BRITISH STANDARD

BS 646:1958
+A2:2013

Specification for

Cartridge fuse-links (rated up to 5 amperes) for a.c. and d.c. service

ICS 29.120.50

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:

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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 31 January 1958

Amendments/corrigenda issued since publication

Amd. No.	Date	Comments
6693	January 1991	
A2	February 2013	See Foreword

The following BSI references relate to the work on this standard:—
Committee reference ELE/4, ELE/4/3
Drafts for comment CX (ELE) 2569 12/30268414 DC

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Contents

Foreword

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution.

BS 646:1958+A2:2013 supersedes BS 646:1958 (incorporating Amendment No. 1), which is withdrawn.

Text introduced or altered by Amendment No. 2 is indicated in the text by tags ⟨A2⟩ and ⟨A2⟩. Previous amendments are not indicated.

This standard makes reference to the following British Standards:

BS 88-1, *Low voltage fuses – Part 1: General requirements*

BS 410-1, *Test sieves – Part 1: Technical requirements and testing*

BS 481, *Woven wire and perforated plate sieves and screens for industrial purposes*

BS 1362, *General purpose fuse-links for domestic and similar purposes (primarily for use in plugs)*

BS 1363-1, *13A plugs, socket-outlets, adaptors and connection units – Part 1: Specification for rewirable and non-rewirable 13 A fused plugs*

The previous (1935) edition of this specification included two types of fuse-link, namely Type A and Type B, but it was decided that when a new edition was issued, it should apply to the Type A fuse-link only. The current edition, therefore, applies to the former Type A fuse-links, and the Type B fuse-links are the subject of a new British Standard, BS 2950 *"Cartridge fuse-links for use with telecommunications and light electrical apparatus"*. The designations Type A and Type B have been discarded and each type of fuse-link should be referred to in terms of its relevant British Standard (i.e., BS 646 or BS 2950).

The specification prescribes new requirements and tests, and the breaking capacity rating has been raised to values corresponding to BS 88 Categories of Duty AC1 and DC1. Both a.c. and d.c. are prescribed for all tests for duty which include tests at prospective currents simulating the most severe operating conditions.

This British Standard is one of a series including the following:

BS 88-1, *Low voltage fuses – Part 1: General requirements*

BS 88-3, *Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications) – Part 3: Examples of standardized systems of fuses A to F*

BS 1362, *General purpose fuse-links for domestic and similar purposes (primarily for use in plugs)*

BS 3036, *Semi enclosed electric fuses (ratings up to 100A and 240V to earth)*

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 in the type test comply with the requirements of the clause in this standard specifying maximum arc voltage, the requirements for electromagnetic compatibility are deemed to be satisfied.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 9 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.

Section 1. General

1 Scope

This British Standard relates to cartridge fuse-links of current-ratings up to 5 amperes (hitherto known as Type A fuse-links) intended for use in plugs, and socket-outlet adaptors A2 *Text deleted* A2 for two-wire circuits of which the declared voltage does not exceed 250 volts a.c. at 50 cycles per second, or 250 volts d.c.

Fuse-links for use in plugs specified in BS 1363 are separately provided for in BS 1362.

2 Definitions

The following definitions have been adopted for the purpose of this standard.

2.1
fuse

a device for the purpose of protecting a circuit against damage from an excessive current flowing in it by opening the circuit on the melting of a fuse-element by such excessive current. The fuse comprises all the parts that form the complete device

2.2
fuse-element

that part of the fuse which is designed to melt and thus open a circuit

2.3
cartridge

a totally-enclosing fuse-element container consisting of insulating material; generally tubular in form, and having its ends enclosed by metallic caps

2.4
cartridge fuse-link (hereinafter called a fuse-link)

a cartridge containing a fuse-element

2.5
voltage-rating

a voltage stated by the manufacturer as the highest declared voltage that may be associated with the fuse-link

2.6
recovery-voltage

the r.m.s. value of the normal-frequency a.c. voltage, or the d.c. voltage, that exists across the terminals of a fuse after the opening of the circuit

2.7
current-rating

a current less than the minimum fusing-current, stated by the manufacturer as the current that the fuse-link will carry continuously in the testing-enclosure without deterioration (see Figure 2)

2.8
minimum fusing-current

the minimum current at which a fuse-element in a fuse-link will melt in the testing-enclosure

2.9
fusing-factor

the ratio, greater than unity, of the minimum fusing-current to the current-rating, namely:

$$\text{Fusing factor} = \frac{\text{Minimum fusing-current}}{\text{current-rating}}$$

2.10
prospective current (of a circuit)

the direct current, or the r.m.s. value of the alternating current, that would flow on the making of the circuit when the circuit is equipped for the insertion of a fuse-link, but the fuse-link is replaced by a link of negligible impedance

2.11
breaking-capacity rating (of a fuse)

a prospective current stated by the manufacturer as the greatest prospective current that may be associated with the fuse under prescribed conditions of voltage and of power-factor or time-constant

2.12
duty (of a fuse)

the satisfactory opening, at declared voltages not higher than its voltage rating, of the circuit or circuits protected by it under conditions that produce for the requisite length of time any prospective current greater than its minimum fusing-current up to its breaking-capacity rating

2.13
type-test

a test of a sample or an article intended to show that all other articles made to the same design would, or would not, pass an identical test

Section 2. Requirements

3 Voltage-ratings

The standard voltage-ratings are 250 volts alternating at 50 c/s, and 250 volts d.c.

A2 *Text deleted* A2

4 Current-ratings

The standard current-ratings are as follows:

1 ampere

2 amperes

3 amperes

5 amperes

Intermediate or lower current-ratings are permissible provided that the fuse-links comply with this specification in all other respects.

5 Fusing-factor

The fusing-factor shall be between 1.6 and 1.9.

6 Breaking-capacity rating

The breaking-capacity rating shall be 1 000 amperes at a lagging power-factor not greater than 0.6 for alternating current, and a time-constant not less than 0.003 second for direct current.

7 Performance

Fuse-links shall open circuits adjusted for any prospective current greater than their minimum fusing-currents up to their breaking-capacity rating, and shall be tested for duty in accordance with Clauses **12** to **15**.

Section 3. Construction

8 Dimensions

The dimensions of the fuse-links shall be as shown in Figure 1.

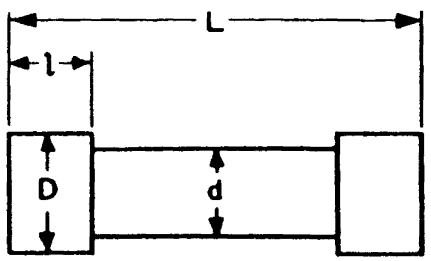


Figure 1

Dimensions of fuse-links

Length (L)		Length of each end-cap (l)	Diameter of end-cap (D)
inches	$^{+1}/_{32}$ $^{3}/_{4}$ $^{-1}/_{64}$	$^{+1}/_{32}$ $^{5}/_{32}$ $^{-1}/_{32}$	+ 0.005 0.210 – 0.005
millimetres	max. 19.84 min. 18.65	4.76 3.18	5.46 5.21

The maximum diameter (d) of the cartridge between the end-caps shall be less than the diameter of the end-caps.

9 End-caps

Fuse links shall have, at each end, a metallic cap with a cylindrical surface, and the outer ends shall be substantially flat and at right-angles to the axis of the cylinder. The end-caps shall be either of non-corroding metal or of a metal suitably protected against corrosion. The cylindrical surface shall be the effective contact.

Section 4. Tests

10 Type tests

All tests of fuse-links specified in the following clauses are type-tests, and the fuse-links used for the type-tests shall be identical in all details likely to affect performance with those to be used in service. The purchaser shall accept certificates of type-tests as evidence of the compliance of fuse-links with the requirements of the relevant clauses of this specification, and the manufacturer shall hold available such certificate together with detail drawings of the fuse-links and a record of any alterations that have been made in the fuse-links subsequent to the type-tests. The manufacturer shall, if required by the purchaser, certify that the fuse-links are identical in material and performance with those covered by a certificate of stated date. Type-tests may be made by the manufacturer, provided that he shall arrange for a recognized authority to make any type-tests for which he himself is not equipped.

Fuse-links shall be deemed to comply with this specification only if all that are tested pass the tests.

11 Preparation and tests for minimum fusing-current and watts loss

Fuse-links shall be mounted for tests for minimum fusing-current and watts loss in the metal testing-enclosure shown in Figure 2, in surroundings free from external draughts, and at the commencement of each test the fuse-links and testing enclosures and conductors connected to them shall be approximately at the ambient temperature, which shall be between 15 °C and 25 °C. The conductors shall be 3/.029 vulcanized-rubber-insulated or polyvinyl-chloride-insulated cable at least 2 ft in length, and shall be connected to the terminal studs by means of electric cable soldering tags of appropriate size.

The fuse-links shall be mounted vertically for test and any adjustment to the test-circuit shall be made prior to the insertion of the fuse-link to be tested. All fuse-links shall be in a clean and new condition.

The fuse-elements of the fuse-links shall not melt within 30 minutes at a current equal to 1.6 times their current-rating, and shall melt within 30 minutes at a current equal to 1.9 times their current-rating. The source of energy for the tests may be alternating or direct current.

For each current-rating, 12 fuse-links shall be tested; 6 at the high current and 6 at the low current.

A test shall be made to verify that at rated current the watts loss in the fuse-links, measured between the end-caps, does not exceed the following values:

Current-rating	Watts loss
1 amp	0.5 watts
2 amp	0.6 watts
3 amp	0.7 watts
5 amp	0.8 watts

The watts loss for any non-standard rating shall not exceed that specified for the next higher standard rating.

12 Preparation of fuse-links for tests for duty

Fuse-links shall be mounted for tests for duty in the metal testing-enclosure shown in Figure 2. The cover of the enclosure shall not be rigidly attached to the box. For these tests only, the enclosure may be of 16-mesh woven-wire cloth as specified in BS 481, "*Woven-wire and perforated sieves and screens*".

All fuse-links shall be in clean new condition and shall be mounted vertically for the tests.

The arrangement of the fuse-link and of the testing apparatus shall be as indicated in Figure 3.

During the tests the metal testing-enclosure shall be connected as shown in Figure 3 to one terminal of the supply through a fine-wire fuse wired with copper wire not greater than 0.0048 in. diameter (No. 40 S.W.G.) with a break not less than 3 in.

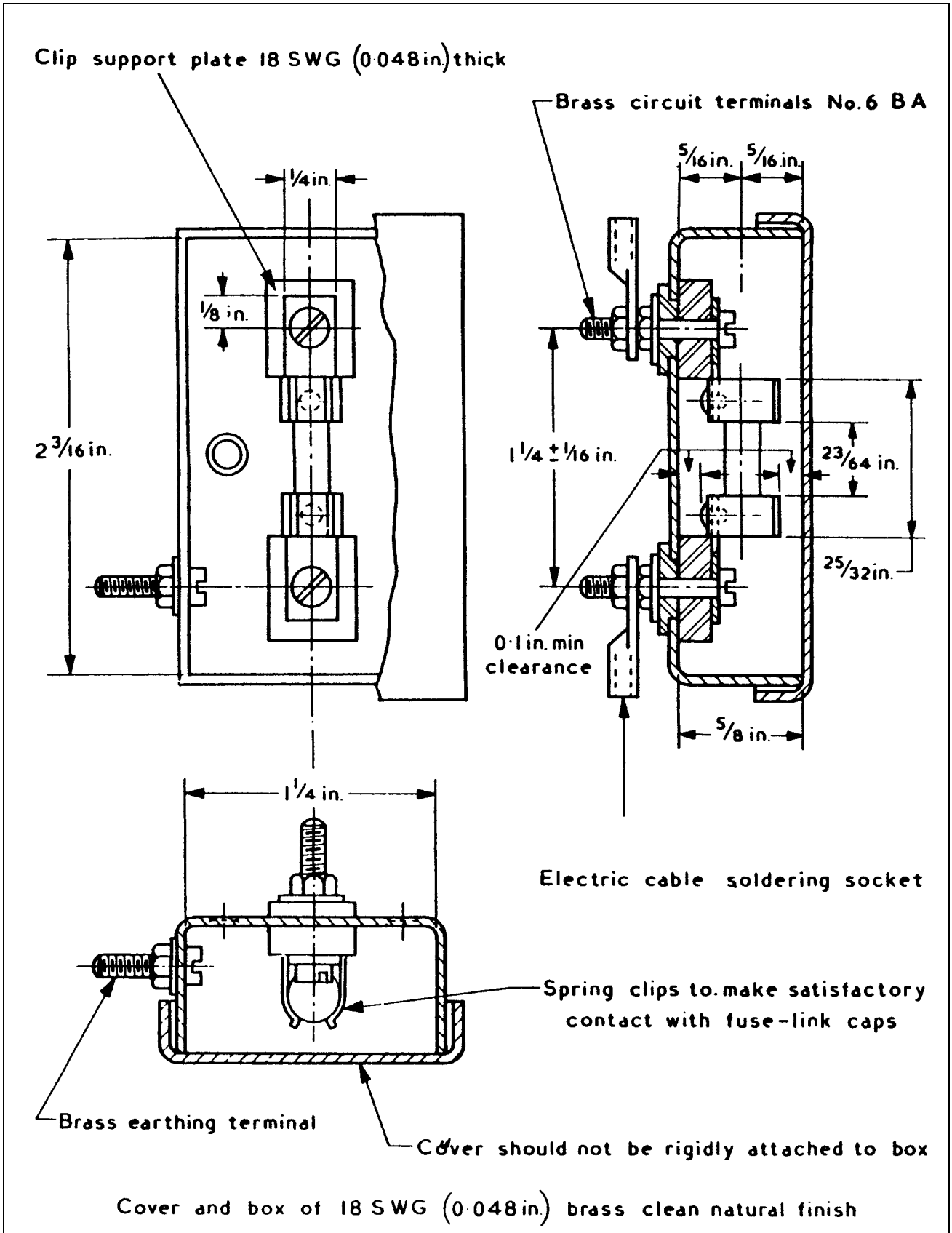
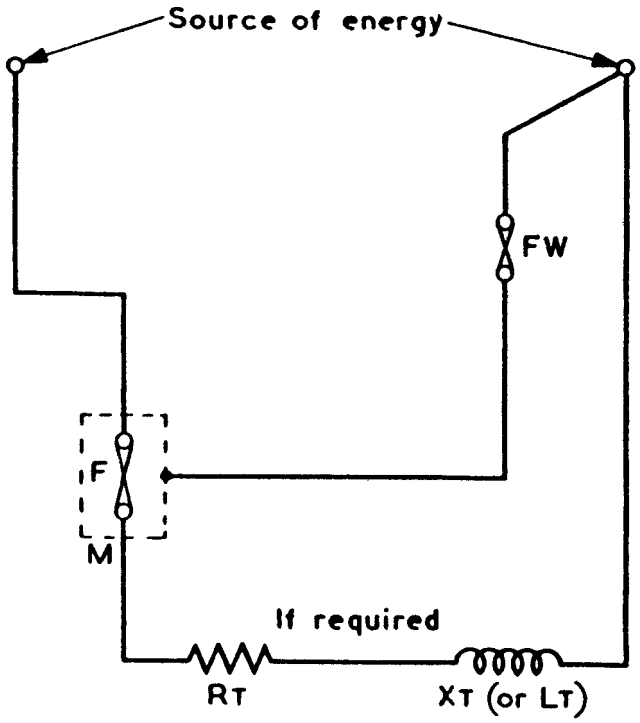


Figure 2 — Testing enclosure



F	Fuse-link on test.	RT	Resistor (for all tests) if required.
M	Testing enclosure.	XT	Reactor (for a.c. tests) if required.
FW	Fine-wire fuse.	LT	Inductor (for d.c. tests) if required.

Figure 3 — Diagram of connections for tests for duty

13 Tests for duty

Fuse-links shall be tested for duty, in accordance with Clause **14**, in a single-phase[2)] a.c. circuit at not less than 250 volts and in a d.c. circuit at not less than 250 volts.

In test a) of the a.c. tests of Clause **14** the circuit shall be "made" at a rising voltage of 50 per cent of the peak value, with a tolerance of plus or minus 15 per cent of the peak value.

The frequency of the source of supply for a.c. tests shall be 50 c/s with a tolerance of plus or minus 25 per cent.

The impedance of an a.c. test circuit, including, if required, a resistor RT and a reactor XT, shall be appropriate to the required prospective current at a power-factor not greater than 0.6 in all tests for duty.

The resistance of a d.c. test-circuit, including, if required, a resistor RT, shall be appropriate to the required prospective current, and the resistance and the inductance of the circuit, including, if required, an inductor LT, shall be such that the circuit has a suitable time-constant not less than 0.0030 second in all tests for duty.

The source of energy for the tests shall be capable of giving the required prospective currents and shall produce initially a recovery-voltage equal to the rated voltage of the fuse-link with a tolerance of plus or minus 5 per cent.

To prove that the fuse-link will withstand indefinitely continued application of its voltage-rating the recovery-voltage shall be maintained within the limits of tolerance for not less than 30 seconds immediately after the opening of the circuit by the fuse-link.

[2)] See Appendix A for a note on single-phase testing.

The insulation-resistance between the end-caps of the fuse-link shall be measured at approximately 500 volts d.c. within three minutes of the conclusion of the above test.

14 Number of tests for duty

Tests for duty shall be as follows (see also Appendix B):

a) Six fuse-links shall be tested in a circuit having a prospective current not less than 100 per cent and not greater than 115 per cent of the breaking-capacity rating of the fuse-link.

b) Three fuse-links shall be tested in a circuit having a prospective current equal to 2.5 times the current-rating of the fuse-link.

c) Six fuse-links shall be tested, one at each of the following values of current: five, ten, fifteen, twenty, twenty-five and thirty times the rated current.

Satisfactory tests for 5-ampere fuse-links shall be deemed to prove that fuse-links of other current-ratings are also satisfactory, provided that they are of the same material and general construction as the 5-ampere fuse-links.

If the material or general construction of fuse-links of current-ratings other than 5 amperes differ from those of the 5-ampere fuse-links tested, separate tests for duty shall be made of fuse-links of the highest current-rating of each construction.

15 Criteria of failure in tests for duty

Fuse-links shall be deemed not to comply with this British Standard if during the test for duty one or more of the following occur:

a) Melting of fine-wire fuse, indicating arcing to the metal case.

b) External damage of the cartridge tube or end-caps.

c) Reduction of the insulation-resistance between the end-caps of the fuse-link to less than 100 000 ohms when measured in accordance with Clause **13**.

Section 5. Marking

16 Marking

Every fuse-link shall be clearly and indelibly marked with its manufacturer's name or identifying mark, with its current rating, and with the number of this specification.

17 Colour Code

The standard current-ratings shall be distinguished by the colours given below:

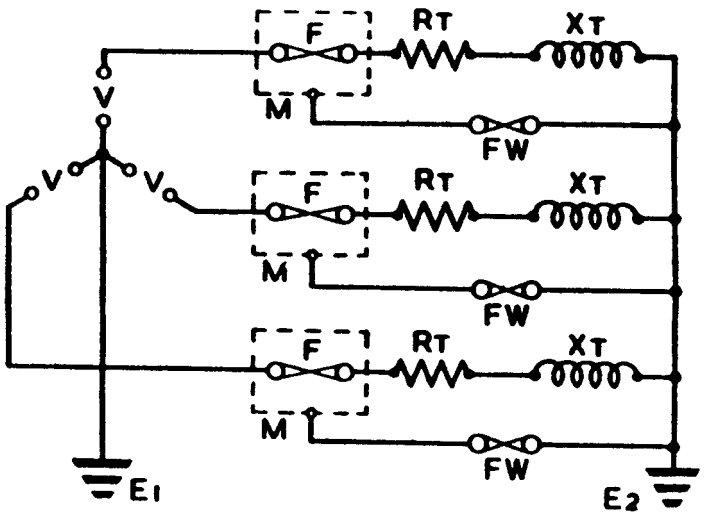
Current-rating	Colour
1 ampere	Green
2 amperes	Yellow
3 amperes	Black
5 amperes	Red

Appendix A Single-phase testing

[A2] *Text deleted* [A2]

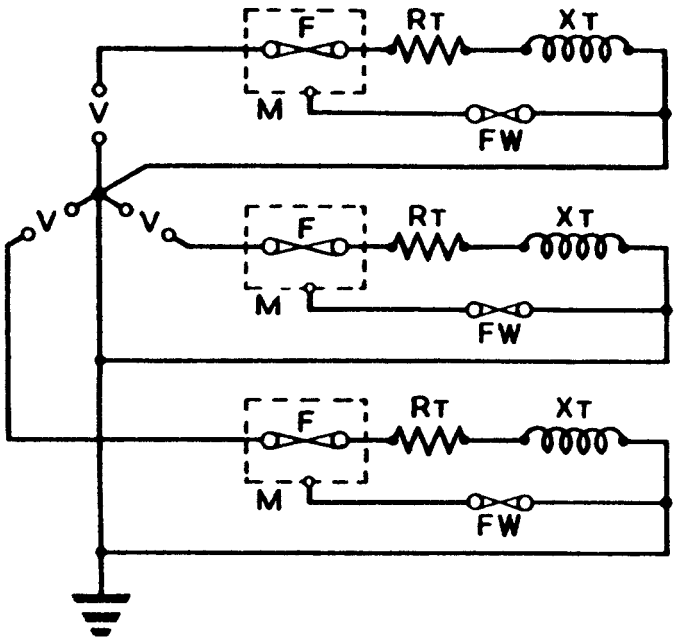
The stipulation [A2] *Text deleted* [A2] that fuses shall be tested for duty by testing single fuses in a single-phase a.c. circuit means that each fuse shall be tested independently, but it does not mean that only one fuse need be tested at once, or that the tests need be only on a single-phase supply.

If, for example, in the absence of a special timing-device it is desired to use phase-differences in the making of the circuit of Test *a* of Clause **21** of BS 88 at the specified part of the voltage-wave, three similar fuses may be tested at once, one in each of three single-phase a.c. circuits each of which has [A2] a rated voltage of ±5% phase to earth [A2]; and the three circuits may be arranged as a three-phase combination in accordance with either Figure 4 or Figure 5. Each fuse is then tested in an independent single-phase a.c. circuit, provided that, if the circuit of Figure 4 is used, the impedance through earth between E1 and E2 is negligible compared with the impedance of the remainder of the test-circuit.



V — Source of energy.
F — Fuse on test.
M — Metal case or woven wire cloth.
FW — Fine-wire fuse.
R_T — Resistor, if required.
X_T — Reactor, if required.

Figure 4 — Diagram of connections for tests for duty, using three fuses



V — Source of energy.
F — Fuse on test.
M — Metal case or woven wire cloth.
FW — Fine-wire fuse.
R_T — Resistor, if required.
X_T — Reactor, if required.

Figure 5 — Alternative diagram of connections for tests for duty, using three fuses

Appendix B Tests for duty

The value of the prospective current stipulated in Clause **14** a) has been formulated on the basis that the fuse protecting the sub-circuit in which the fuse-link to BS 646 is used, will have a cut-off current below the test values specified in this test clause.

The prospective current stipulated in Clause **14** b) has been formulated to ensure tests at a) moderate over-current with values not less than the minimum fusing current and not greater than 1.4 times the maximum fusing current [A2] *Text deleted.* [A2]

Fuse links complying with this specification and tested in accordance with Clause **14** a) will exhibit cut-off. Clause **14** c) has been formulated to ensure that tests are made at smaller prospective values [A2] such that cut-off current is not less than 70% of the numerical value of the symmetrical peak associated with the prospective current for an a.c. circuit or not less than 60% or greater than 80% of the numerical value of the prospective current for a d.c. circuit. [A2]

Appendix C Definitions of terms used in fuse-testing

The following are definitions of terms in common use in fuse-testing:

Arc-voltage. The voltage that exists across a fuse during the arcing time.

NOTE The maximum value of arc-voltage may exceed the peak-value of the a.c. recovery-voltage or the d.c. recovery-voltage.

Loop. The part of an alternating wave which extends from one zero to the next.

NOTE For the purpose of indicating the number of current-zeros during arcing-time, arcing-time may be referred to as including a stated number of loops.

Cut-off. If the melting of a fuse-element prevents the current through the fuse from reaching the otherwise attainable maximum (the peak current of the first major loop on an a.c. circuit, or the steady current in a d.c. circuit), the fuse is said to cut-off, and the instantaneous maximum current attainable is called the cut-off current.

NOTE 1 In an a.c. circuit the numerical value of the cut-off current may be greater than the numerical value of the prospective current.

NOTE 2 A fuse only exhibits cut-off at prospective currents greater than a particular value; the transition point varies with different fuses, and may be at a prospective current greater than the breaking-capacity rating.

Pre-arcing time. The time between the commencement of a current large enough to cause a break in a fuse-element and the instant when an arc is initiated.

Arcing time. The time between the end of the pre-arcing time and the instant when the circuit is broken and the current becomes permanently zero.

Operation (of a fuse). The process in it between the beginning of the pre-arcing time and the end of the arcing-time. Operation is sometimes called "blowing".

Total operating time. The sum of the pre-arcing time and the arcing time.

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