

Specification for

Low-voltage switchgear and controlgear

Part 2. Circuit-breakers

The European Standard EN 60947-2 : 1991 has the status of a
British Standard

Spécification de l'appareillage à basse tension
Deuxième partie: Disjoncteurs

Spezifikation für
Niederspannung-Schaltgeräte
Teil 2: Leistungsschalter

Cooperating organizations

The European Committee for Electrotechnical Standardization (CENELEC), under whose supervision this European Standard was prepared, comprises the national committees of the following countries.

Austria	Italy
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This British Standard, having been prepared under the direction of the Power Electrical Engineering Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on
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Amendments issued since publication

Amd. No.	Date	Text affected

Amendment No. 1
published and effective from 15 September 1993
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Specification for low-voltage switchgear and controlgear
Part 2. Circuit-breakers

NOTE. The English language version of European Standard EN 60947-2 was implemented in the UK by the publication of BS EN 60947-2 : 1992. This amendment implements the corrigendum issued in March 1993 and Amendment 1 : 1993 to EN 60947-2 : 1991.

This amendment together with European Standard EN 60947-2 : 1991 has the status of a British Standard.

Revised text

National foreword

In line 4 of paragraph 1, after 'Circuit-breakers,' insert 'together with amendment 1 : 1993 and the corrigendum of March 1993,'.

In line 6 of paragraph 1, after 'and 1990,' insert 'and amendment 1 : 1992,'.

AMD 7853/September 1993

EN amendment title page and foreword

After the existing EN title page insert the attached EN amendment title page (foreword on reverse).

AMD 7853/September 1993

Foreword to EN 60947-2

After the implementation dates, insert the following.

'For products which have complied with HD 418.1 S1 : 1982 before 1992-09-30, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 1997-09-30.'

AMD 7853/September 1993

Text of EN 60947-2

Amend the text of European Standard EN 60947-2 in accordance with the details given on the attached pages.

AMD 7853/September 1993

National annex NC. Cross-references

Insert the following publication details.

TEC 68-2-30 : 1980	BS 2011 Environmental testing
	Part 2.1 Tests
	Part 2.1Db : 1981 Test Db and guidance: Damp heat, cyclic (12 + 12 hour cycle)

AMD 7853/September 1993

UDC 621.316.542 : 620.1

Descriptors: Low-voltage switchgear and controlgear, circuit-breaker, definition, classification, characteristics, test

Amendment A1 to the English version of EN 60947-2

Low-voltage switchgear and controlgear Part 2: Circuit-breakers

(IEC 947-2 : 1989/A1 : 1992)

Appareillage à basse tension
Deuxième partie: Disjoncteurs
(CEI 947-2 : 1989/A1 : 1992)

Niederspannung-Schaltgeräte
Teil 2: Leistungsschalter
(IEC 947-2 : 1989/A1 : 1992)

This amendment A1 modifies the European Standard EN 60947-2 : 1992. It was approved by CENELEC on 1993-03-09. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this amendment the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This amendment exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword to amendment A1

At the request of the CENELEC Technical Committee TC 17B, Low-voltage switchgear and controlgear including dimensional standardization, the text of amendment 1 : 1992 to the International Standard IEC 947-2 : 1989 was submitted to the CENELEC Unique Acceptance Procedure (UAP) in April 1992 for acceptance as a European Standard.

The text of the amendment to the International Standard was approved by CENELEC as amendment A1 to EN 60947-2 on 9 March 1993.

The following dates were fixed:

- latest date of publication of
an identical national standard (dop) 1994-03-01
- latest date of withdrawal of
conflicting national standards (dow) 1994-03-01

For products which have complied with EN 60947-2 : 1991 before 1994-03-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 1999-03-01.

Annexes designated 'normative' are part of the body of the standard. In this standard, annex ZA is normative.

CONTENTS

Appendix A

Replace the existing title by the following new title:

Coordination under short-circuit conditions between a circuit-breaker and another short-circuit protective device associated in the same circuit ...

Appendix B

Delete from the text of the title the words: "(under consideration)".

APPENDIX A

Replace the existing appendix A by the following new appendix A:

Appendix A

Coordination under short-circuit conditions between a circuit-breaker and another short-circuit protective device associated in the same circuit

INTRODUCTION

To ensure coordination under short-circuit conditions between a circuit-breaker (C_1) and another short-circuit protective device (SCPD) associated with it in the same circuit, it is necessary to consider the characteristics of each of the two devices as well as their behaviour as an association.

NOTE - An SCPD may incorporate additional protective means, for example, overload releases.

The SCPD may consist of a fuse (or a set of fuses) - see figure A.1 - or of another circuit-breaker (C_2) (see figures A.2 to A.5.)

The comparison of the individual operating characteristics of each of the two associated devices may not be sufficient, when reference has to be made to the behaviour of these two devices operating in series, since the impedance of the devices is not always negligible. It is recommended that this should be taken into account. For short-circuit currents it is recommended that reference be made to I^2t instead of time.

C_1 is frequently connected in series with another SCPD for reasons such as the method of power distribution adopted for the installation or because the short-circuit breaking capacity of C_1 alone may be insufficient for the proposed application. In such instances the SCPD may be mounted in locations remote from C_1 . The SCPD may be protecting a main feeder supplying a number of circuit-breakers C_1 or just an individual circuit-breaker.

For such applications the user or specifying authority may have to decide, on the basis of a desk study alone, how the optimum level of coordination may best be achieved. This appendix is intended to give guidance for this decision, and also on the type of information which the circuit-breaker manufacturer should make available to the prospective user.

Guidance is also given on test requirements, where such tests are deemed necessary for the proposed application.

The term "coordination" includes consideration of discrimination (see 2.5.23 of Part 1 and also 2.17.2 and 2.17.3) as well as consideration of back-up protection (see 2.5.24 of Part 1).

Consideration of discrimination can in general be carried out by desk study (see clause A.5), whereas the verification of back-up protection normally requires the use of tests (see Clause A.6).

When considering short-circuit breaking capacity, reference may be made to the rated ultimate short-circuit breaking capacity (I_{cu}), or to the rated service short-circuit breaking capacity (I_{cs}), according to the desired criterion.

A.1 Scope

This appendix gives guidance on and requirements for the coordination of circuit-breakers with other SCPDs associated in the same circuit, as regards discrimination as well as back-up protection.

A.2 Object

The object of this appendix is to state:

- the general requirements for the coordination of a circuit-breaker with another SCPD;
- the methods and the tests (if deemed necessary) intended to verify that the conditions for coordination have been met.

A.3 General requirements for the coordination of a circuit-breaker with another SCPD

A.3.1 General considerations

Ideally, the coordination should be such that a circuit-breaker (C_1) alone will operate at all values of overcurrent up to the limit of its rated short-circuit breaking capacity I_{cu} (or I_{cs}).

NOTE - If the value of the prospective fault current at the point of installation is less than the rated ultimate short-circuit breaking capacity of C_1 , it may be assumed that the SCPD is only in the circuit for considerations other than those of back-up protection.

In practice, the following considerations apply:

- a) if the value of the selectivity limit current I_s (see 2.17.4) is too low, there is a risk of unnecessary loss of discrimination.
- b) if the value of the prospective fault current at the point of installation exceeds the rated ultimate short-circuit breaking capacity of C_1 , the SCPD shall be so selected that the behaviour of C_1 is in accordance with A.3.3 and the take-over current I_B (see 2.17.6), if any, complies with the requirements of A.3.2.

Whenever possible, the SCPD shall be located on the supply side of C_1 . If the SCPD is located on the load side, it is essential that the connection between C_1 and the SCPD be so arranged as to minimize any risks of short-circuit.

NOTE - In the case of interchangeable releases, these considerations should apply to each relevant release.

A.3.2 Take-over current

For the purpose of back-up protection the take-over current I_B shall not exceed the rated ultimate short-circuit breaking capacity I_{cu} of C_1 alone (see figure A.4).



A.3.3 Behaviour of C_1 in association with another SCPD

For all values of overcurrent up to and including the short-circuit breaking capacity of the association, C_1 shall comply with the requirements of 7.2.5 of Part 1, and the association shall comply with the requirements of 7.2.1.2.4 item a).

A.4 Type and characteristics of the associated SCPD

On request, the manufacturer of the circuit-breaker shall provide information on the type and the characteristics of the SCPD to be used with C_1 , and on the maximum prospective short-circuit current for which the association is suitable at the stated operational voltage.

Details of the SCPD used for any tests made in accordance with this appendix, i.e. manufacturer's name, type designation, rated voltage, rated current and short-circuit breaking capacity, shall be given in the test report.

The maximum conditional short-circuit current (see 2.5.29 of Part 1) shall not exceed the rated ultimate short-circuit breaking capacity of the SCPD.

If the associated SCPD is a circuit-breaker, it shall meet the requirements of this Part, or any other relevant standard.

If the associated SCPD is a fuse, it shall be in accordance with the appropriate fuse standard.

A.5 Verification of discrimination

Discrimination can normally be considered by desk study alone, i.e. by a comparison of the operating characteristics of C_1 and the associated SCPD, for example, when the associated SCPD is a circuit-breaker (C_2) provided with an intentional time-delay.

The manufacturers of both the C_1 and the SCPD shall provide adequate data concerning the relevant operating characteristics so as to permit I_s to be determined for each individual association.

In certain cases, tests at I_s are necessary on the association, for example:

- when C_1 is of the current-limiting type and C_2 is not provided with an intentional time-delay;
- when the opening time of the SCPD is less than that corresponding to one half-cycle.

To obtain the desired discrimination when the associated SCPD is a circuit-breaker, an intentional short-time delay may be necessary for C_2 .

Discrimination may be partial (see figure A.4) or total up to the rated short-circuit breaking capacity I_{cu} (or I_{cs}) of C_1 . For total discrimination, the non-tripping characteristic of C_2 or the pre-arcing characteristic of the fuse shall lie above the tripping (break-time) characteristic of C_1 .

Two illustrations of total discrimination are given in figures A.2 and A.3.

A.6 Verification of back-up protection

A.6.1 Determination of the take-over current

Compliance with the requirements of A.3.2 can be checked by comparing the operating characteristics of C_1 and the associated SCPD for all settings of C_1 and, if applicable, for all settings of C_2 .

A.6.2 Verification of back-up protection

a) Verification by tests

Compliance with the requirements of A.3.3 is normally verified by tests in accordance with A.6.3. In this case, all the conditions for the tests shall be as specified in 8.3.2.6 with the adjustable resistors and inductors for the short-circuit tests on the supply side of the association.

b) Verification by comparison of characteristics

In some practical cases and where the SCPD is a circuit-breaker (see figures A.4 and A.5), it may be possible to compare the operating characteristics of C_1 and of the associated SCPD, special attention being paid to the following:

- the Joule integral value of C_1 at its I_{cu} and that of the SCPD at the prospective current of association;
- the effects on C_1 (e.g. by arc energy, by maximum peak current, cut-off current) at the peak operating current of the SCPD.

The suitability of the association may be evaluated by considering the maximum total operating I^2t characteristic of the SCPD, over the range from the rated short-circuit breaking capacity I_{cu} (or I_{cs}) of C_1 up to the prospective short-circuit current of the application, but not exceeding the maximum let-through I^2t of C_1 at its rated short-circuit breaking capacity or other lower limiting value stated by the manufacturer.

NOTE - Where the associated SCPD is a fuse, the validity of the desk study is limited up to I_{cu} of C_1 .

A.6.3 Tests for verification of back-up protection

If C_1 is fitted with adjustable overcurrent opening releases, the operating characteristics shall be those corresponding to the minimum time and current settings.

If C_1 can be fitted with instantaneous overcurrent opening releases, the operating characteristics to be used shall be those corresponding to C_1 fitted with such releases.

If the associated SCPD is a circuit-breaker (C_2) fitted with adjustable overcurrent opening releases, the operating characteristics to be used shall be those corresponding to the maximum time and current settings.

Where applicable, the connecting cables shall be included as specified in 8.3.2.6.4 except that, if the associated SCPD is a circuit-breaker (C_2), the full length of cable (75 cm) associated with this circuit-breaker may be on the supply side (see figure A.6).

Each test shall consist of a O - t - CO sequence of operations made in accordance with 8.3.5 of this part, whether at I_{cu} or I_{cs} , the CO operation being made on C_1 .

A test is made with the maximum prospective current for the proposed application. This shall not exceed the rated conditional short-circuit (see 4.3.6.4 of Part 1).

A further test shall be made at a value of prospective current equal to the rated short-circuit breaking capacity I_{cu} (or I_{cs}) of C_1 , for which test a new sample C_1 may be used, and also, if the associated SCPD is a circuit-breaker, a new sample C_2 .

During each operation:

- a) if the associated SCPD is a circuit-breaker (C_2):
 - either both C_1 and C_2 shall trip at both test currents, no further tests then being required.

This is the general case and provides back-up protection only.

- or C_1 shall trip and C_2 shall be in the closed position at the end of each operation, at both test currents, no further tests then being required.

This requires that the contacts of C_2 separate momentarily during each operation. In this case restoration of the supply is provided, in addition to back-up protection (see note 1 to figure A.4). The duration of interruption of supply, if any, shall be recorded during these tests.

- or C_1 shall trip at the lower test current, and both C_1 and C_2 shall trip at the higher test current.

This requires that the contacts of C_2 separate momentarily at the lower test current. Additional tests shall be made at intermediate currents to determine the lowest current at which both C_1 and C_2 trip, up to which current restoration of supply is provided. The duration of interruption of supply, if any, shall be recorded during these tests.

- b) if the associated SCPD is a fuse (or a set of fuses):
 - in the case of a single phase circuit at least one fuse shall blow;
 - in the case of a multiphase circuit at least two fuses shall blow.

A.6.4 Results to be obtained

8.3.4.1.7 of part 1 applies.

Following the tests, C_1 shall comply with 8.3.7.7 and 8.3.7.8.

In addition, if the associated SCPD is a circuit-breaker (C_2), it shall be verified that the contacts of C_2 have not welded by manual operation or other appropriate means.

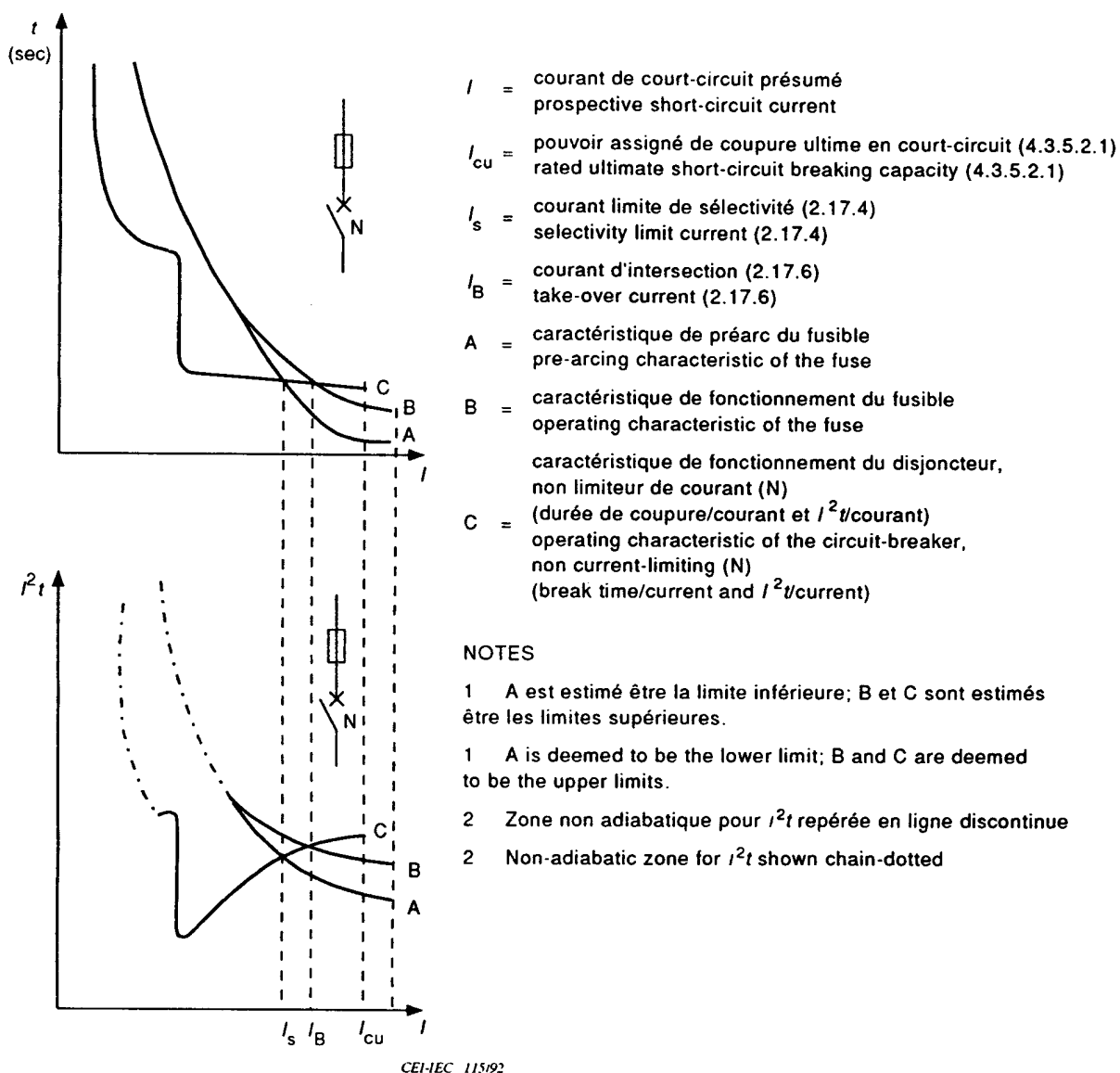
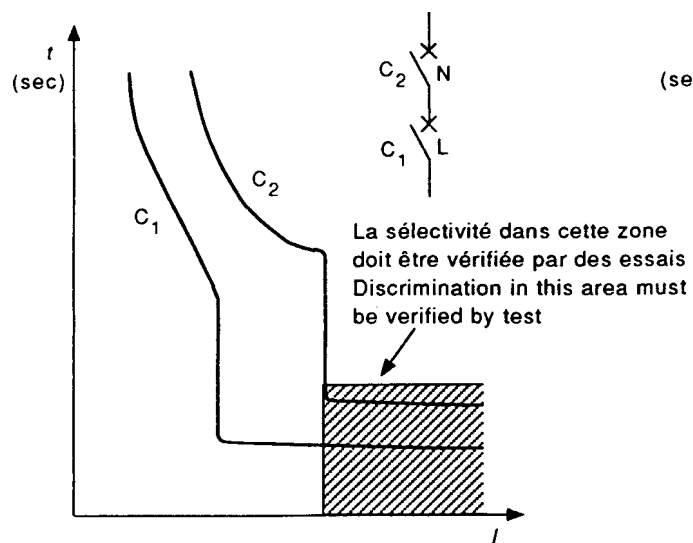


Figure A.1

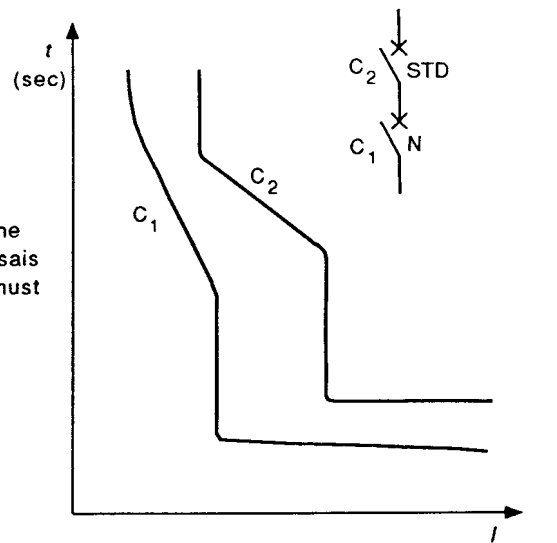
Coordination pour la surintensité entre un disjoncteur et un fusible ou protection d'accompagnement par un fusible: caractéristiques de fonctionnement

Overcurrent coordination between a circuit-breaker and a fuse or back-up protection by a fuse: operating characteristics



CEI-IEC 116/92

Figure A.2



CEI-IEC 117/92

Figure A.3

C_1 = disjoncteur limiteur de courant (L)
(caractéristique de temps de coupure)
current-limiting circuit-breaker (L)
(break time characteristic)

C_2 = disjoncteur non limiteur de courant (N)
(caractéristique de déclenchement)
non current-limiting circuit-breaker (N)
(tripping characteristic)

C_1 = disjoncteur non limiteur de courant (N)
(caractéristique de temps de coupure)
non current-limiting circuit-breaker (N)
(break time characteristic)

C_2 = disjoncteur avec retard intentionnel de courte durée (STD)
(caractéristique de déclenchement)
circuit-breaker with intentional short-time delay (STD)
(tripping characteristic)

Les valeurs I_{cu} (ou I_{cs}) ne sont pas indiquées.

Values of I_{cu} (or I_{cs}) are not shown.

Sélectivité totale entre deux disjoncteurs
Total discrimination between two circuit-breakers

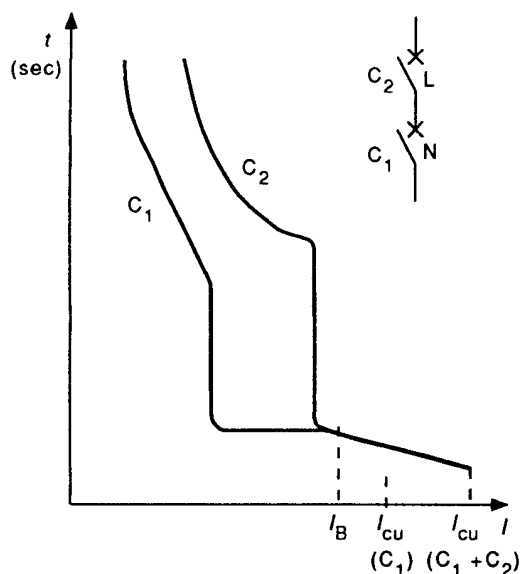


Figure A.4

C_1 = disjoncteur non limiteur de courant (N)
non current-limiting circuit-breaker (N)

C_2 = disjoncteur limiteur de courant (L)
current-limiting circuit-breaker (L)

I_B = courant d'intersection
take-over current

NOTES

- 1 Le cas échéant, le rétablissement de l'alimentation a lieu par C_2 .
- 2 $I_{cu} (C_1 + C_2) \leq I_{cu} (C_2)$.
- 3 Pour les valeurs de $I > I_B$, la courbe est celle de l'association (montrée en gras), pour laquelle les données doivent être obtenues par des essais.

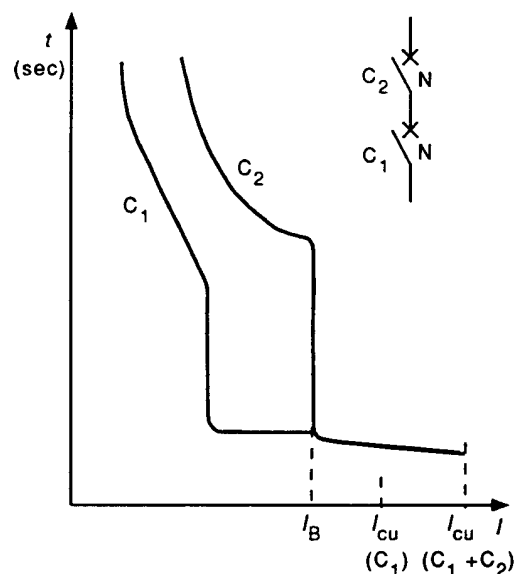


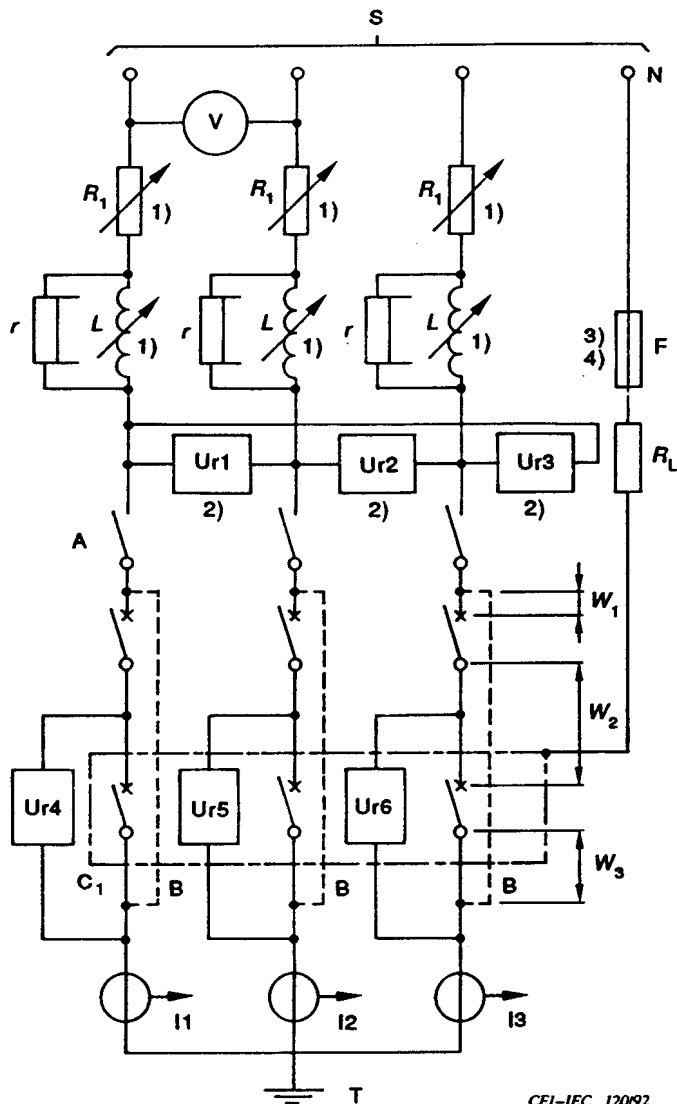
Figure A.5

C_1, C_2 = disjoncteurs non limiteurs de courant (N)
non current-limiting circuit-breakers (N)

NOTES

- 1 Where applicable, restoration of supply by C_2 occurs.
- 2 $I_{cu} (C_1 + C_2) \leq I_{cu} (C_2)$.
- 3 For values of $I > I_B$, the curve is that of the association (shown in bold) for which data must be obtained by tests.

Protection d'accompagnement par disjoncteur - Caractéristiques de fonctionnement
Back-up protection by a circuit-breaker - Operating characteristics



- S = source supply
- Ur1, Ur2, Ur3, = capteurs de tension
Ur4, Ur5, Ur6 voltage sensors
- V = dispositif de mesure de tension
voltage measuring device
- A = dispositif d'enclenchement
closing device
- R₁ = résistance réglable
adjustable resistor
- N = neutre de la source (ou neutre artificiel)
neutral of supply (or artificial neutral)
- F = élément fusible (8.3.4.1.2d) de la partie 1)
fusible element (8.3.4.1.2d) of Part 1)
- L = inductances réglables
adjustable reactors
- R_L = résistance de limitation du courant de défaut
fault current limiting resistor
- B = connexions provisoires d'étalonnage
temporary connections for calibration
- I1, I2, I3 = dispositifs d'enregistrement des courants
current sensing devices
- T = terre - un seul point de terre (côté charge ou côté sou
earth - one earthing point only (load side or supply sic
- r = résistance shunt (8.3.4.1.2b) de la partie 1)
shunting resistor (8.3.4.1.2b) of Part 1)
- W₁ = 75 cm de câble de courant assigné selon le DPCC
75 cm of cable rated for SCPD
- W₂ = 50 cm de câble de courant assigné selon C₁
50 cm of cable rated for C₁
- W₃ = 25 cm de câble de courant assigné selon C₁
25 cm of cable rated for C₁
- DPCC = disjoncteur C₂ ou jeu de 3 fusibles
SCPD = circuit-breaker C₂ or set of 3 fuses

NOTES

- 1 Les charges réglables L et R₁ peuvent être disposées, soit dans la partie haute tension, soit dans la partie basse tension du circuit d'alimentation, le dispositif d'enclenchement A étant disposé dans la partie basse tension.
- 2 Ur1, Ur2, Ur3 peuvent, en variante, être raccordés entre phase et neutre.
- 3 Dans le cas d'appareils destinés à être employés dans un réseau dont une phase est reliée à la terre, F doit être raccordé à une phase de l'alimentation.
- 4 Aux Etats-Unis et au Canada, F doit être relié:
 - à une phase de l'alimentation pour les matériels marqués d'une seule valeur de U_o;
 - au neutre pour les matériels marqués d'une double valeur de U_o (voir note de 5.2).

NOTES

- 1 Adjustable loads L and R₁ may be located either on the high voltage side or on the low voltage side of the supply circuit, the closing device A being located on the low voltage side.
- 2 Ur1, Ur2, Ur3 may, alternatively, be connected between phase and neutral.
- 3 In the case of devices intended for use in a phase-earthed network, F shall be connected to one phase of the supply.
- 4 In the USA and Canada, F shall be connected:
 - to one phase of the supply for equipment marked with a single value of U_o;
 - to the neutral for equipment marked with a twin voltage (see note to 5.2).

Figure A.6 - Exemple de circuit d'essai pour les essais de pouvoir de coupure en court-circuit montrant les connexions d'un disjoncteur triphasé (C₁)

Example of test circuit for conditional short-circuit breaking capacity tests showing cable connections for a 3-pole circuit-breaker (C₁)

Replace "Under consideration" by the following text:

Appendix B

Circuit-breakers incorporating residual current protection

INTRODUCTION

To provide protection against the effects of electric shock hazards, devices reacting to residual differential currents are used as protective systems. Such devices are frequently used in conjunction with or as an integral part of a circuit-breaker to achieve a two-fold goal, i.e.:

- providing protection of installations against overloads and short-circuit currents;
- providing protection of persons against indirect contact, i.e. hazardous increases of ground potential due to defective insulation.

Residual current devices may also provide additional protection against:

- fire and other hazards which may develop as a result of an earth fault of a lasting nature which cannot be detected by the overcurrent protective device.

Residual current devices having a rated residual current not exceeding 30 mA are also used as a means for additional protection against direct contact in case of failure of the relevant protective means.

The requirements for the installation of such devices are specified in various sections of IEC 364.

This appendix is essentially based upon the relevant requirements of IEC 755, IEC 1008 and IEC 1009.

B.1 General

B.1.1 Scope

This appendix applies to circuit-breakers providing residual current protection (CBRs). It covers the requirements for units which concurrently perform residual current detection, compare such measurements with a preset value and cause the protected circuit to be switched off when this value is exceeded.

This appendix applies to:

- circuit-breakers according to this standard which incorporate the residual current function as an integrated feature (hereinafter called integral CBRs);

- CBRs consisting of a combination of a residual current device (hereinafter called r.c. units) and a circuit-breaker according to this standard; their combination both mechanically and electrically, may be carried out either at the factory or in the field by the user according to the manufacturer's instructions.

NOTE - The neutral current sensing means, if any, may be external to the circuit-breaker or the combination, as the case may be.

This appendix applies only to CBRs intended for use in a.c. circuits.

The residual current function of CBRs covered by this appendix may or may not be functionally dependent on line voltage. CBRs depending on an alternative supply source are not covered by this appendix.

This appendix does not apply to equipment where the current sensing means (except the neutral current sensing means) or the processing device are mounted separately from the circuit-breaker.

B.1.2 *Object*

The object of this appendix is to state:

- a) the specific features of the residual current function;
- b) the specific requirements which shall be complied with by the CBR
 - under normal circuit conditions;
 - under abnormal circuit conditions, whether of a residual current nature or not;
- c) the tests which shall be performed to verify compliance with the requirements in b) above, together with the appropriate test procedures;
- d) the relevant product information.

B.2 **Definitions**

As a complement to Clause 2 of this part the following definitions, taken from (or derived from) those of IEC 755, apply:

B.2.1 *Definitions relating to currents flowing from live parts to earth*

B.2.1.1 **earth fault current:** Current flowing to earth due to an insulation fault.

B.2.1.2 **earth leakage current:** Current flowing from the live parts of the installation to earth in the absence of an insulation fault.

B.2.2 *Definitions relating to the energization of a CBR*

B.2.2.1 **energizing quantity:** An electrical energizing quantity which, alone or in combination with other such quantities, shall be applied to a CBR to enable it to accomplish its function under specified conditions.

B.2.2.2 **energizing input-quantity:** Energizing quantity by which the CBR is activated when it is applied under specific conditions.

These conditions may involve, for example, the energizing of certain auxiliary elements.

B.2.2.3 residual current (I_{Δ}): Vectorial sum of the currents flowing in the main circuit of the CBR, expressed as an r.m.s. value.

B.2.2.4 residual operating current: Value of the residual current which causes the CBR to operate under specified conditions.

B.2.2.5 residual non-operating current: Value of the residual current at which (and below which) the CBR does not operate under specified conditions.

B.2.3 Definitions relating to the operation and the functions of a CBR

B.2.3.1 circuit-breaker incorporating residual current protection (CBR): Circuit-breaker (see 2.1) designed to cause the opening of the contacts when the residual current attains a given value under specified conditions.

B.2.3.2 CBR functionally independent of line voltage: CBR for which the functions of detection, evaluation and interruption do not depend on the line voltage.

NOTE - This device is defined in 2.3.2 of IEC 755 as a residual current device without auxiliary source.

B.2.3.3 CBR functionally dependent on line voltage: CBR for which the functions of detection, evaluation and or interruption depend on the line voltage.

NOTES

1 This definition partially covers the definition of residual current devices with auxiliary source given in 2.3.3 of IEC 755.

2 It is understood that the line voltage for detection, evaluation or interruption is applied to the CBR.

B.2.3.4 detection: Function consisting of sensing the presence of a residual current.

NOTE - This function may for example, be performed, by a transformer effecting the vectorial sum of the currents.

B.2.3.5 evaluation: Function consisting of giving to the CBR the possibility to operate when the detected residual current exceeds a specified reference value.

B.2.3.6 interruption: Function consisting of bringing automatically the main contacts of the CBR from the closed position to the open position, thereby interrupting the current flowing through them.

B.2.3.7 limiting non-actuating time: Maximum delay during which a residual current higher than the rated residual non-operating current can be applied to the CBR without bringing it actually to operate.

B.2.3.8 time-delay CBR: CBR specially designed to attain a predetermined value of limiting non-actuating time corresponding to a given value of residual current.

The residual current time-delay characteristic may or may not be of an inverse time/current nature.

B.2.3.9 CBR with resettable r.c. unit: CBR with an r.c. unit which must be intentionally reset by a means different from the operating means of the CBR, following the occurrence of a residual current, before it can be reclosed.

B.2.3.10 test device: Device simulating a residual current for checking that the CBR operates.

B.2.4 Definitions relating to values and ranges of energizing quantities

B.2.4.1 limiting value of the non-operating overcurrent in the case of a single phase load: Maximum value of a single phase overcurrent which, in the absence of a residual current, can flow through a CBR (whatever the number of poles) without causing it to operate (see B.7.2.7).

B.2.4.2 residual short-circuit making and breaking capacity: A value of the a.c. component of a residual prospective short-circuit current which a CBR can make, carry for its opening time and break under specified conditions of use and behaviour.

B.3 Classification

B.3.1 Classification according to the method of operation of the residual current function

B.3.1.1 CBR functionally independent of line voltage (see B.2.3.2)

B.3.1.2 CBR functionally dependent on line voltage (see B.2.3.3 and B.7.2.11)

B.3.1.2.1 Opening automatically in the case of failure of the line voltage with or without delay.

B.3.1.2.2 Not opening automatically in the case of failure of line voltage.

B.3.1.2.2.1 Able to trip in the case of a hazardous situation (e.g. due to an earth fault) arising on failure of line voltage:

- in the case of loss of one phase in a three-phase system;
- in the case of voltage drop.

NOTE - Classification under this subclause also covers CBRs which are unable to open automatically when no hazardous situation exists.

B.3.1.2.2.2 Unable to trip in the case of a hazardous situation (e.g. due to an earth fault) arising on failure of line voltage.

B.3.2 Classification according to the possibility of adjusting the residual current

B.3.2.1 CBR with single rated residual operating current

B.3.2.2 CBR with multiple settings of residual operating current
(see note to B.4.1):

- by fixed steps;
- by continuous variation.

B.3.3 Classification according to time-delay of the residual current function

B.3.3.1 CBR without time-delay: non-time-delayed type

B.3.3.2 CBR with time-delay: time-delayed type (see B.2.3.8)

B.3.3.2.1 CBR with non-adjustable time-delay

B.3.3.2.2 CBR with adjustable time-delay

- by fixed steps;
- by continuous variation.

B.4 Characteristics of CBRs concerning their residual current function

B.4.1 Rated values

B.4.1.1 Rated residual operating current ($I_{\Delta n}$)

The value of residual operating current (see B.2.2.4) assigned to the CBR by the manufacturer, at which the CBR must operate under specified conditions.

NOTE - For a CBR with multiple settings of residual operating current, the highest setting is used to designate its rating. See, however, clause B.5 concerning marking.

B.4.1.2 Rated residual non-operating current ($I_{\Delta no}$)

The value of a residual non-operating current (see B.2.2.5) assigned to the CBR by the manufacturer, at which the CBR does not operate under specified conditions.

B.4.1.3 Rated residual short-circuit making and breaking capacity ($I_{\Delta m}$)

The r.m.s. value of the a.c. component of the prospective residual short-circuit current (see B.2.4.2) assigned to the CBR by the manufacturer, which the CBR can make, carry and break under specified conditions.

B.4.2 Preferred and limiting values

B.4.2.1 Preferred values of rated residual operating current ($I_{\Delta n}$)

Preferred values of rated residual operating current are

0,006 A - 0,01 A - 0,03 A - 0,1 A - 0,3 A - 0,5 A - 1 A - 3 A - 10 A - 30 A

Higher values may be required.

$I_{\Delta n}$ may be expressed as a percentage of the rated current.

B.4.2.2 Minimum value of rated residual non-operating current ($I_{\Delta no}$)

The minimum value of rated residual non-operating current is $0,5 I_{\Delta n}$.

B.4.2.3 Limiting value of non-operating overcurrent in the case of a single-phase load

The limiting value of non-operating overcurrent in the case of a single-phase load shall be in accordance with B.7.2.7.

B.4.2.4 Break time and time-delay values

B.4.2.4.1 Non-time-delay type

The maximum values of break time are given in table B.1.

Table B.1 - Maximum break times for non-time-delay type

Residual current	$I_{\Delta n}$	$2 I_{\Delta n}$	$5 I_{\Delta n}^*$
Maximum break time (s)	0,3	0,15	0,04

* For CBRs having $I_{\Delta n} \leq 30$ mA, 0,25 A may be used as an alternative to $5 I_{\Delta n}$.

CBRs having $I_{\Delta n} \leq 30$ mA shall be of the non-time-delay type.

B.4.2.4.2 Time-delay type

B.4.2.4.2.1 Limiting non-actuating time (See B.2.3.7)

For a time-delay type the limiting non-actuating time is defined at $2 I_{\Delta n}$ and shall be declared by the manufacturer.

The minimum limiting non-actuating time is 0,06 s.

Preferred values of limiting non-actuating time at $2 I_{\Delta n}$ are

0,06 s - 0,1 s - 0,2 s - 0,3 s - 0,4 s - 0,5 s - 1 s

For protection against indirect contact the maximum time-delay at $I_{\Delta n}$ is 1 s (see clause 413.1 of IEC 364-4-41).

B.4.2.4.2.2 Maximum break times

For CBRs having a limiting non-actuating time higher than 0,06 s the manufacturer shall declare the maximum break times at $I_{\Delta n}$, $2 I_{\Delta n}$ and $5 I_{\Delta n}$.

For CBRs having a limiting non-actuating time of 0,06 s the maximum break times are given in table B.2.

Table B.2 - Maximum break times for time-delay type having a limiting non-actuating time of 0,06 s

Residual current	$I_{\Delta n}$	$2 I_{\Delta n}$	$5 I_{\Delta n}$
Maximum break time (s)	0,5	0,2	0,15

In the case of a CBR having an inverse current/time characteristic, the manufacturer shall state the residual current/break time characteristic.

B.4.3 Value of the rated residual short-circuit making and breaking capacity ($I_{\Delta m}$)

The minimum value of $I_{\Delta m}$ is 25 % of I_{cu} .

Higher values may be tested and declared by the manufacturer.

B.5 Marking

a) The following data shall be marked on integral CBRs (see B.1.1), in addition to the marking specified in 5.2, and be clearly visible in the installed position:

- rated residual operating current $I_{\Delta n}$;
- settings of residual operating current, when applicable;
- limiting non-actuating time at $2 I_{\Delta n}$, for time-delay type, by the symbol Δt followed by the limiting non-actuating time in ms; alternatively, where the limiting non-actuating time is 0,06 s, the symbol may be $\boxed{S}$ (S in a square);
- where applicable, the operating means of the test device by the letter T (see also B.7.2.6).

b) The following data shall be marked on r.c. units and be clearly visible in the installed position:

- rated voltage(s) if different from the rated voltage(s) of the circuit-breaker;
- value (or range) of the rated frequency if different from that of the circuit-breaker;
- the indication $I_n \leq \dots A$ (I_n being the maximum current rating of the circuit-breaker with which the r.c. unit may be combined);
- rated residual operating current $I_{\Delta n}$;
- settings of residual operating current, when applicable;
- limiting non-actuating time, as specified in item a);
- the operating means of the test device, as specified in item a).

c) The following data shall be marked on r.c. units and be visible after assembly with the circuit-breaker:

- manufacturer's name or trade mark;
- type designation or serial number;

- identification of the circuit-breaker(s) with which the r.c. unit may be assembled, unless incorrect assembly (such as to render the protection ineffective) is made impossible by the design;
 - IEC 947-2.
- d) The following data shall be marked on integral CBRs or r.c. units, as applicable, or made available in the manufacturer's literature:
- rated residual short-circuit making and breaking capacity $I_{\Delta m}$ if higher than 25 % of I_{cu} (see B.4.3);
 - diagram of connections, including those of the test circuit and, if applicable, those to the line, for CBRs dependent on the line voltage.

B.6 Normal service, mounting and transport conditions

Clause 6 applies.

B.7 Design and operating requirements

B.7.1 Design requirements

It shall not be possible to modify the operating characteristic of a CBR except by means which are specifically provided for setting the rated residual operating current or the definite time-delay.

CBRs combining a r.c. unit device and a circuit-breaker shall be so designed and built that:

- the coupling system of the r.c. unit and the associated circuit-breaker does not require any mechanical and/or electrical connection that may adversely affect the installation or result in injury to the user;
- the addition of the r.c. unit does not adversely affect in any way either the normal operation or the performance capabilities of the circuit-breaker;
- the r.c. unit does not sustain any permanent damage due to the short-circuit currents during test sequences II (I_{cs}) and III (I_{cu}).

B.7.2 Operating requirements

B.7.2.1 Operation in case of a residual current

The CBR shall be open automatically in response to any earth leakage current or earth fault current equal to or exceeding the rated residual operating current for a time exceeding the non-actuating time.

The operation of the CBR shall be in compliance with the time requirements specified in B.4.2.4. Compliance shall be checked by the tests of B.8.2.

B.7.2.2 Rated residual current short-circuit making and breaking capacity $I_{\Delta m}$

CBRs shall meet the test requirements of B.8.10.

B.7.2.3 *Operational performance capability*

CBRs shall comply with the tests of B.8.1.1.1.

B.7.2.4 *Effects of environmental conditions*

CBRs shall operate satisfactorily, taking into account the effects of environmental conditions.

Compliance is checked by the test of B.8.11.

B.7.2.5 *Dielectric properties*

CBRs shall withstand the tests of B.8.3.

B.7.2.6 *Test device*

CBRs intended for protection against electric shock shall be provided with a test device causing the passing through the detecting device of a current simulating a residual current, in order to allow a periodic testing of the ability of the CBRs to operate.

The test device shall satisfy the tests of B.8.4.

The protective conductor, if any, shall not become live when the test device is operated.

It shall not be possible to energize the protected circuit by operating the test device when the CBR is in the open position.

The test device shall not be the sole means of performing the opening operation and is not intended to be used for this function.

The operating means of the test device shall be designated by the letter T, and its colour shall not be red or green; a light colour should preferably be used.

NOTE - The test device is only intended to check the tripping function, not the value at which the function is effective with respect to the rated residual operating current and to the break time.

B.7.2.7 *Value of the non-operating overcurrent in the case of a single-phase load*

CBRs shall withstand the smaller of the following two overcurrent values without tripping:

- $6 I_n$;
- 80 % of the maximum short-circuit release current setting.

Compliance is checked by the test of B.8.5.

NOTE - Tests for polyphase balanced loads are not necessary since they are considered to be covered by the requirements of this subclause.

B.7.2.8 Resistance of CBRs to unwanted tripping due to surge currents resulting from impulse voltages

CBRs shall withstand the test of B.8.6.

B.7.2.9 Behaviour of CBRs in the case of an earth fault current comprising a d.c. component

Under consideration.

B.7.2.10 Conditions of operation for CBRs with resettable r.c. units

It shall not be possible to reclose CBRs having resettable r.c. units (see B.2.3.9) after tripping due to a residual current, if they have not been reset.

Compliance is checked by the relevant tests of clause B.8.

B.7.2.11 Additional requirements for CBRs functionally dependent on line voltage

CBRs functionally dependent on line voltage shall operate correctly at any value of the line voltage between 0,85 and 1,1 times its rated value.

Compliance is checked by the tests of B.8.2.3.

According to their classification CBRs functionally dependent on line voltage shall comply with the requirements given in table B.3.

Table B.3 - Requirements for CBRs functionally dependent on line voltage

Classification of the device according to B.3.1		Behaviour in case of failure of line voltage
CBRs opening automatically in the case of failure of the line voltage (B.3.1.2.1)	Without delay	Opening without delay according to item a) of B.8.8.2
	With delay	Opening with delay according to item b) of B.8.8.2
CBRs not opening automatically in the case of failure of the line voltage (B.3.1.2.2)		No opening
CBRs not opening automatically in the case of failure of the line voltage but able to open in the case of a hazardous situation arising (B.3.1.2.2.1)		Opening according to B.8.9

B.8 Tests

This clause specifies tests for CBRs having a rated residual operating current $I_{\Delta n}$ up to and including 30 A.

The applicability of the tests specified in this clause when $I_{\Delta n} > 30$ A is subject to agreement between manufacturer and user.

B.8.1 General

Tests specified in this appendix are type tests and are supplementary to the tests of clause 8.

CBRs shall be submitted to all relevant test sequences of clause 8. For the dielectric withstand verifications during these test sequences the control circuit of residual current devices functionally dependent on line voltage may be disconnected from the main circuit (see 8.3.3.2.2).

For CBRs comprising a separate r.c. unit and a circuit-breaker, the assembly shall be performed in compliance with the manufacturer's instructions.

In the case of CBRs with multiple settings of residual operating current, the tests shall be made at the lowest setting, unless otherwise stated.

In the case of CBRs with adjustable time-delay (see B.3.3.2.2) the time-delay shall be set at maximum, unless otherwise stated.

B.8.1.1 Tests to be made during the test sequences of clause 8 of this part

B.8.1.1.1 Operational performance capability

During the operating cycles with current (see 8.3.3.3.4) specified in table VIII (see 7.2.4.2), a third of the breaking operations shall be performed by actuating the test device, and a further third by applying a residual current of value $I_{\Delta n}$ (or, if applicable, of the lowest setting of the residual operating current) to any one pole.

No failure to trip shall be admitted.

B.8.1.1.2 Verification of the withstand capability to short-circuit currents

B.8.1.1.2.1 Rated service short-circuit breaking capacity (Test sequence II)

Following the tests of 8.3.4, verification of the correct operation of the CBR in case of residual current shall be performed in accordance with B.8.2.4.1.

B.8.1.1.2.2 Rated ultimate short-circuit breaking capacity (Test sequence III)

For the purpose of verifying the correct operation of the overload releases, the single pole tests specified in 8.3.5.1 and 8.3.5.4 shall be replaced by two-pole tests, on all possible combinations of phase poles in turn, the test conditions being as specified in 8.3.5.1 and 8.3.5.4 but applicable to two poles.

Following the tests of 8.3.5, verification of the correct operation of the CBR shall be performed in accordance with B.8.2.4.3.

B.8.1.1.2.3 Rated short-time withstand current (Test sequence IV)

Under consideration.

B.8.1.1.2.4 Integrally fused circuit-breakers (Test sequence V)

For the purpose of verifying the correct operation of the overload releases, the single pole tests specified in 8.3.7.4 and 8.3.7.8 shall be replaced by two-pole tests, on all possible combinations of phase poles in turn, the test conditions being as specified in 8.3.7.4 and 8.3.7.8 but applicable to two poles.

Following the tests of 8.3.7, verification of the correct operation of the CBR shall be performed in accordance with B.8.2.4.3.

B.8.1.1.2.5 Combined test sequence

Following the tests of 8.3.8, verification of the correct operation of the CBR shall be performed in accordance with B.8.2.4.3.

B.8.1.2 Additional test sequences

Additional test sequences shall be performed on CBRs in accordance with table B.4.

Table B.4 - Additional test sequences

Sequences	Test	Subclause
B I	Operating characteristic	B.8.2
	Dielectric properties	B.8.3
	Operation of the test device at the limits of rated voltage	B.8.4
	Limiting value of the non-operating current under overcurrent conditions	B.8.5
	Resistance against unwanted tripping due to surge currents resulting from impulse voltages	B.8.6
	Behaviour in the case of an earth fault current comprising a d.c. component	B.8.7
	Behaviour in the case of failure of line voltage for CBRs classified under B.3.1.2.1	B.8.8
	Behaviour in the case of failure of line voltage for CBRs classified under B.3.1.2.2.1	B.8.9
B II	Residual short-circuit making and breaking capacity ($I_{\Delta m}$)	B.8.10
B III	Effects of environmental conditions	B.8.11

One sample shall be tested for each test sequence.

Test sequence B I

B.8.2 Verification of the operating characteristic

B.8.2.1 Test circuit

The CBR is installed as in normal use.

The test circuit shall be in accordance with figure B.1.

B.8.2.2 Test voltage for CBRs functionally independent of line voltage

Tests may be made at any convenient voltage.

B.8.2.3 Test voltage for CBRs functionally dependent on line voltage

Tests shall be made at the following values of voltage applied to the relevant terminals:

- 0,85 times the minimum rated voltage for the tests specified in B.8.2.4 and B.8.2.5.1;
- 1,1 times the maximum rated voltage for the tests specified in B.8.2.5.2.

B.8.2.4 Off-load test at $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$

The connections being as in figure B.1 the CBR shall perform the tests of B.8.2.4.1, B.8.2.4.2 and B.8.2.4.3, and also, where applicable, B.8.2.4.4, all made on one pole only. Each test shall comprise three measurements or verifications, as applicable.

Unless otherwise specified in this appendix

- for CBRs having multiple settings of residual operating current, the tests shall be made for each setting;
- for CBRs having a continuously variable setting of residual operating current, the tests shall be made at the highest and lowest settings, and at one intermediate setting;
- for CBRs of the adjustable time-delay type, the time-delay is set at its minimum value.

B.8.2.4.1 Verification of the correct operation in the case of a steady increase of the residual current

The switches S1 and S2 and the CBR being in the closed position, the residual current is steadily increased, starting from a value not higher than $0,2 I_{\Delta n}$ so as to attain the value $I_{\Delta n}$ in approximately 30 s, the tripping current being measured each time. The three measured values shall be greater than $I_{\Delta no}$ and less than or equal to $I_{\Delta n}$.

B.8.2.4.2 *Verification of the correct operation of closing on residual current*

The test circuit being calibrated at the rated value of the residual operating current $I_{\Delta n}$ (or setting of the residual operating current if applicable), and the switches S1 and S2 being closed, the CBR is closed onto the circuit so as to simulate service conditions as closely as possible. The break time is measured three times.

No measurement shall exceed the limiting value specified for $I_{\Delta n}$ in B.4.2.4.1 or B.4.2.4.2.2, as applicable.

B.8.2.4.3 *Verification of the correct operation in the case of sudden appearance of residual current*

The test circuit being calibrated at each of the values of the residual operating current I_{Δ} specified in B.4.2.4.1 or B.4.2.4.2, as applicable, and the switch S1 and the CBR being in the closed position, the residual current is suddenly established by closing switch S2.

The CBR shall trip during each test.

Three measurements of the break time are made at each value of I_{Δ} . No value shall exceed the relevant limiting value.

B.8.2.4.4 *Verification of the limiting non-actuating time of CBRs of the time-delayed type*

The test circuit being calibrated at the value of $2 I_{\Delta n}$, the test switch S1 and the CBR being in the closed position, the residual current is established by closing the switch S2 and applied for a time equal to the limiting non-actuating time declared by the manufacturer, in accordance with B.4.2.4.2.1.

During each of the three verifications the CBR shall not trip. If the CBR has an adjustable residual operating current setting and/or an adjustable time-delay, the test is made, as applicable, at the lowest setting of residual operating current and at the maximum setting of time delay.

B.8.2.5 *Tests at the temperature limits*

NOTE - The upper temperature limit may be the reference temperature.

The temperature limits of this subclause may be extended by agreement between manufacturer and user, in which case tests shall be performed at the agreed temperature limits.

B.8.2.5.1 *Off-load test at -5°C*

The CBR is placed in a chamber having a stabilized ambient temperature within the limits of -7°C and -5°C . After reaching thermal steady-state conditions, the CBR is submitted to the tests of B.8.2.4.3 and, if applicable, B.8.2.4.4.

B.8.2.5.2 *On-load test at the reference temperature or at $+40^{\circ}\text{C}$*

The CBR, connected in accordance with figure B.1, is placed in a chamber having a **stabilized ambient temperature equal to the reference temperature (see 4.7.3) or, in the absence of a reference temperature, equal to $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$. A load current equal to I_n (not indicated on figure B.1) is applied on all phase poles.**

After reaching thermal steady-state conditions, the CBR is submitted to the tests of B.8.2.4.3 and, where applicable, B.8.2.4.4.

B.8.3 Verification of dielectric properties

The dielectric properties of CBRs shall be tested for their withstand against impulse voltages.

The test is made in accordance with 8.3.3.4 of Part 1.

B.8.4 Verification of the operation of the test device at the limits of rated voltage

- a) The CBR being supplied with a voltage equal to 1,1 times the highest rated voltage, the test device is momentarily actuated 25 times at intervals of 5 s, the CBR being closed again before each operation.
- b) Test a) is then repeated at 0,85 times the lowest rated voltage, the device being actuated three times.
- c) Test a) is then repeated, but only once, the operating means of the test device being held in the closed position for 5 s.

For these tests:

- in the case of CBRs with identified line and load terminals, the supply connections shall be in accordance with the marking;
- in the case of CBRs with unidentified line and load terminals, the supply shall be connected to each set of terminals in turn, or alternatively to both sets of terminals simultaneously.

At each test the CBR shall operate.

For CBRs having an adjustable residual operating current

- the lowest setting shall be used for tests a) and c);
- the highest setting shall be used for test b).

For CBRs having an adjustable time-delay the test is made at the maximum setting of time-delay.

NOTE - The verification of the endurance of the test device is considered to be covered by the tests of B.8.1.1.1.

B.8.5 Verification of the limiting value of the non-operating current under overcurrent conditions

The CBR is connected according to figure B.2.

The impedance Z is adjusted so as to let a current equal to the lower of the following two values flow in the circuit:

- $6 I_n$;
- 80 % of the maximum short-circuit release current setting.

NOTE - For the purpose of this current adjustment, the device CBR D (see figure B.2) may be replaced by connections of negligible impedance.

For CBRs with an adjustable residual current setting the test is made at the lowest setting.

CBRs functionally independent of line voltage are tested at any convenient voltage.

CBRs functionally dependent on line voltage are supplied on the line side with their rated voltage (or, if relevant, with a voltage having a value within the range of rated voltages).

The test is made at a power factor of 0,5.

The switch S1, being open, is closed and reopened after 2 s. The test is repeated three times for each possible combination of the current paths, the interval between successive closing operations being at least 1 min.

The CBR shall not trip.

NOTE - The time of 2 s may be reduced (but to not less than the minimum break time) to avoid the risk of tripping by action of the overload release(s) of the CBR.

B.8.6 *Verification of the resistance against unwanted tripping due to surge currents resulting from impulse voltages*

Under consideration.

B.8.7 *Verification of the behaviour of CBRs in the case of an earth fault current comprising a d.c. component*

Under consideration.

B.8.8 *Verification of the behaviour of CBRs functionally dependent on line voltage classified under B.3.1.2.1*

For CBRs having an adjustable residual operating current, the test is made at the lowest setting.

For CBRs with an adjustable time-delay, the test is made at any one of the time-delay settings.

B.8.8.1 *Determination of the limiting value of the line voltage*

A voltage equal to the rated voltage is applied to the line terminals of the CBR and is then progressively lowered to zero over a time period corresponding to the longer of the two values given hereinafter:

- about 30 s;
- a period long enough with respect to the delayed opening of the CBR, if any (see B.7.2.11);

until automatic opening occurs.

The corresponding voltage is measured.

Three measurements are made. All the values shall be less than 0,85 times the minimum rated voltage of the CBR.

Following these measurements it shall be verified that the CBR trips when a residual current equal to $I_{\Delta n}$ is applied, the applied voltage being just above the highest value measured.

It shall then be verified that, for any value of voltage less than the lowest value measured, it is not possible to close the CBR by manual operating means.

B.8.8.2 Verification of the automatic opening in the case of failure of the line voltage

The CBR being closed, a voltage equal to its rated voltage is applied to its line terminals. The voltage is then switched off. The CBR shall trip. The time interval between the switching off and the opening of the main contacts is measured.

Three measurements are made:

- a) for CBRs opening without delay (see B.7.2.11) no value shall exceed 0,2 s;
- b) for CBRs opening with delay the maximum and minimum values shall be situated within the range indicated by the manufacturer.

B.8.9 Verification of the behaviour of CBRs functionally dependent on line voltage as classified under B.3.1.2.2.1 in the case of failure of line voltage

For CBRs having an adjustable residual operating current, the test is made at the lowest setting.

For CBRs having an adjustable time-delay the test is made at any one of the time-delay settings.

B.8.9.1 Case of loss of one phase in a 3-phase system

The CBR is connected according to figure B.3 and is supplied on the line side at 0,85 times the lowest rated voltage.

One phase is then switched off by opening switch S4; the CBR is then submitted to the test of B.8.2.4.3. The switch S4 being closed again, a further test is made by opening switch S5; the CBR is then submitted to the test of B.8.2.4.3.

This test procedure is then repeated by connecting the adjustable resistor R to each of the other two phases in turn.

B.8.9.2 In the case of voltage drop

Under consideration.

Test sequence B II

B.8.10 Verification of the residual short-circuit making and breaking capacity

This test is intended to verify the ability of the CBR to make, to carry for a specified time and to break residual short-circuit currents.

B.8.10.1 Test conditions

The CBR shall be tested according to the general test conditions specified in 8.3.2.6, using figure 9 of Part 1, but connected in such a manner that the short-circuit current is a residual current.

The test is carried out at phase to neutral voltage on one pole only which shall not be the neutral pole. The current paths which do not have to carry the residual short-circuit current are connected to the supply voltage at their line terminals.

Where applicable, the CBR is adjusted at the lowest setting of residual operating current and at the maximum setting of time-delay.

If the CBR has more than one value of I_{cu} , each one having a corresponding value of $I_{\Delta m}$, the test is made at the maximum value of $I_{\Delta m}$, at the corresponding phase to neutral voltage.

B.8.10.2 Test procedure

The sequence of operations to be performed is:

O - t - CO

B.8.10.3 Conditions of the CBR after test

B.8.10.3.1 Following the test of B.8.10.2 the CBR shall show no damage likely to impair its further use and shall be capable, without maintenance, of

- withstanding for 1 min a voltage equal to twice its maximum rated operational voltage, under the conditions of 8.3.3.2;
- making and breaking its rated current at its maximum rated operational voltage.

B.8.10.3.2 The CBR shall be capable of performing satisfactorily the tests specified in B.8.2.4.3, but at a value of $1,25 I_{\Delta n}$ and without measurement of break time. The test is made on any one pole, taken at random.

If the CBR has an adjustable residual operating current, the test is made at the lowest setting, at a current of a value of 1,25 times that setting.

B.8.10.3.3 Where applicable the CBR shall also be submitted to the test of B.8.2.4.4.

B.8.10.3.4 CBRs functionally dependent on line voltage shall also satisfy the tests of B.8.8 or B.8.9, as applicable.

Test sequence B III

B.8.11 *Verification of the effects of environmental conditions*

The test is carried out according to IEC 68-2-30.

The upper temperature shall be $55\text{ °C} \pm 2\text{ °C}$ and the number of cycles shall be

- 6 for $I_{\Delta n} > 1\text{ A}$
- 28 for $I_{\Delta n} \leq 1\text{ A}$

NOTE - The 28 cycle test should be applied to CBRs having multiple settings of residual operating current when one of the possible settings is $\leq 1\text{ A}$.

At the end of the cycles the CBR shall be capable of complying with the tests of B.8.2.4.3, but with a residual operating current of $1,25\text{ }I_{\Delta n}$ and without measurement of break time. Only one verification need be made.

Where applicable the CBR shall also comply with the test of B.8.2.4.4. Only one verification need be made.