

- (1) High speed type
- (2) Time delay type
- (3) Inverse time type

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_n)						
100	200	100/200(²)	230	240(265)	400	415(460)

Note (²) 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_n)						
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_m)	
1000 ⁽³⁾	30000
1500	35000
2500	42000
5000	50000
7500	65000
10000	85000
14000	100000
18000	125000
22000	150000
25000	200000

Note (3) 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_{cs}) ⁽⁴⁾
$I_n \leq 30$	1000 ⁽⁵⁾ 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 ⁽⁴⁾ This is the r.m.s. value of a.c. component 1/2 cycle after occurrence of short circuit.

⁽⁵⁾ 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. 4934

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 ⁽⁶⁾ and silver alloys	- ⁽⁷⁾
	Others	40
Joint ⁽⁸⁾	Silver, silver plating and silver alloys	- ⁽⁷⁾
	Between tin, solder or nickel plated parts one to another	60 ⁽⁹⁾
	Others	40
Insulation	Synthetic resin products	- ⁽¹⁰⁾
Terminals		60 ⁽¹¹⁾
Blade and blade receptacle of RCOCB of plug-in type		30
Filling compound		- ⁽¹²⁾
Manually operated parts	Insulating material	35 ⁽¹³⁾



- 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 Ω . 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 Ω . 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.