BS 1362:1973

*Incorporating Amendment Nos. 1 and 2*

CONFIRMED
DECEMBER 2007

Specification for

# General purpose fuse links for domestic and similar purposes (primarily for use in plugs)



UDC 64.06 – 83:621.316.923.2

# Co-operating organizations

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

Association of Manufacturers of Domestic Electrical Appliances
Associated Offices Technical Committee
Association of Consulting Engineers*
Association of Mining Electrical and Mechanical Engineers
Association of Supervisory and Executive Engineers*
British Electrical and Allied Manufacturers' Association*
British Railways Board
British Radio Equipment Manufacturers' Association
British Steel Corporation
Crown Agents for Oversea Governments and Administrations
Department of Employment*
Department of the Environment
Department of Trade and Industry
Electric Cable Makers' Confederation
Electrical Contractors' Association (Incorporated)
Electrical Contractors' Association of Scotland
Electrical Research Association*
Electricity Council, the Central Electricity Generating Board and the Area Boards in England and Wales*
Electronic Engineering Association
Engineering Equipment Users' Association*
Institution of Electrical Engineers*
Institution of Electrical and Electronics Technician Engineers
Lighting Industry Federation Limited
Ministry of Defence
National Inspection Council for Electrical Installation Contracting
National Physical Laboratory (Department of Trade and Industry)
Oil Companies Material Association*
Post Office*
South of Scotland Electricity Board

The Government department 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
Electrical Power Engineers' Association
Lloyd's Register of Shipping
London Transport Executive
Ministry of Defence (Army)
Ministry of Defence (Navy)
Radio and Electronic Component Manufacturers Federation

This British Standard, having been approved by the Electrical Industry Standards Committee, was published under the authority of the Executive Board on 28 February, 1973



First published March 1947
First revision July 1953
Second revision February 1973

The following BSI references relate to the work on this standard:
Committee reference ELE/78/1
Draft for comment 70/21750

**ISBN 0 580 07438 2**

**Amendments issued since publication**

| Amd. No. | Date of issue | Comments |
|---|---|---|
| 4573 | June 1984 | |
| 6691 | April 1991 | Indicated by a sideline in the margin |
| | | |
| | | |

# Contents

# Foreword

This revision of BS 1362 incorporates a new arrangement of the clauses. This has been done in order to agree as closely as possible with the arrangement and content of Publication 269-1 of the International Electrotechnical Commission, as modified for fuses for domestic and similar purposes.

To ensure interchangeability, the dimensions of the fuse links are unchanged but, as with other quantities, are now given in metric units.

The electrical characteristics of the fuse links are the same as in the previous edition of this standard, but further standardization has been achieved by specifying time/current zones within which these characteristics of any fuse link must lie. The testing procedure, particularly for the breaking capacity tests, has been improved and clarified. A mechanical (tumbling) test and an appendix on the measurement of power factor have been added.

Fuses within the scope of this standard are not sensitive to normal electromagnetic disturbances, and therefore no immunity tests are required.

Significant electromagnetic disturbance generated by a fuse is limited to the instant of its operation. Provided that the maximum arc voltages during operation to the type test comply with the requirements of the clause in the standard specifying maximum arc voltage, the requirements for electromagnetic compatibility are deemed to be satisfied.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

**Compliance with a British Standard does not of itself confer immunity from legal obligations.**

**Summary of pages**

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 16, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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# 1 General

## 1.1 Scope

This British Standard specifies dimensions and performance requirements for general purpose cartridge fuse links of current ratings not exceeding 13 A for domestic and similar purposes (primarily for use in plugs complying with the requirements of BS 1363) on declared supply voltages not exceeding 250 V (see **3.5**) at a nominal frequency of 50 Hz or 60 Hz.

It does not cover fuse bases or fuse holders for use with these fuse links.

NOTE The Publications referred to in this standard are listed on the inside back cover.

## 1.2 Object

The object of this specification is to standardize the characteristics, construction, tests and markings of fuse links coming within its scope. In particular to standardize:

the rated voltage,

the rated currents,

the rated power loss,

the time/current zones and conventional currents,

the rated breaking capacity,

the dimensions.

# 2 Definitions

For the purposes of this British Standard, the following definitions apply.

### 2.1 Fuses and their component parts

**2.1.1**
**fuse**

a device that, by the fusion of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted and breaks the current when this exceeds a given value for a sufficient time. The fuse comprises all the parts that form the complete device

**2.1.2**
**fuse base**

the fixed part of a fuse provided with terminals for connection to the system. The fuse base comprises all the parts necessary for insulation

**2.1.3**
**fuse carrier**

the movable part of a fuse designed to carry the fuse link. The fuse carrier does not include any fuse link

**2.1.4**
**fuse holder**

the combination of a fuse base with its fuse carrier

**2.1.5**
**fuse link**

the part of a fuse including the fuse element which requires replacement by a new fuse link after the fuse has operated and before the fuse can be put back into service

**2.1.6**
**fuse link contact**

a conducting part of fuse link designed to engage with a fuse base contact or with a fuse carrier contact

**2.1.7**
**fuse element**

the part of a fuse designed to melt when the fuse operates

### 2.2 General terms

**2.2.1**
**enclosed (cartridge) fuse link**

a fuse link in which the fuse element is totally enclosed, so that during operation it cannot produce any harmful external effects due to the development of an arc, the release of gas or the ejection of flame or metallic particles

**2.2.2**
**current limiting fuse link**

a fuse link that, during and by its operation in a specified current range, limits the current to a substantially lower value than the peak value of the prospective current

**2.2.3**
**general purpose fuse link**

a current limiting fuse link capable of breaking under specified conditions all currents which cause melting of the fuse element, up to its rated breaking capacity

**2.2.4**
**ambient air temperature**

the temperature, determined under prescribed conditions, of the air surrounding the complete device (e.g. for fuses installed inside an enclosure it is the temperature of the air outside the enclosure)

## 2.3 Characteristic quantities

**2.3.1**
**rated values**

terms employed to designate the characteristic values that together define the working conditions upon which the tests are based and for which the equipment is designed. For fuses the rated values usually stated are the voltage, current and breaking capacity

**2.3.2**
**prospective current of a circuit (with respect to a fuse)**

the current that would flow in a circuit if a fuse situated therein were replaced by a conductor of negligible impedance without any other change in the circuit or of the supply

**2.3.3**
**prospective breaking current**

the prospective current at a time corresponding to the instant of the initiation of the arc in a fuse during a breaking operation

**2.3.4**
**breaking capacity**

the prospective breaking current that a fuse is capable of breaking at a stated recovery voltage under prescribed conditions

**2.3.5**
**cut-off current**

the maximum instantaneous value reached by the current during the breaking operation of the fuse, when the fuse operates in such a manner as to prevent the current from reaching the otherwise attainable maximum

**2.3.6**
**cut-off characteristic**

a curve giving the cut-off current as a function of the prospective breaking current under stated conditions of operation

NOTE In the case of a.c., the values of the cut-off currents are the maximum values reached whatever the degree of asymmetry. In the case of d.c., the values of the cut-off currents are the maximum values reached, related to the time constant as specified.

**2.3.7**
**pre-arcing time (melting time)**

the time between the commencement of a current large enough to cause the fuse element(s) to melt and the instant when an arc is initiated

**2.3.8**
**arcing time**

the interval of time between the instant of the initiation of the arc and the instant of final arc extinction

**2.3.9**
**operating time**

the sum of the pre-arcing time and the arcing time

**2.3.10**
**$I^2t$**

the integral of the square of the current for a given time interval:

$$I^2t = \int_{t_0}^{t_1} t^2 dt$$

NOTE $I^2t$ values usually stated for fuse links are the pre-arcing $I^2t$ and operating $I^2t$ extending over the pre-arcing time and the operating time respectively.

**2.3.11**
**$I^2t$ characteristic**

a curve giving $I^2t$ values (pre-arcing $I^2t$ and/or operating $I^2t$) as a function of prospective current under stated conditions of operation

**2.3.12**
**virtual time**

the $I^2t$ divided by the square of the prospective breaking current

NOTE The virtual times usually stated for fuse links are the pre-arcing time and the operating time.

**2.3.13**
**time/current characteristic**

a curve giving the virtual time (e.g. pre-arcing time or operating time) as a function of the prospective breaking current under stated conditions of operation

**2.3.14**
**conventional non-fusing current ($I_{nf}$)**

a value of current specified as that which the fuse link is capable of carrying for a specified time (conventional time) without melting

**2.3.15**
**conventional fusing current ($I_f$)**

a value of current specified as that which causes operation of fuse link within a specified time (conventional time)

**2.3.16**
**power loss of a fuse link**

the power loss in a fuse link carrying rated current under specified conditions, measured after the fuse link has attained a steady temperature

**2.3.17**
**recovery voltage**

the voltage which appears across the terminals of a fuse after the breaking of the current

NOTE This voltage may be considered in two successive intervals of time, one during which transient voltage exists (see **2.3.18**), followed by a second one during which the power-frequency recovery voltage (see **2.3.19**) alone exists.

**2.3.18**
**transient recovery voltage**

the recovery voltage during the time in which it has a significant transient character

NOTE 1 The transient voltage may be oscillatory or non-oscillatory or a combination of both, depending on the characteristics of the circuit and the fuse. It includes the voltage shift of the neutral of a polyphase circuit.

NOTE 2 The transient recovery voltage in three-phase circuits is, unless otherwise stated, that which appears across the first pole to clear because this voltage is generally higher than that which appears across each of the other two poles.

**2.3.19**
**power-frequency recovery voltage**

the recovery voltage after the transient voltage phenomena have subsided

NOTE The power-frequency recovery voltage may be referred to as a percentage of the rated voltage.

**2.3.20**
**switching voltage**

the maximum value of the voltage, expressed as a peak value, which appears across the terminals of a fuse due to the operation of the fuse link

**2.3.21**
**time/current zone**

the time/current zone is the zone contained by the minimum pre-arcing characteristic and the maximum operating characteristic

## 3 Standard conditions for operation in service

The fuse link shall be suitable for use under the following conditions. These conditions apply also to the tests, except where otherwise specified in clause **8**.

NOTE Where fuse links are to be used under conditions differing from these, the manufacturer should be consulted.

### 3.1 Ambient air temperature

The ambient air temperature does not exceed 40 °C, its mean value measured over a period of 24 h does not exceed 35 °C and its mean value measured over a period of one year is lower.

The lower limit of the ambient air temperature is – 5 °C.

### 3.2 Temperature inside an enclosure

Where fuse links are mounted inside an enclosure, the air temperature inside the enclosure does not exceed the ambient air temperature specified in **3.1** by more than 15 °C.

### 3.3 Altitude

The altitude of the site of installation of the fuse link does not exceed 2 000 m above sea level.

### 3.4 Atmospheric conditions

The air is clean and its relative humidity does not exceed 50 % at the maximum temperature of 40 °C. The corresponding relative humidity at lower temperatures would be higher, e.g. 90 % at 20 °C.

NOTE Under these conditions moderate condensation may occasionally occur due to variations in temperature.

### 3.5 Voltage

The a.c. system voltage has a maximum value not exceeding 110 % of the rated voltage of the fuse link.

NOTE For applications involving the use of these fuse links on d.c. circuits, the manufacturer should be consulted.

### 3.6 Current

The currents to be carried and to be broken are within the range specified in **7.3** and **7.4**.

### 3.7 Frequency

The frequency is within the range 45 Hz to 62 Hz.

### 3.8 Conditions of installation

The fuse link is installed and used in normal conditions experienced in domestic and similar surroundings.

NOTE If the fuse link is likely to be exposed in service to abnormal conditions, the manufacturer should be consulted.

## 4 Classification

### 4.1 General

For the purposes of international classification, these fuse links are described as “General purpose B type fuse links with ferrule contacts, principally intended for use in plugs”.

## 5 Characteristics of fuse links

### 5.1 Summary of characteristics

The characteristics of the fuse link shall be stated in the following terms:

| | |
|---|---|
| 1) rated voltage | (see **5.2**) |
| 2) rated current | (see **5.3.2**) |
| 3) rated frequency | (see **5.4**) |
| 4) rated power loss | (see **5.5**) |
| 5) time/current characteristics | (see **5.6**) |
| 6) rated breaking capacity | (see **5.7**) |
| 7) dimensions | (see **5.8**) |

### 5.2 Rated voltage

The rated voltage shall be 240 V a.c.

NOTE The rated voltage of the fuse link may have a different value from the rated voltage of the fuse base in which the fuse link is to be used. The rated voltage of the complete fuse is the lowest value of the rated voltages of its parts (fuse base, fuse carrier and fuse link).

### 5.3 Rated currents

**5.3.1 Rated current of the fuse base and fuse holder.** This specification does not cover fuse bases or fuse holders. Such devices, if intended for use with fuse links complying with the requirements of this standard should have a rated current of at least 13 A.

**5.3.2 Rated current of the fuse link.** The rated current may be any value not exceeding 13 A. For use in plugs, the preferred rated currents are 3 A and 13 A.

### 5.4 Rated frequency

The rated frequency shall be 50 Hz.

### 5.5 Rated power loss

The rated power loss shall not exceed one watt when carrying rated current.

### 5.6 Time/current characteristics and conventional currents

**5.6.1 Time/current zone.** For 3 A and 13 A fuse links, the manufacturer's nominal time/current characteristic curve (see **5.6.3**) shall, together with a tolerance of ± 10 % in terms of current, lie wholly within the appropriate time/current zone of Figure 2.

**5.6.2 Conventional currents.** The conventional non-fusing current $I_{nf}$ and the conventional fusing current $I_f$ shall bear the following relationship to the rated current $I_n$:

$I_{nf} = 1.6\ I_n$ and $I_f = 1.9\ I_n$

**5.6.3 Presentation of time/current characteristics.** The time/current characteristics shall be presented, at least for pre-arcing times exceeding 0.01 s, with current as abscissa and time as ordinate. Logarithmic scales shall be used on both co-ordinate axes.

The basis of the logarithmic scales (the dimensions of one decade) shall be in the ratio 1 : 2 with the longer dimension on the abscissa, the preferred dimensions being 28 mm and 56 mm.

It is recommended that the international size A4 (210 mm × 297 mm) should be used for the graph paper (see BS 4000).

Figure 2 is an example of this form of presentation.

### 5.7 Rated breaking capacity

The rated breaking capacity shall be 6 kA.

### 5.8 Dimensions

The dimensions of the fuse links shall be as given for Figure 1 and Table 1.

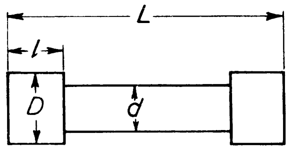



**Figure 1 — Dimensions of fuse link**

**Table 1 — Dimensions of fuse links**

| Length $L$ | Dimension $l$ of end cap | Diameter $D$ of end cap |
|---|---|---|
| mm | mm | mm |
| 25.4 $^{+0.8}_{-0.4}$ | 5.5 ± 0.8 | 6.3 $^{+0.2}_{-0.05}$ |

The maximum diameter, $d$, of the cartridge between the end caps shall be less than the diameter, $D$, of the end caps.

## 6 Marking

### 6.1 Marking on fuse links

Each fuse link shall be clearly and indelibly marked with the following:

1) the manufacturer's name or identifying mark,

2) the number of this British Standard, i.e. BS 1362,

3) the rated current in amperes.

The fuse link barrel shall be marked in red for 3 A and brown for 13 A; for all other ratings the marking shall be black.

## 7 Standard conditions for construction

### 7.1 Mechanical design and construction of fuse links

**7.1.1** Fuse links shall comply with the dimensions in Table 1.

**7.1.2** The bodies of fuse links shall be of inorganic material.

**7.1.3** Fuse links shall be provided with cylindrical end caps which shall be substantially co-axial with the body. End caps shall be either of non-corroding metal or of a metal suitably protected against corrosion. The end surfaces shall be substantially flat and at right angles to the axis of the fuse link.

### 7.2 Temperature rise and power loss

No temperature rise limits are specified. These are governed by the design of the equipment in which the fuse links are used (see, for example, BS 1363).

The fuse link shall carry continuously, under standard conditions of service, its rated current without exceeding the rated power loss (see **5.5**).

### 7.3 Operation

Fuse links shall be so designed and constructed as to comply with the following requirements when operated at an ambient air temperature of 20 °C.

**7.3.1** The fuse link shall carry continuously any value of current up to its rated current without influencing the time/current characteristics to such an extent that the limits stated in **5.6.1** are exceeded.

**7.3.2** The fuse element shall not melt in a time shorter than the conventional time of 30 min when it carries a current not exceeding the conventional non-fusing current.

**7.3.3** The fuse link shall open a circuit in a time shorter than the conventional time when it carries a current exceeding the conventional fusing current.

**7.3.4** The fuse link shall be capable of opening a circuit in a time within the tolerances of its time/current characteristic when it carries a current whose value is between the conventional fusing current and the rated breaking capacity.

### 7.4 Breaking capacity

The fuse link shall be capable of breaking, at a voltage not exceeding the recovery voltage specified in **8.4.2** (see Table 3), any circuit having a prospective current between the smallest current which causes melting of the fuse element and the rated breaking capacity, at a power factor not lower than those shown in Table 3 appropriate to the value of the prospective current.

During operation of the fuse link, in a test circuit as described in **8.4**, the switching voltage shall not exceed 3 kV.

## 8 Tests

### 8.1 General

The requirements specified in **5.5**, **5.6** and **5.7** shall be verified in accordance with **8.2**, **8.3** and **8.4** respectively. The tests specified in this British Standard are type tests and are performed under the responsibility of the manufacturer.

If acceptance tests are required, they shall be selected from the type tests as agreed between the manufacturer and the purchaser.

Fuse links supplied by the manufacturer shall be regarded as complying with the requirements of this standard, provided that in the following respects they are identical with those tested in the type tests:

1) the cartridge bodies have the same dimensions, material and method of manufacture,

2) the caps or other end closures of the cartridge have the same dimensions, materials and method of attachment and sealing,

3) the granular filler of the cartridge is of the same material, grain size and completeness of filling,

4) the fuse elements and their arrangement are the same in every respect.

The manufacturer shall hold available evidence of type tests proving compliance with the requirements of this clause, together with detailed drawings of the fuse links and a record of any alterations that have been made subsequent to the type tests. Type tests shall be repeated if a fuse link is modified in a manner liable to affect its performance characteristics.

**8.1.1 Fuse links in a series.** When a range of fuse links of different current ratings are all of the same physical size and construction as specified in 1), 2) and 3)[1] of **8.1** and, in addition, have fuse elements of the same type and material, differing only in cross section, they are said to constitute an homogeneous series. Provided that the complete tests are made on the highest current rating in such a series, some of the breaking capacity tests need not be performed on the lower current ratings. Details are given in **8.1.5** and Table 2.

**8.1.2 Ambient air temperature.** The ambient air temperature shall be measured by suitable devices protected against draughts and heat radiation. At the beginning of each test the fuse link shall be approximately at the ambient air temperature.

**8.1.3 Condition of the fuse link.** Tests shall be made on new fuse links which shall be in a clean and dry condition. Before making the electrical tests they shall be inspected for compliance with the requirements for marking and construction given in **6.1** and **7.1**.

**8.1.4 Arrangement for the fuse link for tests.** For all electrical tests the fuse links shall be mounted in the test fuse base shown in Figure 3, with the axis of the fuse link vertical.

[1] It should be noted that the grain size may vary between different current ratings.

**Table 2 — Survey of tests on fuse links**

| | | Sample numbers to be tested | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Complete tests on max. current rating | | 1–6 | 7–12 | 13–15 | 16–18 | 19–21 | 22–24 | 25–27 | 28–30 | 31–33 |
| Tests on intermediate current ratings | | 1–6 | 7–12 | 13–15 | 16–18 | 19–21 | | | 22–24 | |
| Tests on lowest current rating in a series | | 1–6 | 7–12 | 13–15 | 16–18 | 19–21 | | 22–24 | 25–27 | |
| Subclause | Tests | | | | | | | | | |
| **8.2** | Power loss | X | | | | | | | | |
| **8.3.3** | Conventional non-fusing current | | X | | | | | | | |
| **8.3.4** | Conventional fusing current | | | | | | | | X | |
| **8.3.5** | Overload | X | | | | | | | | |
| **8.4** | Breaking capacity No. 5 | | | X | | | | | | |
| **8.4** | Breaking capacity No. 4 | | | | X | | | | | |
| **8.4** | Breaking capacity No. 3 | | | | | X | | | | |
| **8.4** | Breaking capacity No. 2 | | | | | | X | | | |
| **8.4** | Breaking capacity No. 1 | | | | | | | X | | |
| **8.5** | Mechanical tests | | | | | | | | | X |

**8.1.5 Testing of fuse links.** For the complete tests, 33 samples shall be tested. If the fuse links constitute an homogeneous series (see **8.1.1**), 27 samples are required of the lowest current rating and 24 samples of any intermediate current rating. The tests to be made in each case are given in Table 2.

The initial cold resistance of the appropriate number of samples shall be measured when carrying not more than 10 % rated current. They shall then be sorted and numbered consecutively in descending order of cold resistance. These numbers are then used to determine which samples shall be used for the various tests, as indicated in Table 2.

NOTE If the test has to be repeated for reasons other than the failure of the fuse link, spare fuse links having approximately the same initial resistance as the original samples should be used for the repeat test.

**8.1.6 Acceptability of test results.** There shall be no failure in any of the tests.

**8.2 Test for power loss**

**8.2.1 Test conditions.** The connections to the test base (see **8.1.4**) shall be by means of single core copper cables, with PVC or similar insulation, 0.3 ± 0.05 m in length and 2.5 $mm^2$ cross-section. The surroundings shall be free from draughts and the ambient air temperature, measured by a suitable thermocouple or thermometer at a horizontal distance of 1 m to 2 m from the fuse link, shall be within the range of 15 °C to 25 °C.

**8.2.2 Test method.** Six fuse links, selected in accordance with Table 2, shall be tested. After carrying rated current continuously for one hour, the cover of the test base shall be removed. The millivolt drop shall then be measured between the end surfaces of the end caps of the fuse link whilst carrying rated current. Direct current is recommended for this test but if a.c. is used, care should be taken to avoid errors caused, for example, by distorted wave form.

**8.2.3 Results.** The product of the measured millivolt drop, multiplied by the rated current, shall not exceed one watt for any rated current.

**8.3 Verification of operating characteristics**

**8.3.1 Test conditions.** These shall be as specified in **8.2.1**. The tests shall be made using a.c. of substantially sinusoidal wave form.

**8.3.2 Time/current characteristics.** These shall be verified from the results obtained during the breaking capacity tests 2 to 5 of **8.4** and the conventional fusing current tests of **8.3.4**.

The results obtained shall lie within ± 10 %, in terms of current, of the manufacturer's time/current curve for the times obtained in the test.

**8.3.3 Conventional non-fusing current.** Six fuse links, selected in accordance with Table 2, shall carry the conventional non-fusing current (1.6 $I_n$) for a conventional time of 30 min and shall not operate during this time.

**8.3.4 Conventional fusing current.** Three fuse links, selected in accordance with Table 2, shall be subjected to the conventional fusing current (1.9 $I_n$). They shall operate satisfactorily within the conventional time of 30 min. The recorded time to operate shall be used to verify the time/current characteristics.

**8.3.5 Overload tests.** During the following tests the current shall be maintained within ± 2.5 % of the adjusted value. Precautions should also be taken to limit switching surges during the cycling test.

1) Three fuse links, selected from those used for the power loss test of **8.2**, after being allowed to cool down to approximately ambient temperature, shall be subjected to 100 cycles of current. Each cycle shall comprise an on period of one hour at $1.2I_n$, followed by an off period of 15 min. This test should be run continuously but, where unavoidable, a single interruption is permitted.

Following this, a current of $1.4I_n$ shall be passed through the fuse link for a period of one hour.

Finally, the millivolt drop at rated current shall again be measured as in **8.2** and the values obtained shall not exceed those recorded in the original test by more than 10 % and the marking of the fuse link shall still be legible.

2) The three remaining fuse links from the power loss test of **8.2**, after being allowed to cool down to approximately room temperature, shall carry rated current for 1 000 h.

After this period the power loss shall be determined as in **8.2** and shall not exceed the specified value of one watt.

**8.4 Breaking capacity tests**

**8.4.1 Arrangement of the apparatus.** The fuse links shall be mounted in the enclosed fuse base shown in Figure 3. However, the cable soldering sockets shown in this figure shall be removed and the fuse base bolted directly to two copper bars of cross section approximately 25 mm × 3 mm by means of the test terminals.

Substantial terminals shall be provided in these copper bars adjacent to the mounting terminals, so that the fuse base can be shorted out by a copper link of negligible impedance during the calibration test.

A typical arrangement for the test circuit connections is shown in Figure 4. The metal enclosure of the test fuse base shall be connected to one pole of the supply through a fine wire fuse (FW) wired with a copper wire of diameter not greater than 0.1 mm and having a free length of not less than 75 mm.

**8.4.2 Characteristics of the test circuit.** The breaking capacity tests shall be performed with alternating current at a frequency of between 45 Hz and 62 Hz. One fuse link shall be tested at a time in a single pole circuit as shown in Figure 4. The source of energy(S) supplying this circuit shall be of sufficient power to enable the specified characteristics to be proved.

Table 3 and Table 4 give details of the values and their tolerances for each of the five breaking capacity tests. The current and power factor shall be adjusted by means of an air cored reactor in series with a suitable resistor, as specified in **8.4.4**.

The peak value of the power frequency recovery voltage during the first full half cycle after clearing, and the next five successive peaks, shall be within the limits of the peak values which correspond to the r.m.s. values given in Table 3.

**Table 3 — Values for breaking capacity tests**

| Breaking capacity Test No. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Prospective current | 6 000 A | Depends on rated current (see Table 4) | $I_3 = 6.3I_n$ | $I_4 = 4I_n$ | $I_5 = 2.5I_n$ |
| Tolerance on test current | $^{+10\ \%}_{-0}$ | ± 10 % | | | |
| Power factor | 0.3 – 0.4 | Not specified (see **8.4.4**) | | | |
| Making angle after voltage zero | 70 ± 10° | $0\ ^{+20°}_{-0°}$ | Not specified | | |
| Power frequency recovery voltage (r.m.s) | 110 % $^{+5\ \%\text{a}}_{-0}$ of the rated voltage | | | | |

[a] By agreement with the manufacturer this tolerance may be exceeded.

**Table 4 — Values of prospective current for breaking capacity test No. 2**

| Rated current of fuse link (A) | ⩽ 2 | > 2 ⩽ 4 | > 4 ⩽ 6 | > 6 ⩽ 10 | >10 ⩽ 13 |
|---|---|---|---|---|---|
| Prospective current (A) | 100 | 160 | 315 | 500 | 630 |

**8.4.3 Measuring instruments.** The values of the current and voltage during calibration and breaking capacity tests shall be recorded by means of a suitable oscillograph. Referring to Figure 4, the current trace is derived from a shunt or other suitable measuring device connected to circuit $0_1$. The voltage trace is derived from a voltage divider or transformer connected to $0_2$ during calibration and to $0_2$ during the breaking capacity tests.

**8.4.4 Calibration of test circuit.** The test fuse base shall be shorted out by means of the copper link as specified in **8.4.1**.

The air cored reactor and series resistor shall then be adjusted so that the current and power factor specified for breaking capacity test 1 in Table 3 are obtained.

The value of the current shall be computed from the oscillograms (see **8.4.7**).

The power factor shall be determined as described in Appendix A, preferably by using method 1.

The required current values for tests 2 – 5 (see Table 3) shall be obtained by adjustment of the series resistance only, the air cored reactor remaining as adjusted for test 1.

**8.4.5 Test method.** In order to verify that fuse links of any given current rating comply with the requirements of **7.4**, each of the breaking capacity tests 1 – 5 (see Table 3) shall be made on three samples of that current rating, chosen in accordance with Table 2. The test conditions to be achieved in these five tests are those given in Table 3 and Table 4.

However, where the fuse links form an homogeneous series, breaking capacity tests 1 and 2 need not be performed on all the current ratings in the series (see **8.1.1**, **8.1.5** and Table 2). Tests 3, 4 and 5 on any intermediate current ratings in such a series may be made at reduced voltage in order to verify the time/current characteristics.

After each breaking capacity test the recovery voltage shall be maintained at a value of $100^{+15}_{-0}$ % of the rated voltage for at least 30 s after operation of the fuse link.

Within the 3 min following this period, the fuse link shall be removed from the test base and the insulation resistance between the end caps shall be measured (see 4) of **8.4.8**).

**8.4.6 Ambient air temperature.** Where the test results are to be used for the verification of time/current characteristics (see **8.3.2**), the breaking capacity tests shall be made at an ambient air temperature of between 15 °C and 25 °C.

It is permissable to make the breaking capacity test No.1 at an ambient air temperature of between – 5 °C and + 40 °C.

**8.4.7 Interpretation of oscillograms.** The method of interpreting the oscillograms is illustrated in Figure 5 which shows examples for two particular cases.

The power frequency recovery voltage shall be determined from the oscillogram made during the test on the fuse link and shall be evaluated as shown in Figure 5*b* and Figure 5*c*.

In order to determine the value of prospective breaking current, the current trace obtained in the calibration test (see Figure 5*a*) shall be compared with that obtained in the breaking test (see Figure 5*b* and Figure 5*c*). For test duties 3, 4 and 5 (see Table 3) a calibration test may not be necessary.

The value of the prospective breaking current is the r.m.s. value of the power frequency component of the calibration curve corresponding to the instant of initiation of the arc.

If the time between the instant when the circuit is closed and the instant when the arc is initiated is shorter than one half cycle, the value of prospective breaking current shall be measured after the elapse of a time equal to a half cycle.

**8.4.8 Acceptability of test results.** The switching voltage occuring during operation of the fuse links during breaking capacity tests 1 and 2 (see Table 3) shall not exceed 3 kV as stated in **7.4**.

The fuse links shall operate without external effects and damage beyond those specified below.

1) There shall be no permanent arcing or flashover nor any ejection of flames sufficient to cause the fine wire fuse to melt.

2) After operation, the test base shall not have suffered damage sufficient to hinder its further use.

3) After operation, the fuse link shall not be so damaged that its replacement might be difficult or dangerous to the user. This means in particular that the fuse link parts, whilst they may have changed their colour or may have cracks, must remain in one piece.

4) The insulation resistance measured after each breaking capacity test of **8.4.5**, when measured with a direct voltage of approximately 500 V, shall be not less than 50 kΩ.

**8.5 Mechanical test for strength of fuse links**

Three fuse links, selected as shown in Table 2, shall be tested in a tumbling barrel with 20 mm thick hardwood (hornbeam) ends as shown in Figure 6. Alternatively, with the consent of the manufacturer, the tumbling barrel specified in BS 1363 (which has a greater dropping distance) may be used.

Only one fuse link is tested at a time. The barrel is rotated at 5 rev/min and the fuse link subjected to 50 falls, i.e. 25 revolutions of the barrel.

After the test, the body shall not be broken, filling shall not have come out and the end caps shall remain tight when tested by hand.

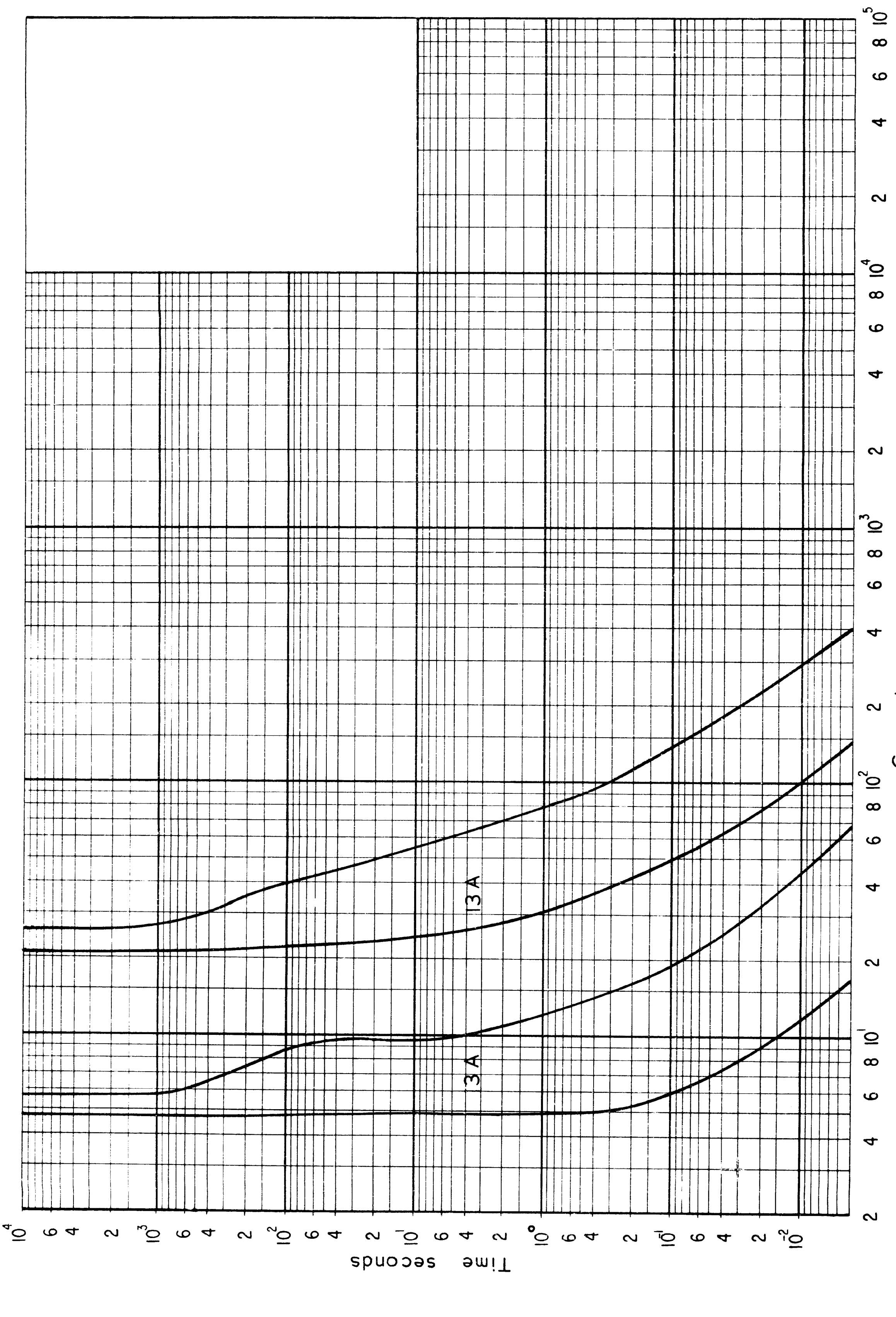
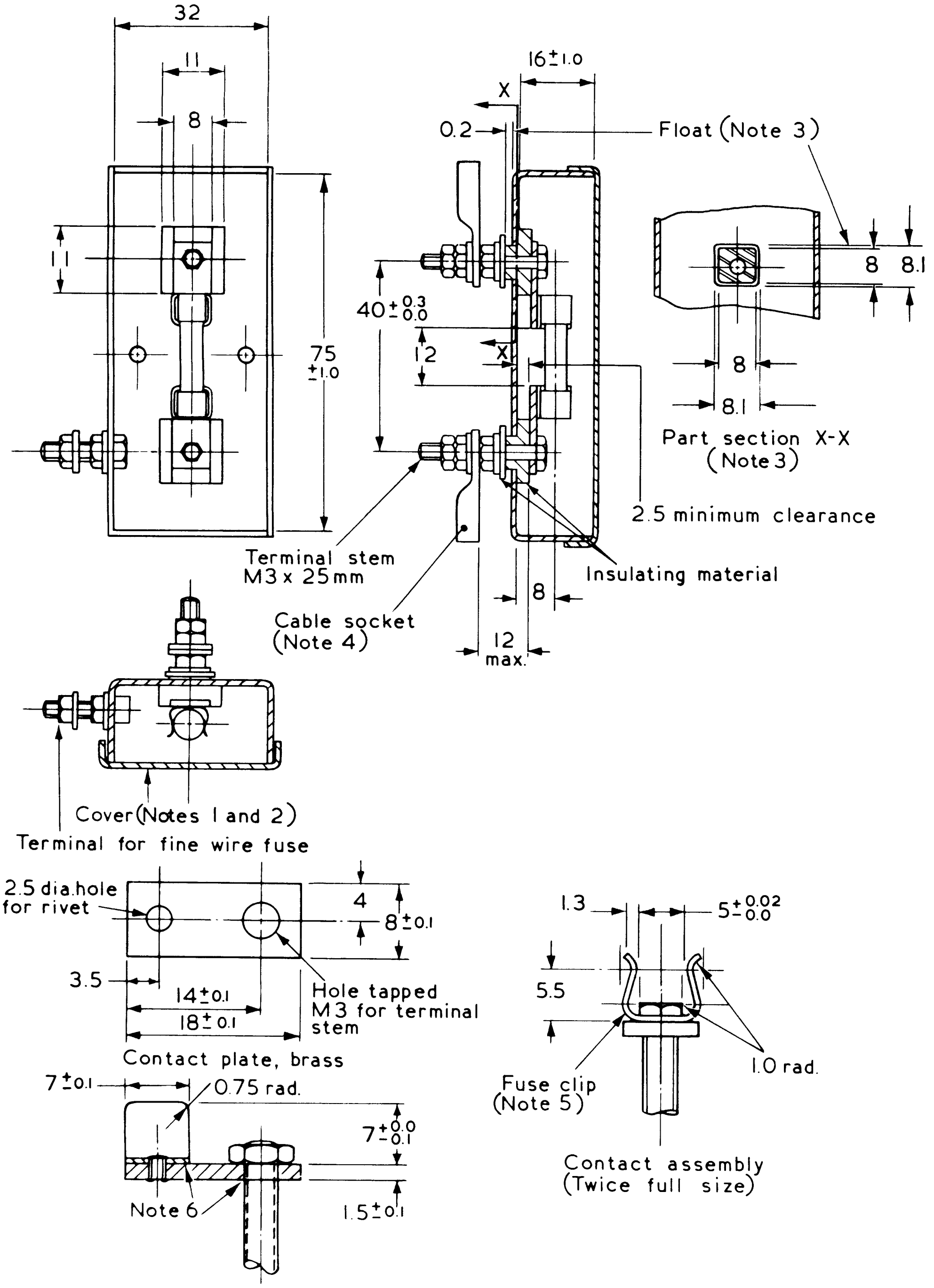



**Figure 2 — Standard time/current zones for:** $I_n = 13A$, $I_n = 3A$




NOTE 1 Box and cover made from 1.25 mm brass sheet, clean natural finish.

NOTE 2 Cover should be a push fit on box and must not be rigidly attached.

NOTE 3 The end float and clearance between the insulation and the box is to allow the contacts to be self-aligning.

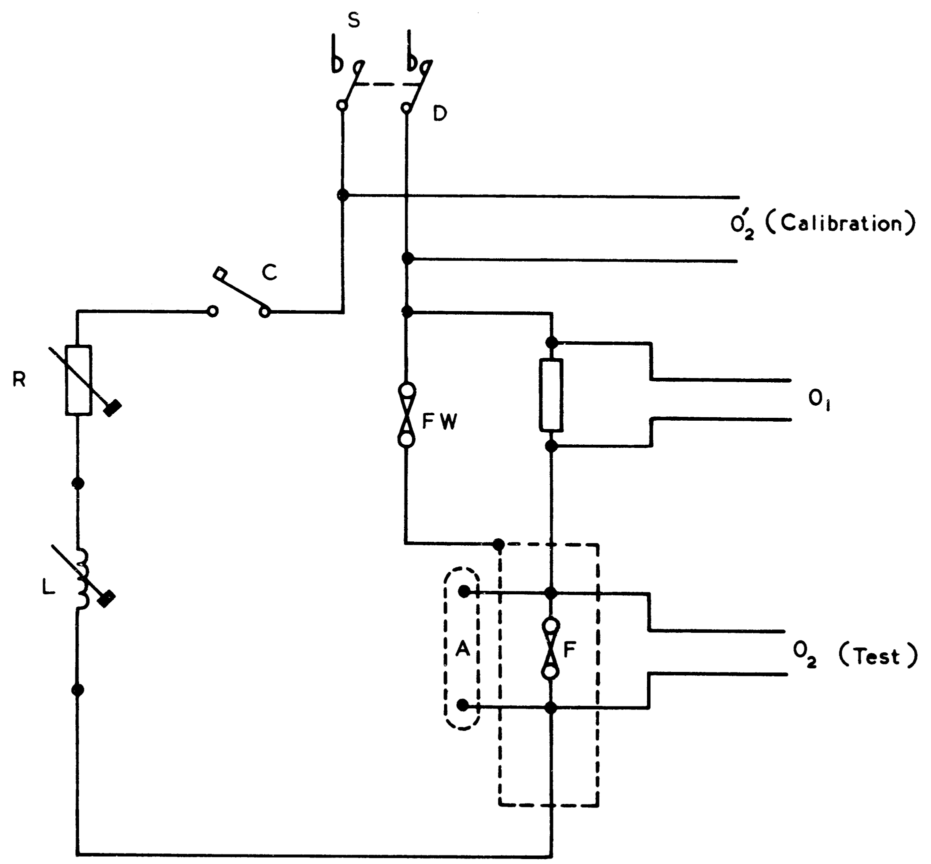
NOTE 4 Cable sockets for 2.5 $mm^2$ cable for power loss test. (Replaced by copper bar for breaking capacity test, see **8.4.1**.)

NOTE 5 Fuse clip. Made from beryllium copper 0.45 mm thick and heat treated (170 HV minimum). Base of clip to be flat; finish, silver plated.

NOTE 6 Joints between clip, contact plate and terminal stem to be soldered.

All dimensions in millimetres.

**Figure 3 — Test fuse base**




| | | |
|---|---|---|
| A | = | removable link used for the calibration test |
| C | = | apparatus for closing the circuit |
| D | = | circuit-breaker or other apparatus for the protection of the source |
| F | = | fuse on test |
| FW | = | fine wire fuse |
| L | = | adjustable inductor |
| $0_1$ | = | measuring circuit for recording the current |
| $0_2$ | = | measuring circuit for recording the voltage during the test |
| $0_2'$ | = | measuring circuit for recording the voltage during calibration |
| R | = | adjustable resistor |
| SS | = | source of energy |

**Figure 4 — Typical diagram of the circuit used for breaking capacity tests** (see **8.4**)

Applied voltage for the calibration = $B_{00}$

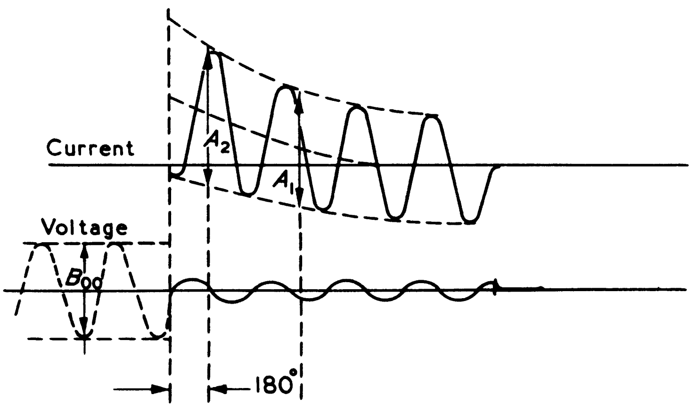



Fig. 5*a*. Calibration of the circuit

Current $I_{\text{r.m.s.}} = \dfrac{A_1}{2\sqrt{2}} \times \dfrac{B_0}{B_{00}}$

Recovery voltage $U_{\text{r.m.s.}} = \dfrac{B_1}{2\sqrt{2}}$

Applied test voltage = $B_0$

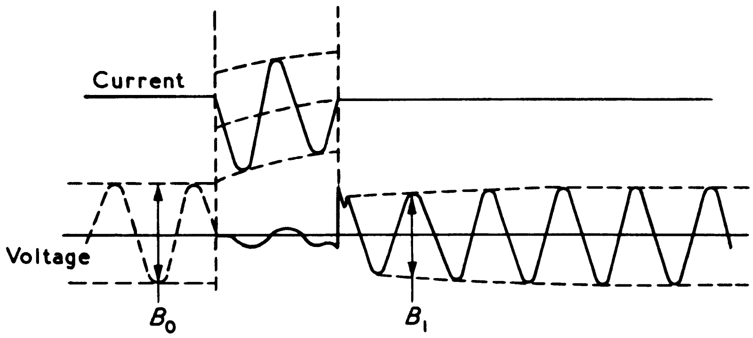



Fig. 5*b*. Oscillogram corresponding to a breaking operation where the arc is initiated later than 180 electrical degrees after making.

Current $I_{\text{r.m.s.}} = \dfrac{A_2}{2\sqrt{2}} \times \dfrac{B_0}{B_{00}}$

Recovery voltage $U_{\text{r.m.s.}} = \dfrac{B_2}{2\sqrt{2}}$

Applied test voltage = $B_0$

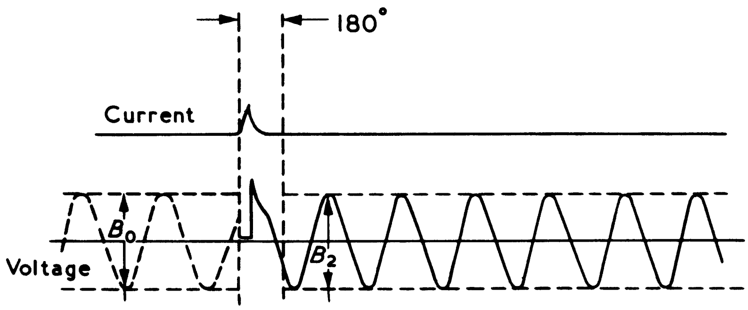
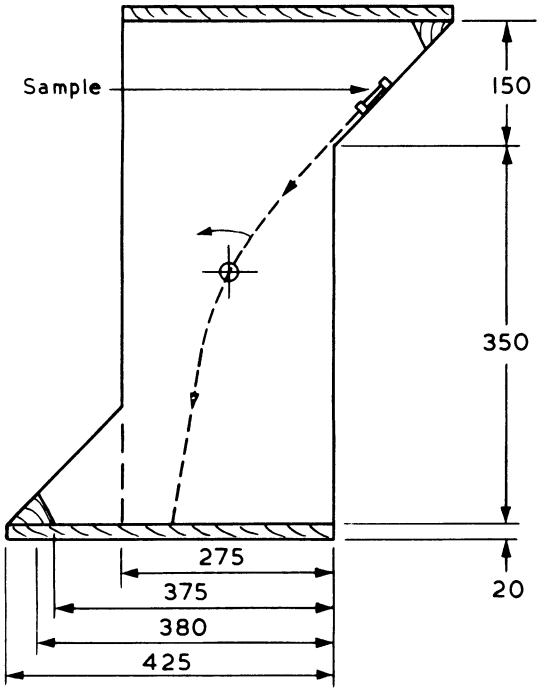



Fig. 5*c*. Oscillogram corresponding to a breaking operation where the arc is initiated earlier than 180 electrical degrees after making.

**Figure 5 — Interpretation of oscillograms taken during breaking capacity tests** (see **8.4.7**)




All dimensions are in millimetres

**Figure 6 — Principal dimensions of tumbling barrel**

## Appendix A Measurement of short-circuit power-factor

There is no method by which the short-circuit power-factor can be determined with precision, but for the purpose of this specification, the determination of the power-factor in the test circuit may be made with sufficient accuracy by whichever of the three following methods is the most appropriate.

**A.1 Method I: Calculation from circuit constants.** The power-factor may be calculated as the cosine of an angle $\varphi$ where $\varphi$ = arc tan $X/R$, $X$ and $R$ being respectively the reactance and resistance of the test-circuit during the period in which the short-circuit exists.

Owing to the transitory nature of the phenomenon, no accurate method can be given for determining $X$ and $R$, but for compliance with this specification the values may be determined by the following method.

$R$ is measured in the test circuit with direct current; if the circuit includes a transformer the resistance $R_1$ of the primary circuit and the resistance $R_2$ of the secondary circuit are measured separately and the required value $R$ is then given by the formula:

$R = R_2 + R_1 r_2$

in which $r$ is the ratio of transformation of the transformer

$X$ is then obtained from the formula:

$$\sqrt{R^2 + X^2} = \frac{E}{I}$$

the ratio $\frac{E}{I}$ (circuit-impedance) being obtained from the oscillogram as indicated in Figure 7.

**A.2 Method II: Determination from d.c. component.** (Not recommended for these fuses, since the power factor is too high.) The angle $\varphi$ may be determined from the curve of the d.c. component of the asymmetrical current wave between the incidence of short-circuit and the beginning of arcing as follows:

1) The formula for the d.c. component is:

$$i_d = I_{do}\, e^{-Rt/L}$$

where

| | |
|---|---|
| $i_d$ | is the value of the d.c. component at any instant |
| $I_{do}$ | is the initial value of the d.c. component |
| $L/R$ | is the time-constant of the circuit in seconds |
| t | is the time-interval, in seconds, between $i_d$ and $I_{do}$ |
| e | is the base of Napierian logarithms |

The time-constant $L/R$ can be ascertained from the above formula as follows:

a) measure the value of $I_{do}$ at the instant of short-circuit and the value of $i_d$ at any other time $t$ before beginning of arcing;

b) determine the value of $e^{-Rt/L}$ by dividing $i_d$ by $I_{do}$;

c) from a table of values of $e^{-x}$ determine the value of $-x$ corresponding to the ratio $i_d/I_{do}$;

d) the value $x$ then represents $Rt/L$, from which $R/L$ can be determined by dividing $x$ by $t$, and so $L/R$ is obtained.

2) Determine the angle $\varphi$ from:

$\varphi$ = arc tan $\omega\, L/R$

where $\omega$ is $2\,\pi$ times the actual frequency.

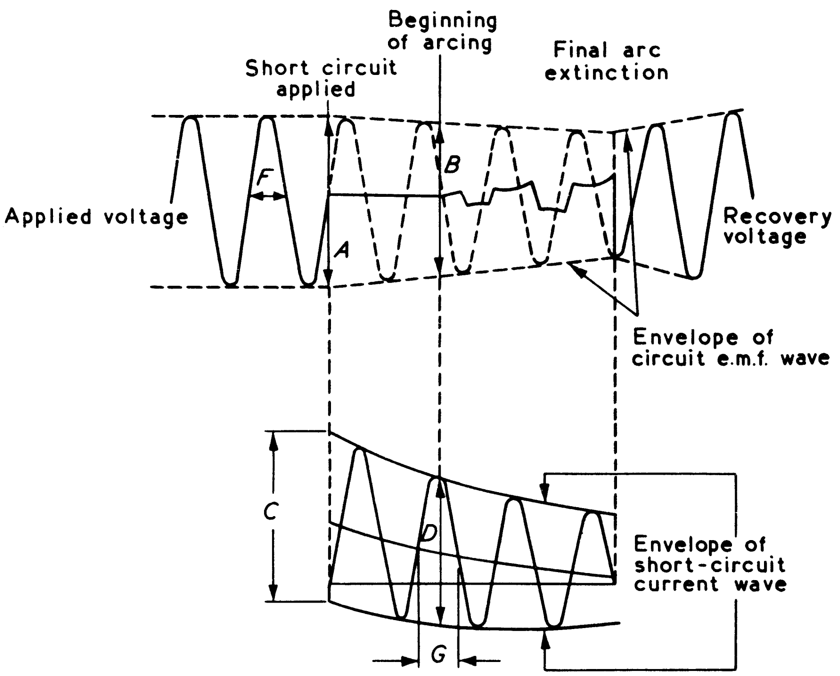
This method should not be used when the currents are measured by current transformers.

**A.3 Method III. Determination with pilot generator or transformer.** When a pilot generator is used on the same shaft as the test generator, the voltage of the pilot generator on the oscillogram may be compared in phase first with the voltage of the test generator and then with the current of the test generator.

The difference between the phase angles between pilot generator voltage and main generator voltage on the one hand and pilot generator voltage and test generator current on the other hand gives the phase angle between the voltage and current of the test generator, from which the power-factor can be determined.

A similar principle applies when the testing station supply is fed directly from a transformer.

(see also **F.1.2** of BS 88-1:1967.)




Circuit-impedance $= \frac{E}{I} = \frac{B}{D} = \frac{A}{C} \times \frac{F}{G}$

where $E$ is the circuit e.m.f. at the beginning of arcing = $\frac{B}{2\sqrt{2}}$, expressed in volts

$I$ is the breaking-current = $\frac{D}{2\sqrt{2}}$, expressed in amperes

$A$ is twice the peak value of the applied-voltage, expressed in volts

$C$ is twice the peak value of the symmetrical component of the current wave at the beginning of the short-circuit, expressed in amperes

$F$ is the duration in seconds of one half-cycle of the applied-voltage wave

$G$ is the duration in seconds of one half-cycle of the current wave at the beginning of arcing

**Figure 7 — Determination of circuit-impedance for calculation of power-factor in accordance with method I**

# Publications referred to

This standard makes reference to the following British Standards:
BS 88, *Cartridge fuses of voltage ratings up to 660 volts Part Performance and dimensions of fuse links.*
BS 1363, *13 A plugs, switched and unswitched socket-outlets and boxes.*
BS 4000, *Sizes of papers and boards.*

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