

BRITISH STANDARD 3871 : Part 1 : 1965

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**SPECIFICATION FOR
MINIATURE
AND MOULDED CASE
CIRCUIT-BREAKERS**

**Part 1. Miniature Air-break
Circuit-breakers for a.c. Circuits**

BRITISH STANDARDS INSTITUTION

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B.S. 3871 : 1965

Incorporating amendments issued August 1968 (AMD 43),
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BRITISH STANDARDS INSTITUTION

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THIS BRITISH STANDARD, having been approved by the Electrical Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 31st March, 1965.

The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 9,000, fully indexed and with a note of the contents of each, will be found in the BSI Catalogue which may be purchased from BSI Sales Department. The Catalogue may be consulted in many public libraries and similar institutions.

This standard makes reference to the following British Standards:

- B.S. 7. Rubber-insulated cables and flexible cords for electric power and lighting (for working voltages up to and including 11 kV).
- B.S. 842. Voltage-operated earth-leakage circuit-breakers for use on consumers' premises.
- B.S. 2757. Classification of insulating materials for electrical machinery and apparatus on the basis of thermal stability in service.
- B.S. 3042. Standard test finger (for checking protection against electric shock).

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following B.S.I. references relate to the work on this standard:
Committee reference ELE/10/23 Draft for comment AB(ELE) 1118

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CO-OPERATING ORGANIZATIONS

The Electrical Industry Standards Committee under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Associated Offices' Technical Committee

- *Association of Consulting Engineers
- *Association of Mining Electrical and Mechanical Engineers
- *Association of Supervising Electrical Engineers
- *British Electrical and Allied Manufacturers' Association
- *British Railways Board
- *Cable Makers' Association
- *Crown Agents for Oversea Governments and Administrations
- Electric Lamp Industry Council
- Electric Light Fittings Association
- *Electrical Contractors' Association (Incorporated)
- Electrical Contractors' Association of Scotland
- *Electrical Research Association
- *Electricity Council, The Generating Board and the Area Boards in England and Wales
- Electronic Engineering Association
- *Engineering Equipment Users' Association
- Independent Cable Makers' Association
- *Institution of Electrical Engineers
- *Ministry of Aviation
- Ministry of Defence, Army Department
- *Ministry of Defence, Navy Department
- *Ministry of Labour (H.M. Factory Inspectorate)
- *Ministry of Power
- *Ministry of Public Building and Works
- Municipal Passenger Transport Association (Incorporated)
- National Inspection Council for Electrical Installation Contracting
- *National Physical Laboratory (D.S.I.R.)
- *Oil Companies Materials Association
- *Post Office
- Public Transport Association (Incorporated)
- *South of Scotland Electricity Board

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the Committee entrusted with the preparation of this British Standard:

Association of Short-circuit Testing Authorities.
 Engineer Surveyors' Association
 Lloyd's Register of Shipping
 London Transport Board
 Ministry of Defence, Air Force Department
 National Coal Board
 Radio and Electronic Component Manufacturers Federation

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BRITISH STANDARD SPECIFICATION FOR MINIATURE AND MOULDED CASE CIRCUIT-BREAKERS

Part 1. Miniature Air-break Circuit-breakers for a.c. Circuits

FOREWORD

This British Standard has been prepared under the authority of the Electrical Industry Standards Committee and is the first part of a two-part standard covering circuit-breakers of the miniature and moulded case type. It is intended to standardize a device which has become widely used in industrial, commercial and domestic electrical installations.

Part 2 of this standard, dealing with moulded case circuit-breakers, is in course of preparation. Standards for current-operated earth-leakage circuit-breakers and for miniature circuit-breaker distribution boards, are also being prepared, and attention is drawn to B.S. 842, 'Voltage-operated earth-leakage circuit-breakers'. It is common practice for a single unit to function both as a miniature-breaker and as an earth-leakage circuit-breaker.

Because of the difficulty in obtaining satisfactory and reproducible results, it has not been found possible to specify in the present edition suitable tests for mechanical strength, and resistance to moisture and heat.

Appendices have been included to assist in ensuring a proper application of miniature circuit-breakers and attention is directed to these, particularly to Appendices A and B.

SPECIFICATION

SECTION ONE : GENERAL

SCOPE

1. This British Standard specifies miniature a.c. air-break circuit-breakers (not included in B.S. 862) with sealed cases for the mechanism and with fixed un-adjustable time/current characteristics. They are intended to be used for the protection of industrial, commercial and domestic electrical installations. The standard deals with circuit-breakers having voltage ratings up to 415 volts, current ratings up to 100 amperes and short-circuit capacities up to 9000 amperes.

NOTE. It is recognized that miniature circuit-breakers complying with this specification may be used on d.c. circuits. In such cases, the application of the circuit-breakers and the relevancy of this standard should be the subject of agreement between the manufacturer and purchaser.

DEFINITIONS

2. For the purposes of this British Standard the following definitions apply:

a. Miniature circuit-breaker. (Hereinafter referred to as circuit-breaker.) A compact mechanical device for making and breaking a circuit both in normal conditions, and in abnormal conditions such as those of overcurrent and short-circuit. In abnormal conditions the circuit is broken automatically.

b. Number of poles. The number of main conducting paths which the circuit-breaker is required to open or close simultaneously.

This includes a path normally intended for connection to a neutral conductor but does not include a switched neutral.

c. Switched neutral. Contacts not intended to make or break current and arranged to close before and open after the main contacts for the purpose of isolating the neutral.

d. Case. The sealed container which encloses the circuit-breaker mechanism.

e. Enclosure. The container which encloses one or more circuit-breakers (for the purposes of electrical distribution and/or mechanical or climatic protection).

f. Prospective current. The current (r.m.s. value of the a.c. component) that would flow in a circuit due to the applied voltage if the circuit-breaker were replaced by a link or links of negligible impedance but without any other circuit change.

NOTE. For the purpose of this definition the term *circuit-breaker* includes the short length of cable used to connect the circuit-breaker to the test circuit.

g. Short-circuit capacity. The maximum value of prospective current at which the circuit-breaker is capable of complying with a prescribed test duty cycle at the prescribed voltage and power factor (see Clause 31).

h. Tripping factor. The ratio between the minimum value of overcurrent at which the circuit-breaker will trip and the current rating.

j. Main contacts. The fixed and moving contacts in the main current carrying circuit.

k. Arcing contacts. Contacts which open after, and close before the main contacts, to protect the latter from damage by an arc.

l. Auxiliary contacts. Contacts working in conjunction with, and actuated by the operation of, the main contacts, to control a circuit for operating auxiliary devices such as trip coils or audible alarms.

m. Break. The sum of the gaps introduced in one pole between contacts or arcing contacts (if any) when the circuit-breaker is in the fully opened position.

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n. Overcurrent release. A device which causes the circuit-breaker to open the circuit automatically when the current exceeds the pre-determined value at which the release has been adjusted to operate.

p. Inverse time-lag overcurrent release. A device which retards the tripping of the circuit-breaker by a period of time which is an inverse function of the overcurrent.

q. Under-voltage release. A device which causes the circuit-breaker to open the circuit if the voltage falls below a pre-determined value.

r. Shunt-trip release. A device which enables the circuit-breaker to be operated by a relay, push-button or other apparatus which may be independent of the circuit-breaker and arranged for distant operation.

s. Operating duty. A defined sequence of make and/or breaking operations, carried out without any deliberate alteration to the main circuit in which the circuit-breaker is placed.

t. Rating of a circuit-breaker. The set of values assigned by the manufacturer to define the working conditions for which it is built.

u. Performance of a circuit-breaker. The general terms used to denote its behaviour on, and the values obtained from, tests made on it in the prescribed conditions.

v. Applied voltage. The r.m.s. value of the voltage applied to a test circuit immediately before the initiation of current.

w. Recovery voltage. The normal-frequency r.m.s. voltage that exists across the poles of the circuit-breaker immediately after final arc extinction.

x. Rated voltage. The voltage assigned by the manufacturer to indicate the nominal r.m.s. system voltage between phases or between phase and neutral for which the circuit-breaker is intended.

y. Opening time. The time interval between the application of the test current and the instant of contact separation.

NOTE. This is the equivalent of *pre-arcing* time for a fuse.

z. Total operating time. The sum of the opening time and the arcing time.

aa. Type test. A test intended to show that all circuit-breakers made to the same specification and having the same essential details would pass an identical test.

bb. Routine test. A test of every circuit-breaker made to the same specification.

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cc. Instantaneous tripping current. The minimum value of current causing the circuit-breaker to operate automatically with an opening time not exceeding 0.1 s.

*As amended
May, 1981*

Symbols. The following symbols are used to define the steps of any operating duty or test duty.

B—denoting a breaking operation;

M—denoting a making operation;

MB—denoting a making operation, followed by a breaking operation, without the introduction of any intentional time lag.

t—(or a numeral)—denoting a time in minutes between successive operations of an operating duty.

SERVICE CONDITIONS

3. Circuit-breakers complying with this standard shall be suitable for use in the following conditions of service:

a. At an ambient temperature having a peak value not exceeding 35°C with an average value not exceeding 30°C over any 24 hour period.

The circuit-breakers are not suitable for exposure to direct radiation from the sun or other source of heat likely to raise temperatures above the designed ambient. Attention is drawn to the possible effect on the tripping characteristics due to variations in the ambient temperature (see Clause 12).

NOTE. In normal conditions of service, the available cooling air is subject to natural atmospheric variations of temperature and hence the peak temperature occurs only occasionally during the hot season and on those days when it does occur it does not persist for lengthy periods. Meteorological records indicate that temperatures of at least 10 centigrade degrees below the peak temperature will occur within the 24 hour period, and that the average temperature of any 24 hour period that includes the peak temperature will be at least 5 centigrade degrees below the peak value.

b. At an altitude not exceeding 1000 m. above sea level.

c. In an atmosphere not subject to abnormally high humidity, excessive pollution by smoke, chemical fumes, salt-laden spray or other abnormal conditions.

NOTE. Where service conditions differ appreciably from those specified above, the relevancy of this standard should be the subject of agreement between manufacturer and purchaser.

*As
altered
Nov.
1974*

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SECTION TWO : RATING, SIZES AND MARKING

RATING

4. Circuit-breakers shall be rated in terms of the following:

- a. Number of poles.
- b. Voltage.
- c. Current.
- d. Type, according to instantaneous tripping current.
- e. Short-circuit capacity.
- f. Frequency.

*As amended
May, 1981*

VOLTAGE AND CURRENT RATINGS

5. a. The voltage ratings are not standardized, but preferred values are given in Table 1A.

*As amended
May, 1981*

TABLE 1A, VOLTAGE RATINGS

Voltage rating	Nominal voltage to earth
240	240
415	240

b. The current ratings are not standardized, but preferred values are given in Table 1B.

TABLE 1B, CURRENT RATINGS

Amp	Amp
5	40
6	45
10	50
15	60
16	63
20	100
25	
30	
32	

INSTANTANEOUS TRIPPING CURRENT

6. Circuit-breakers are classified according to their instantaneous tripping current as given in Table 2.

*As amended
May, 1981*

TABLE 2. TYPES OF CIRCUIT-BREAKER, ACCORDING TO INSTANTANEOUS TRIPPING CURRENT

Type	Instantaneous tripping current
	Amp
1	$> 2.7 I_n, \leq 4.0 I_n$
2	$> 4.0 I_n, \leq 7.0 I_n$
3	$> 7.0 I_n, \leq 10 I_n$
4	$> 10 I_n, \leq 50 I_n$
B	$> 3 I_n, \leq 5 I_n$
C	$> 5 I_n, \leq 10 I_n$
D	$> 10 I_n, \leq 20 I_n$

SHORT-CIRCUIT CAPACITIES

7. **Category of duty.** Circuit-breakers are rated according to their category of duty. The categories are not standardized, but preferred values are given in Table 3.

*As amended
May, 1981*

TABLE 3. CATEGORIES OF DUTY

Category of duty	Prospective current of the test circuit	Power factor of the test circuit
	amp	
M1	1 000	0.85 to 0.9
M1.5	1 500	0.8 to 0.85
M2	2 000	0.75 to 0.8
M3	3 000	0.75 to 0.8
M4	4 000	0.75 to 0.8
M6	6 000	0.75 to 0.8
M9	9 000	0.55 to 0.6

The code for the category of duty consists of the short-circuit capacity expressed in kiloamperes preceded by the letter 'M'. For categories of duties other than the preferred ones given in the table, the range of power factors of the test circuit shall be taken to be the same as that for the next higher category of duty in the table, e.g. for the non-preferred category of duty M8, the power factor of the test circuit shall be 0.55 to 0.6, i.e. the same as for category of duty M9.

*As amended
May, 1981*

B.S. 3871 : 1965**FREQUENCY***As amended
May, 1981*

8. Frequencies are not standardized. The preferred value is 50 Hz and this value shall be assumed unless otherwise specified.

NOTE. In general, circuit-breakers rated for 50 Hz are suitable also for 60 Hz.

CIRCUIT-BREAKER MARKING*As amended
May, 1981*

9. Circuit-breakers shall be indelibly marked with the following particulars:

- a. B.S. 3871.
- b. Rated voltage and the associated number of phases.
- c. Rated current.
- d. Reference calibration temperature.
- e. Type, according to instantaneous tripping current.
- f. Manufacturer's name or distinguishing mark.
- g. Frequency, if other than 50 Hz.
- h. Manufacturer's type reference, where more than one type is manufactured.
- j. Category of duty.
- k. Country of manufacture.

NOTE. The current rating should be readily visible without removing the circuit-breaker from its mounting.

TERMINAL MARKINGS

10. The terminals shall be clearly and indelibly marked for those circuit-breakers which require distinction between the supply side and the load side and/or between phases and neutral.

SECTION THREE : DESIGN AND CONSTRUCTION**TEMPERATURE RISE**

11. The temperature rise, measured by any suitable method, shall not exceed the values given below when the circuit-breaker is tested in accordance with Clause 26.

- a. Terminals (for connection of external conductors) of circuit-breakers fitted with copper contacts. 35 degC
- b. Terminals (for connection of external conductors) of circuit breakers fitted with contacts having adequate and durable facings of silver or materials not subject to progressive deterioration. 50 degC

*As
altered
Nov.
1974*

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NOTE. If the tripping time is less than 1 hour when tested at an ambient temperature of 35°C and with 1.2 I_n , an additional temperature rise of 5 degC is allowed for Sub-clauses 11a and 11b.

- c. Handles, operating devices and parts of enclosures likely to be handled when operating the circuit-breaker (other external parts to comply with Table 4) 35 degC
- d. The temperature rise of insulating material not likely to be handled shall not exceed the values given in Table 4.

TABLE 4. TEMPERATURE RISE OF INSULATION

Insulating material	Maximum temperature rise
	degC
Class Y	55
Class A	70
Class E	85
Class B	95
Class F	120
Class H	145

NOTE. Details of insulating materials covered by the classes specified in Table 4, are contained in B.S. 2757, 'Classification of insulating materials for electrical machinery and apparatus on the basis of thermal stability in service'.

OVERCURRENT DEVICE CALIBRATION

12. a. The circuit-breaker shall have a fixed unadjustable time/current tripping characteristic.

*As amended
May, 1981*

b. The calibration shall be such that the circuit-breakers, according to their type and rating, comply with the requirements of Table 5 when tested in the conditions specified in Clause 24.

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As amended
May, 1981

TABLE 5. OPERATING DUTIES

Type of instantaneous operation	Rated current, I_n	Test current	Test period	Result	Ambient temperature					
					Reference calibration temperature 20 °C*		Reference calibration temperature 30 °C*		Reference calibration temperature 40 °C*	
					Min.	Max.	Min.	Max.	Min.	Max.
	Amp	Amp			°C	°C	°C	°C	°C	°C
1 2 3 4	All ratings	1.0 I_n	2 h	No trip	20	25			40	45
1 2 3 4	< 10	1.5 I_n	1 h	Trip	20	25			40	45
1 2 3 4	> 10	1.35 I_n	1 h	Trip	20	25			40	45
1† 2† 3† 4†	All ratings	2.5 I_n	1 s – 60 s	Trip	20	25			40	45
1	All ratings	2.7 I_n	0.1 s	No trip	20	25			40	45
1†	All ratings	4.0 I_n	0.1 s	Trip	20	25			40	45
2	All ratings	4.0 I_n	0.1 s	No trip	20	25			40	45
2†	All ratings	7.0 I_n	0.1 s	Trip	20	25			40	45
3	All ratings	7.0 I_n	0.1 s	No trip	20	25			40	45
3†	All ratings	10 I_n	0.1 s	Trip	20	25			40	45
4	All ratings	6.0 I_n	10 s	Trip	20	25			40	45
4	All ratings	10 I_n	0.1 s	No trip	20	25			40	45
4†	All ratings	50 I_n	0.1 s	Trip	20	25			40	45
1 2 3 4	< 10	1.75 I_n	1 h	Trip	0	5			20	25
1 2 3 4	> 10	1.5 I_n	1 h	Trip	0	5			20	25
1 2 3 4	All ratings	0.9 I_n	2 h	No trip	34	36			54	56
B C D	< 63	1.13 I_n	1 h	No trip			30	35		
B C D	> 63	1.13 I_n	2 h	No trip			30	35		
B C D†	< 63	1.45 I_n	1 h	Trip			30	35		
B C D†	> 63	1.45 I_n	2 h	Trip			30	35		
B C D	< 63	1.13 I_n	1 h	No trip			-7	-3		
B C D	> 63	1.13 I_n	2 h	No trip			-7	-3		
B C D†	< 63	1.9 I_n	1 h	Trip			-7	-3		
B C D†	> 63	1.9 I_n	2 h	Trip			-7	-3		
B C D	< 63	I_n	1 h	No trip			38	42		
B C D	> 63	I_n	2 h	No trip			38	42		
B† C† D†	All ratings	2.55 I_n	1 s	No trip			30	35		
B† C† D†	< 32	2.55 I_n	1 min	Trip			30	35		
B† C† D†	> 32	2.55 I_n	2 min	Trip			30	35		
B	All ratings	3 I_n	0.1 s	No trip			30	35		
B†	All ratings	5 I_n	0.1 s	Trip			30	35		
C	All ratings	5 I_n	0.1 s	No trip			30	35		
C†	All ratings	10 I_n	0.1 s	Trip			30	35		
D	All ratings	10 I_n	0.1 s	No trip			30	35		
D†	All ratings	20 I_n	0.1 s	Trip			30	35		

*The reference calibration temperature for types B, C or D shall be 30 °C and for types 1, 2, 3 and 4 shall be either 20 °C or 40 °C, the purpose of the latter value being to avoid the necessity of de-rating thermally sensitive circuit-breakers which are to be mounted in enclosures.

†These tests are repeated in Table 8.

‡See Clause 24.

It shall be possible to reclose a circuit-breaker on to rated current within five minutes of the end of the minimum trip test.

c. All circuit-breakers rated at 6 amp or less shall be checked in accordance with Clause 32 for their ability to protect small flexible cords.*

TIME/CURRENT CHARACTERISTICS

13. Time/current characteristic curves shall be prepared in accordance with Clause 25 and the manufacturer shall make copies available to the purchaser upon request.

*As amended
May, 1981*

The curves shall be prepared with both axes scaled logarithmically.

NOTE. It is recommended that the time scale be plotted vertically and the current scale horizontally.

UNDER-VOLTAGE RELEASE

14. If an under-voltage release is provided it shall operate on a slowly falling voltage, at normal frequency, between the limits of 66 per cent and 10 per cent of the normal operating voltage.

At half the normal frequency, the lower limit of operation shall be not less than 15 per cent of the normal operating voltage.

If the release is self resetting it shall require not more than 85 per cent of the normal operating voltage to reset it.

SHUNT-TRIP RELEASE COIL

15. If voltage operated tripping coils are provided they shall operate between the limits of 60 per cent and 110 per cent of the normal operating voltage.

CONSTRUCTION

16. The operating mechanism case shall be effectively sealed by the manufacturer to prevent access to the mechanism. The case may be of insulating material or of metal, and shall be designed to withstand reasonably rough usage without fracture or permanent distortion.

The construction shall be such that when the circuit-breaker is mounted as in service, any person operating the circuit-breaker shall be safeguarded from injury.

Live parts shall not be accessible to the standard test finger specified in B.S. 3042.

Provision shall be made for earthing of exposed metal parts which require earthing in accordance with the current edition of the 'Regulations for the electrical equipment of buildings', published by the Institution of Electrical Engineers. If an earthing terminal is provided it shall have a size of not less than M5 if of steel, or M6 if non-ferrous metal.

Metallic contact with the enclosure, if of metal, is deemed sufficient earthing for movable parts such as covers. When the earthing terminal is of steel, it shall be effectively protected against corrosion.

NOTE. Manufacturers should provide, if required, means for ensuring that circuit-breakers cannot inadvertently be switched to the ON position. Such means can, for example, be provided by the use of circuit-breakers of the withdrawable type.

OPERATING MECHANISM

17. Circuit-breakers shall be arranged for manual closing and opening and for automatic tripping on overcurrent.

The mechanism shall be fitted with an automatic release which shall at all times function independently of the means used to close the circuit-breaker.

Both the ON and OFF position of the circuit-breaker shall be clearly indicated. The indication shall be clearly visible to the operator when the circuit-breaker is mounted in the normal manner.

The metallic portions of the mechanisms shall be either inherently resistant to, or so treated as to make them resistant to, atmospheric corrosion.

*As altered
Aug. 1968*

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CONNECTION ARRANGEMENTS

18. If wiring terminals are provided, they shall adequately accommodate and securely clamp the conductors specified in Table 6.

Each terminal of circuit-breakers having a rating of 30/32 amp shall, in addition, have adequate means for accommodating and clamping firmly any number of conductors each size 2.5 mm², up to and including three.

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*As amended
May, 1981*

*As amended
May, 1981*

TABLE 6. TERMINAL CAPACITIES

Circuit-breaker rating	To accommodate and clamp conductors of	
	1 and 2-pole	3 and 4-pole
A	mm ²	mm ²
5/6	2.5 (2 cables)	2.5 (2 cables)
10 } 15/16 }	4	4
20 } 30/32 }	10	10
50	16	16
60/63	16	25
100	35	35

NOTE. For circuit-breaker ratings not specified in Table 6 the terminals should accommodate the cables specified for the next higher rating.

Terminals, unless of a form which will prevent the conductor wire from spreading, shall be fitted with special washers or other suitable means to prevent spreading.

Wiring terminal screws shall thread into metal. The ends of the screws shall be rounded or chamfered and the arrangement shall be such as to prevent damage to the conductors.

Circuit-breakers intended for use without any additional enclosure shall have cable entries allowing the introduction of the insulation and sheath of the cable so as to afford mechanical and electrical protection.

Where practicable terminal screws shall be captive.