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BSI Standards Publication

Specification for single-phase street lighting cut-out assemblies for low-voltage public electricity distribution systems – 25 A rating for highway power supplies and street furniture

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Contents

Summary of pages
This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 28, an inside back cover and a back cover.

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Foreword

Publishing information

This British Standard is published by BSI and came into effect on 28 February 2010. It was prepared by Technical Committee PEL/17, *Switchgear, Controlgear and HV-LV co-ordination*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 7654:1997, which is withdrawn.

Relationship with other publications

This British Standard is to be read in conjunction with BS EN 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*. The provisions of the general rules dealt with in BS EN 60947-1:2007 are only applicable when specifically cited and they may be supplemented or modified as detailed in the standard.

The clause numbering of this British Standard follows that of BS EN 60947-1:2007 as closely as possible. Where a subclause of BS EN 60947-1:2007 is not relevant to this British Standard, it is marked as "Vacant" or omitted.

Information about this document

This is a full revision of the standard and introduces the following principal changes:

- the standard has been aligned as closely as possible with the principal reference standard, BS EN 60947-1:2007;
- all other references have been updated.

Hazard warnings

WARNING. This British Standard calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Use of this document

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

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.

1 Scope and references

1.1 Scope

This British Standard specifies the requirements for street lighting cut-out assemblies of 25 A rating for the protection of power supplies to highway lighting and street furniture. The cut-out assemblies are for use on single-phase, or one phase of a three-phase, low-voltage public electricity supply system with a maximum voltage up to 440 V a.c. and at a frequency of 50 Hz, the neutral being effectively earthed.

The cut-out assemblies can also be used on distribution systems owned by lighting and highway authorities.

The provisions of the general rules dealt with in BS EN 60947-1:2007 are applicable to this standard when specifically called for.

*NOTE Clauses and subclauses, tables, figures and annexes of the general rules thus applicable are identified by reference to BS EN 60947-1:2007, for example, BS EN 60947-1:2007, **1.2.3**; BS EN 60947-1:2007, Table 1; BS EN 60947-1:2007, Annex A.*

1.2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 923-1, *Guide on high-voltage testing techniques – Part 1: General*

BS 3643-1, *ISO metric screw threads – Part 1: Principles and basic data*

BS 4579-2, *Specification for performance of mechanical and compression joints in electric cable and wire connectors – Part 2: Compression joints in nickel, iron and plated copper conductors*

BS 6004, *Electric cables – PVC insulated, non-armoured cables for voltages up to and including 450/750V, for electric power, lighting and internal wiring*

BS 7870-3.10, *LV and MV polymeric insulated cables for use by distribution and generation utilities – Part 3: Specification for distribution cables of rated voltage 0.6/1 kV – Section 3.10: PVC insulated combined neutral and earth copper wire concentric cables with copper or aluminium conductors*

BS EN 12163, *Copper and copper alloys – Rod for general purposes*

BS EN 12164, *Copper and copper alloys – Rod for free machining purposes*

BS EN 12167, *Copper and copper alloys – Profiles and rectangular bar for general purposes*

BS EN 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

BS EN 60269-1:2007+A1:2009, *Low voltage fuses – Part 1: General requirements*

BS EN 60335-1:2002+A2:2006, *Household and similar electrical appliances – Safety – Part 1: General requirements*

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BS EN 60439-1, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies*

BS EN 60529:1992, *Specification for degrees of protection provided by enclosures (IP code)*

BS EN 60695-11-10:1999, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

BS EN 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*

BS EN 61238-1:2003, *Compression and mechanical connectors for power cables for rated voltages up to 36 kV (U_m = 42 kV) – Part 1: Test methods and requirements*

2 Terms and definitions

For the purposes of this British Standard, the definitions given in BS EN 60947-1:2007 apply, together with the following.

2.1 cut-out assemblies, fuses and their components

2.1.1 cut-out assembly

combination of fuse-link(s), neutral terminal(s), earth terminal(s), combined neutral and earth terminal(s), ancillary terminals block(s), connecting units and anti-tamper facilities, as applicable, so as to provide facilities for terminating service cables and a means of protection, isolation and earthing of electricity supplies to highway lighting and street furniture

2.1.2 fuse

device that by fusing of one or more of its specifically designed and proportioned components opens the circuit in which it is inserted by breaking the current when this exceeds a given value for a sufficient time

NOTE The fuse comprises all the parts that form the complete device.

[BS EN 60269-1:2007+A1, IEC 60050-441:1984+A1]

2.1.3 fuse-base (fuse-mount)

fixed part of a fuse provided with contacts and terminals

[BS EN 60269-1:2007+A1, IEC 60050-441:1984+A1]

NOTE Where applicable, covers are considered as part of the fuse-base.

2.1.4 fuse-carrier

moveable part of a fuse designed to carry a fuse-link

[BS EN 60269-1:2007+A1, IEC 60050-441:1984+A1]

2.1.5 fuse-holder

combination of a fuse-base with its fuse-carrier

[BS EN 60269-1:2007+A1, IEC 60050-441:1984+A1]

2.1.6 fuse-link

part of a fuse [including the fuse-element(s)] intended to be replaced after the fuse has operated

[BS EN 60269-1:2007+A1, IEC 60050-441:1984+A1]

2.1.7 fuse-unit
fuse-holder incorporating neutral and earth terminals for the termination of multi-core cables, within an integral enclosure(s) which can also include a protective cover

2.1.8 fuseway
outgoing circuit in which the protective device is a fuse that is connected to a pole of the system of distribution fed into the fuse-unit

2.1.9 integral fuse-carrier and neutral–earth cover
removable part of a fuse-unit designed to carry a fuse-link(s) having an integral extension cover plate which shields the fuseway(s) and neutral and earth or neutral–earth terminals when it is inserted into the fuse-unit

2.2 insulation

2.2.1 basic insulation
insulation applied to live parts to provide basic protection against electric shock

[BS EN 60335-1:2002+A2]

2.2.2 supplementary insulation
independent insulation applied in addition to the basic insulation in order to ensure protection against electric shock in the event of a failure of the basic insulation

[BS EN 60335-1:2002+A2]

2.2.3 double insulation
insulation system comprising both basic insulation and supplementary insulation

[BS EN 60335-1:2002+A2]

2.2.4 reinforced insulation
single insulation applied to live parts that provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in this standard

NOTE It is not implied that the term insulation system is one homogeneous piece. The insulation can comprise several layers which cannot be tested singly as supplementary or basic insulation.

[BS EN 60335-1:2002+A2]

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3 Classification

The fuse-unit type shall be classified in accordance with Table 1.

Table 1 **Classification of fuse-units**

Classification	Incoming terminal type	Separate neutral and earth terminals	Combined neutral and earth terminals	Number of fuseways	Poles
Type 1 Type 1L	Pillar Lug	Yes	No	One	Single
Type 2 Type 2L	Pillar Lug	No	Yes		
Type 3 Type 3L	Pillar Lug	No	Yes	Two	
Type 4 Type 4L	Pillar Lug	Yes	No	One	Double
Type 5 Type 5L	Pillar Lug	No	Yes		
Type 6 Type 6L	Pillar Lug	Yes	No	Two	

- The fuse-unit includes a cable termination cover which can be separate from, or integral with, the fuse-base.
- A double-pole type of fuse-unit provides disconnection of the outgoing phase and neutral terminals from the incoming phase and neutral terminals.
- All fuse-units are provided with pillar type terminals for the connection of outgoing conductors, unless otherwise agreed between manufacturer and user.

4 Characteristics

4.1 General

BS EN 60947-1:2007, **4.1**, applies.

4.2 Type of equipment

BS EN 60947-1:2007, **4.2**, applies.

4.3 Rated and limiting values for the main circuit

4.3.1 Rated voltages

4.3.1.1 Rated operational voltage (U_e)

BS EN 60947-1:2007, **4.3.1.1**, applies.

4.3.1.2 Rated insulation voltage (U_i)

BS EN 60947-1:2007, **4.3.1.2**, applies.

4.3.1.3 Rated impulse withstand voltage (U_{imp})

BS EN 60947-1:2007, **4.3.1.3**, applies.

4.3.2 Currents

4.3.2.1 Vacant

4.3.2.2 Vacant

4.3.2.3 Vacant

4.3.2.4 Rated uninterrupted current (I_u)

BS EN 60947-1:2007, **4.3.2.4**, applies with the following addition.

Fuse-units.

A fuse-unit shall be capable of carrying current up to its rated uninterrupted current of 25 A, and the currents associated with the operation under fault conditions of any fuse-link which the fuse-units are designed to accommodate. In addition, the incoming phase and neutral terminal assemblies shall be capable of carrying twice the rated uninterrupted current to allow service looping.

4.3.3 Rated frequency

BS EN 60947-1:2007, **4.3.3**, applies.

4.3.4 Vacant

4.3.5 Vacant

4.3.6 Short-circuit characteristics

4.3.6.1 Vacant

4.3.6.2 Vacant

4.3.6.3 Vacant

4.3.6.4 Rated conditional short-circuit current

BS EN 60947-1:2007, **4.3.6.4**, applies.

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5 Product information

5.1 Nature of information

BS EN 60947-1:2007, **5.1**, applies with the following modification.

Characteristics:

Delete the text and substitute the following:

- rated operational voltage (U_e) 250 V a.c (see BS EN 60947-1:2007, **4.3.1.1**);
- rated uninterrupted current (I_u) (see BS EN 60947-1:2007, **4.3.2.4**);
- the value of the rated frequency ~ 50 Hz;
- rated insulation voltage (U_i) 440 V a.c. r.m.s.;
- rated impulse withstand voltage (U_{imp}) 6 kV;
- rated conditional short-circuit current 16 kA a.c. r.m.s. (see BS EN 60947-1:2007, **7.2.4**);
- IP code (see **7.1.12** and BS EN 60947-1:2007, Annex C);
- pollution degree 3.

5.2 Marking

The fuse-carrier shall be clearly and permanently marked in accordance with BS EN 60269-1, and shall be identified with its appropriate fuse-base and cable termination cover.

6 Normal service and mounting conditions

6.1 Normal service conditions

BS EN 60947-1:2007, **6.1**, applies with the following modification and addition.

a) Modification.

BS EN 60947-1:2007, **6.1.1**, Ambient air temperature.

The requirements for the lower limit of the ambient temperatures are as follows.

For outdoor installed low-voltage switchgear and controlgear assemblies, the lower limit of the ambient air temperature shall be –25 °C in accordance with BS EN 60439-1.

b) Addition.

BS EN 60947-1:2007, **6.1.3.2**, Pollution degree.

The fuse-units shall be suitable for operation in a pollution degree 3 environment.

6.2 Vacant

6.3 Mounting

Fuse-units shall be capable of being fixed to a 12 mm thick mounting board manufactured from material which is substantially non-hygroscopic and rot-resistant, by a minimum of two corrosion-proof, cross-head screws. Suitable screws shall be supplied with the fuse-unit.

7 Constructional and performance requirements

7.1 Constructional requirements

7.1.1 General

BS EN 60947-1:2007, **7.1.1**, paragraph 1, applies.

7.1.2 Materials

BS EN 60947-1:2007, **7.1.2**, applies with the following addition.

The insulating integral enclosures shall conform to BS EN 60335-1 for Class II appliances using reinforced insulation.

For all types of fuse-units, the materials shall have thermal properties as follows.

a) When tested in accordance with **8.2.1.2**, each set of specimens shall achieve a classification of category HB40 criteria a) or b) in accordance with BS EN 60695-11-10:1999, **8.4.1**.

b) When tested in accordance with **8.2.1.3**, the diameter of the impression caused by the ball shall not exceed 2 mm.

When tested in accordance with **8.2.1.4**, the material shall have a comparative tracking index (CTI) of not less than 500.

7.1.3 Current carrying parts and their connections

BS EN 60947-1:2007, **7.1.3**, applies with the following additions.

a) Fuse-carriers.

The fuse-carriers shall be suitable for accepting fuse-links up to 25 A rating which conform to the general requirements of BS EN 60269-1 and to Figure 1, Figure 2, Figure 3 and Figure 4 of this standard.

Constant pressure shall be maintained between fuse-carrier contacts and fuse-base contacts, and this shall be unaffected by the means provided for clamping the fuse-link.

The fuse-carriers shall be capable of being withdrawn from the fuse-bases without undue force. If the fuse-carrier dismantles to receive the fuse-link, the fixing components shall be captive, to facilitate reassembly.

Fuse-carrier contacts shall be fabricated from high conductivity copper, or equally suitable copper alloys.

Fuse-carriers shall have a rated uninterrupted current of 25 A and shall fit the fuse-bases in accordance with **7.1.3**b).

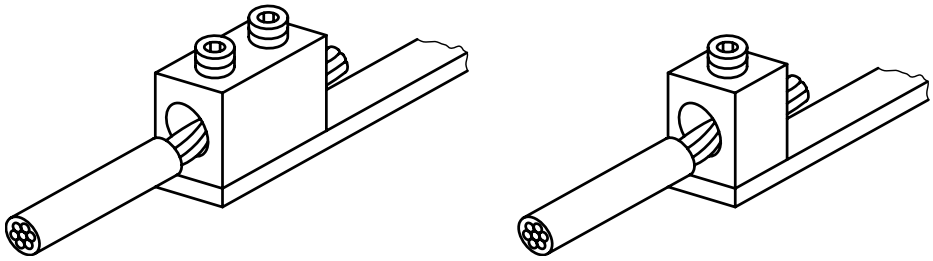
For Type 1 and Type 2, it shall be possible to fit the fuse-carrier correctly to the fuse-base either way up, unless intentional asymmetry is obvious.

For Type 3, Type 4, Type 5 and Type 6, it shall only be possible to fit the integral fuse-carrier and neutral–earth cover to the fuse-base in the correct position. For Type 4, Type 5 and Type 6, it shall not be possible to fit the specified fuse-link in the neutral position.

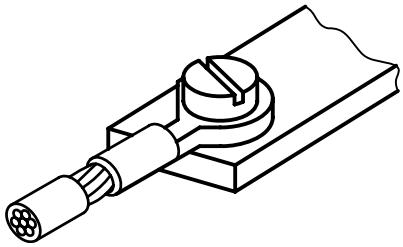
b) Fuse-bases.

Fuse-bases shall be suitable for use with fuse-carriers conforming to **7.1.3**a).

Figure 1 **Typical pillar and lug terminals**

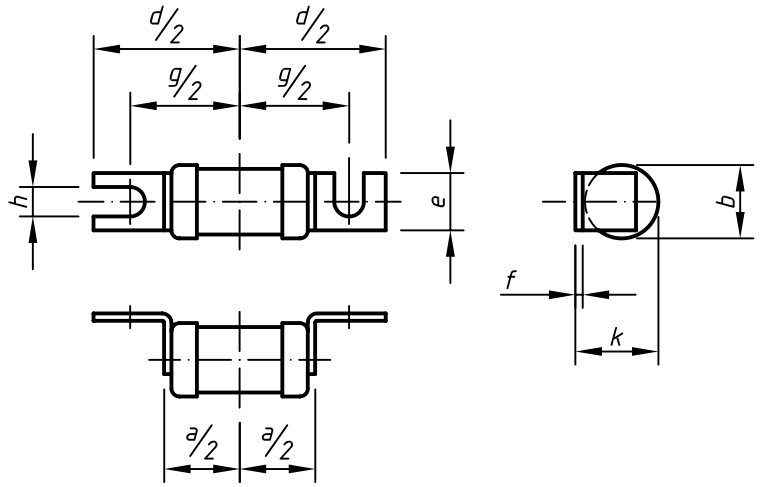


a) Pillar terminals with direct pressure



b) Lug terminal

Figure 2 **Fuse-links for street lighting fuses**

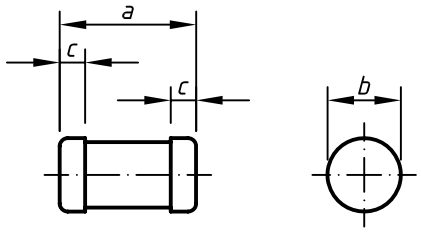


a) Dimensions: Fuse-link with offset tag contacts

Dimensions in millimetres

a	*b*	*d*	*e*	*f*		*g*	*h*	*k*
max.	max.	max.	max.	min.	max.	nom.	nom.	max.
27	14	48	12	0.77	0.84	38	4.87	15

NOTE Dimension a includes all projections such as rivet heads.



b) Dimensions: Fuse-link with ferrule contacts

Dimensions in millimetres

a	*b*	*c*
29 ±0.4	12.7 ±0.1	8.0 ±0.5

NOTE The diameter of the cartridge between the end caps should not exceed diameter b.

Rated voltage 240 V a.c

Rated breaking capacity 16 kA (minimum)

Maximum current rating 25 A

Maximum power dissipation 2.5 W

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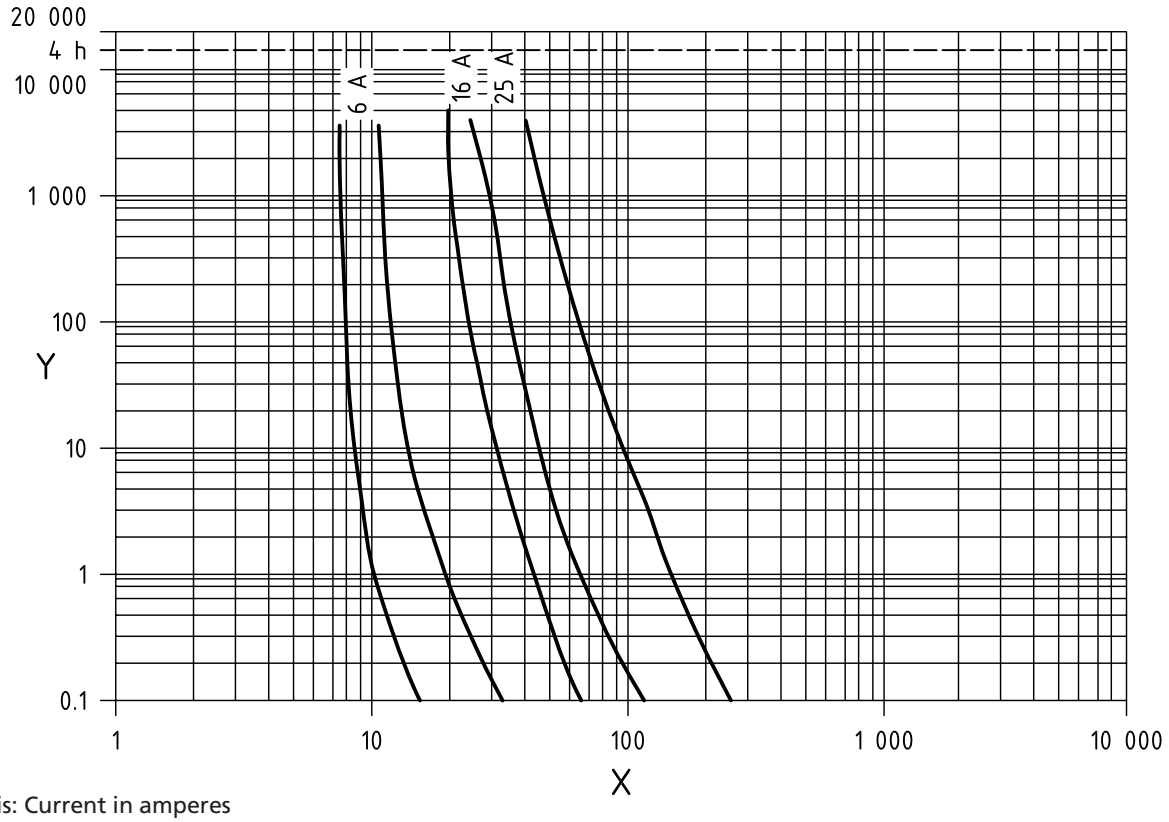
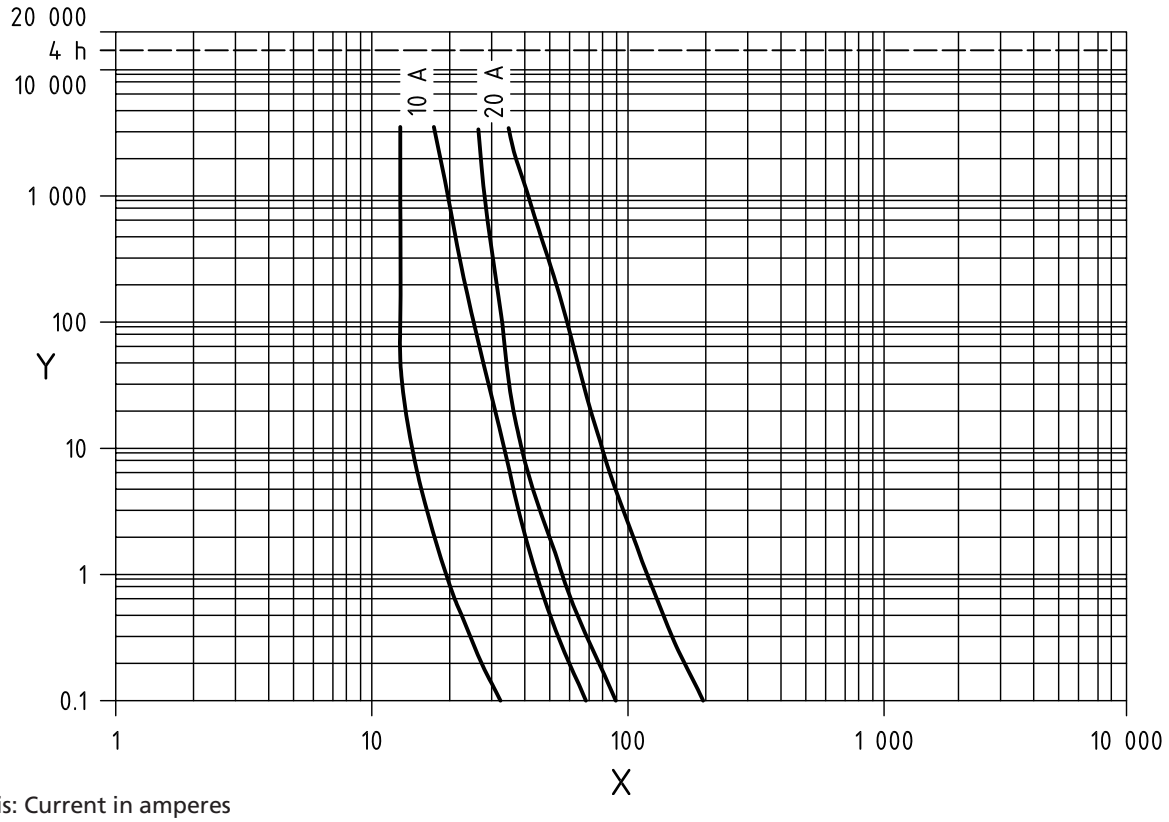
Figure 3 **Time current zones for 6 A, 16 A and 25 A fuse-links**



X-axis: Current in amperes

Y-axis: Time in seconds

Figure 4 **Time current zones for 10 A and 20 A fuse-links**



X-axis: Current in amperes

Y-axis: Time in seconds

7.1.4 Clearances and creepage distances

The minimum distance for clearance and creepage shall be 6 mm.

7.1.5 Vacant

7.1.6 Vacant

7.1.7 Vacant

7.1.8 Terminals

7.1.8.1 Constructional requirements

7.1.8.1.1 General

All parts of the terminals which maintain contact and carry current shall have adequate mechanical strength, such that when tested in accordance with **8.2.4**, there shall be no visible signs of failure, e.g. cracks.

Terminals shall be so constructed that the conductors can be clamped between suitable surfaces without any significant damage (for example, part shearing of the conductor, visible to a person with normal or corrected vision) to either conductors or terminals.

Terminals shall be constructed such that neither the conductors nor the terminals themselves can be displaced in a manner detrimental to the operation of equipment, and the insulation voltage shall not be reduced below rated values.

All terminals shall be suitable for terminating singlecore stranded copper cables conforming to BS 6004 and having a minimum cross-section of 1.5 mm^2.

The incoming phase and neutral terminals shall be suitable for all types of service cable with a circular conductor and having a cross-section of up to and including 25 mm^2.

The outgoing phase terminals and all neutral and earth terminals shall be suitable for terminating stranded copper conductors with a cross-section of up to and including 16 mm^2.

All terminal assemblies shall be captive within the fuse-unit.

The incoming phase terminal shall be close to the bottom of the fuse-base and the neutral and earth terminals shall be approximately in line with this phase terminal, to facilitate the entry of the service cable and to allow interchangeability between the fuse-units of different manufacturers.

7.1.8.1.2 Pillar type terminals

Pillar type terminals (see Figure 1) shall be fabricated from brass conforming to BS EN 12163, BS EN 12164 or BS EN 12167 and shall not be manufactured by hollow die extrusion methods.

Terminals shall be suitable for terminating the conductor with one brass pinching screw of minimum size M6, except the incoming neutral–earth terminals of Type 2, Type 3 and Type 5 fuse-units, which shall be provided with two of these pinching screws. The incoming phase and neutral terminals shall have a sharply serrated contour to break through the aluminium oxide layers to ensure a good contact. All screw holes with pinching screws shall contain at least three full threads conforming to BS 3643-1.

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7.1.8.1.3 Lug type terminals

NOTE Lug type terminals (see Figure 1) may be used to terminate the incoming and looping cables only, unless otherwise agreed between manufacturer and user.

The bottom fuse-base contact terminal bar [see Figure 7d)] shall be fabricated from brass conforming to BS EN 12163, BS EN 12164 or BS EN 12167 and shall be suitable for fixing the appropriate number and size of cable lugs, specified in this standard, by studs and nuts or screws. The strength of the fixing devices shall be sufficient to withstand the appropriate tightening torques specified in BS EN 60947-1:2007, Table 4. All cable lugs shall conform to BS 4579-2 or BS EN 61238-1, as appropriate.

7.1.8.2 Connecting capacity

Fuse-units shall be provided with terminals in accordance with Table 2.

Table 2 **Terminals – Number and disposition**

Type	Incoming terminals				Outgoing terminals		
	Phase	Neutral	Earth	Combined neutral and earth	Per fuseway	Neutral	Earth
1 1L	2	2	2	Not applicable	1	1	1
2 2L	2	Not applicable	Not applicable	2	1	1	1
3 3L	2	Not applicable	Not applicable	2	1	1 minimum	1 minimum
4 4L	2	2	2	Not applicable	1	1	1
5 5L	2	Not applicable	Not applicable	2	1	1	1
6 6L	2	2	2	Not applicable	1	1 minimum	1 minimum

7.1.8.3 Connection

BS EN 60947-1:2007, **7.1.8.3**, applies.

7.1.8.4 Terminal identification and marking

BS EN 60947-1:2007, **7.1.8.4**, applies.

7.1.8.5 Terminal positions

With a fuse-base in its normal service orientation and viewed from the front, the order of the terminals from left to right shall be phase, neutral and earth.

7.1.9 Vacant

7.1.10 Vacant

7.1.11 Enclosures for equipment

7.1.11.1 Design

7.1.11.1.1 General

BS EN 60947-1:2007, **7.1.11.1**, paragraphs 1, 2 and 5 apply with the following addition.

An insulating integral enclosure shall be provided. This enclosure shall have a mechanical strength sufficient to withstand the forces that might be expected to occur in normal service. When tested in accordance with **8.2.2**, the fuse-units shall show no significant damage and no accessible live parts. The appearance of small dents shall be ignored.

7.1.11.1.2 Cable termination cover

When required by the purchaser, the manufacturer shall provide a cable termination cover for the protection of incoming cables.

NOTE The cable termination cover can be an integral part of the fuse-unit or it can interlock into the fuse-base so that the cover cannot be removed until the fuse-carrier has been withdrawn.

A cover that is separate from the fuse-base shall be capable of being fixed securely to a 12 mm thick mounting board by not more than two corrosion-proof, cross-head screws, which shall be supplied.

The cover shall have two cable entry ports provided at the bottom, for which grommets shall be supplied.

The interior shall have adequate space to accommodate incoming cables having the maximum conductor sizes stated in **7.1.8.1.1**.

Where integrally moulded diaphragms are used to protect cable entry positions, it shall be possible to remove them without damage to the surrounding moulding.

7.1.11.1.3 Dimensions

The dimensions of the fuse-units, including cable termination cover, shall be kept to a practical minimum. The maximum permitted dimensions for Type 1 and Type 2 fuse-units shall be 150 mm high, 80 mm wide and 70 mm deep.

7.1.11.2 Vacant

7.1.12 Degrees of protection of enclosed equipment

Segregation shall be provided by insulating barriers between any adjacent terminal assemblies. They shall be designed to prevent inadvertent bridging by the fuse-carrier of the phase and neutral–earth terminals.

Fuse-links, fuse-carrier contacts and terminals shall be shielded to protect persons from accidental contact with live parts.

For single-pole fuse-units, a red coloured insulating shield shall be provided in each fuse-base covering the incoming phase terminals. The insulating shield shall have a protection rating of not less than IP 2X as specified in BS EN 60529:1992, be captive in the fuse-unit and only be removable by use of a tool.

For double-pole fuse-units only, an insulating shield(s) shall cover both the incoming phase and neutral terminals. The insulating shield(s) shall have a protection rating of not less than IP 2X as specified in

BS EN 60529:1992, shall be captive in the fuse-unit and shall only be removable by use of a tool.

Access to any internal parts, including those enclosed by cable termination covers, shall only be possible once the seals applied for security purposes have been removed.

When a fuse-unit is mounted in a normal service operating position with all removable parts of the fuse-unit in place, the degree of protection provided to all internal or live parts shall be not less than IP 22 as specified in BS EN 60529:1992.

Type 1 and Type 2 fuse-carriers shall have the facility to be secured to the fuse-base by means of security sealing wire and seals. The sealing hole shall be positioned to prevent inadvertent entry of the sealing wire to the interior of the fuse-unit. Installed fixing screws shall only be capable of release by first opening the respective security seal(s). Sealing tabs shall be provided for all accessible screws.

The sealing lug holes shall allow the insertion of two high tensile meter-sealing wire ropes of maximum overall diameter 0.914 mm, having seven zinc coated strands, and shall prevent the passage of a 3 mm diameter ferrule. There shall be adequate clearance around the sealing lugs, with or without a cable termination cover, to facilitate the fixing and removal of the security systems.

7.2 Performance requirements

*COMMENTARY ON **7.2**.*
*The requirements in **7.2** apply to new fuse-units manufactured in accordance with this standard.*

7.2.1 Vacant

7.2.2 Temperature-rise

7.2.2.1 General

The temperature-rise at rated current of a fuse-unit, fitted with an appropriate fuse-link, shall have no deleterious effect on the materials of the fuse-unit, the connecting cables, fuse-link or the mounting support.

When tested in accordance with **8.3.3.3**, under the conditions specified in **8.3.2.1**, the temperature-rise of the parts of a fuse-unit shall be no greater than the values given in Table 3.

Table 3 **Maximum temperature-rise at rated current**

Terminal assemblies	Fuse-carrier contacts	Fuse-carrier grip [A)]	Insulating integral enclosure
45 K	50 K	25 K	35 K

[A)] Manual operating means only.

7.2.2.2 Long term contact stability

Adequate contact shall be maintained between the fuse-carrier contacts and the fuse-base contacts and between the conductors and the terminals after a fuse-unit has remained in service and undisturbed for a long period.

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When tested in accordance with **8.3.3.3.4.4**, Test 4 and Test 5, there shall be no signs of deterioration that could affect the normal operation of the fuse-unit, for example distortion or cracking of insulation, and the temperature-rises recorded under test condition 2) shall exceed those observed at the end of the test in **8.3.3.3.4.1** by no more than 3 K.

When tested in accordance with **8.3.3.3.4.4**, Test 6, the recorded results shall meet the appropriate requirements of BS EN 61238-1:2003, **6.4** and **6.5**.

7.2.2.3 Mechanical endurance

Adequate contact shall be maintained between the fuse-carrier contacts and the fuse-base contacts of fuse-units after repeated disengagement and re-engagement. When tested in accordance with **8.3.3.3.4.2**, the recorded temperature-rises shall differ by no more than 3 K from those observed at the end of the test in **8.3.3.3.4.1**.

7.2.3 Dielectric properties

When tested in accordance with **8.3.3.4**, there shall be no disruptive discharges and the insulation resistance shall be not less than 50 MΩ. If the power frequency voltage cannot be maintained at the specified value, or there is evidence of sparking or tracking visible to a person with normal or corrected vision without additional magnification, this shall be regarded as failure of the test.

7.2.4 Performance on overload and short-circuit

A fuse-unit shall be capable of carrying overload currents associated with the operation under fault conditions of any fuse-link conforming to **7.1.3**a). When tested in accordance with **8.3.3.3.4.3**, there shall be no signs of deterioration, for example cracking or melting of insulation, visible by normal or corrected vision and the temperature-rises recorded shall exceed those observed at the end of the test in **8.3.3.3.4.1** by no more than 5 K.

The rated conditional short-circuit current shall be determined by the test of **8.3.4**. When tested in accordance with **8.3.4**, the fuse-carrier contacts and fuse-base contacts shall have adequate engagement of the contacts for normal service. After the test, it shall be possible to operate the equipment by its normal operating means.

8 Tests

8.1 Kinds of tests

8.1.1 General

BS EN 60947-1:2007, **8.1.1**, applies.

8.1.2 Type tests

BS EN 60947-1:2007, **8.1.2**, applies with the following addition.

Unless otherwise stated in the relevant test, fuse-units shall be tested in batches, each of which shall consist of a sample of six, selected at random from the manufacturer's stock of new fuse-units. The type tests applicable shall be as given in Table 4.

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Table 4 **Type tests**

Test	Test series A	Test series B	Number of samples
Constructional requirements			
Protection	**8.2.3**	**8.2.3**	1 new sample fuse-unit
Impact:			
Test 1 – normal temperate climate temperature	**8.2.2**a)	**8.2.2**a)	6 new sample fuse-units
Test 2 – lower limit of temperate climate temperature	**8.2.2**b)	**8.2.2**b)	6 new sample fuse-units
Resistance to tracking	**8.2.1.4**	**8.2.1.4**	1 new specimen
Flammability	**8.2.1.2**	**8.2.1.2**	3 new specimens
Hot ball	**8.2.1.3**	**8.2.1.3**	3 new specimens
Terminal torque	**8.2.4**	**8.2.4**	6 new sample terminals of each type
Performance			
Dielectric properties	**8.3.3.4.1**	**8.3.3.4.1**	6 new sample fuse-units
Test 1 – temperature-rise at rated current	**8.3.3.3.4.1**	**8.3.3.3.4.1**	6 new sample fuse-units
Mechanical endurance	**8.3.3.3.4.2**	**8.3.3.3.4.2**	A)
Overload temperature-rise looped fuses	**8.3.3.3.4.3**	**8.3.3.3.4.3**	A), B)
Test 2 – copper conductors	**8.3.3.3.4.1**	**8.3.3.3.4.1**	6 new sample fuse-units
Test 3 – aluminium conductors	**8.3.3.3.4.1**	Not applicable	6 new sample fuse-units
Cyclic loading temperature-rise:			
Test 4 – copper conductors	**8.3.3.3.4.4**	**8.3.3.3.4.4**	6 new sample fuse-units
Test 5 – aluminium conductors	**8.3.3.3.4.4**	Not applicable	6 new sample fuse-units
Test 6 – aluminium conductors	Not applicable	**8.3.3.3.4.4**	6 new sample terminal bars each with 2 cable lugs
Test for mechanical strength of the electrical components	**8.3.4**	**8.3.4**	1 new sample fuse-unit

A) These tests are to be carried out in the stated sequence on the same samples as those used for temperature-rise Test 1.

B) The dielectric properties tests include impulse withstand voltage dry tests, power frequency withstand voltage dry tests and measurement of insulation resistance. These tests are repeated after completion of the overload test of **8.3.3.3.4.3**.

NOTE Either Test series A or Test series B may be carried out at the discretion of the manufacturer.

8.2 Conformity to constructional requirements

8.2.1 Materials

8.2.1.1 General

Specimens of the materials used for the insulating integral enclosure shall be tested in accordance with **8.2.1.2**, **8.2.1.3** and **8.2.1.4**.

8.2.1.2 Flammability test

Representative specimens of each of the materials of enclosures, barriers and other insulating parts shall be subjected to a flammability test in accordance with BS EN 60695-11-10:1999, test method A, horizontal burning test.

NOTE When agreed between user and manufacturer, other tests to check the resistance to fire of materials of enclosures, barriers and other insulating parts may be carried out.

8.2.1.3 Hot ball test

Specimens of the material shall be subjected to a ball pressure test by means of the apparatus shown in Figure 5. The surface of the part to be tested shall be placed in the horizontal position and a steel ball of 5 mm diameter shall be pressed against this surface by a force of 20 N.

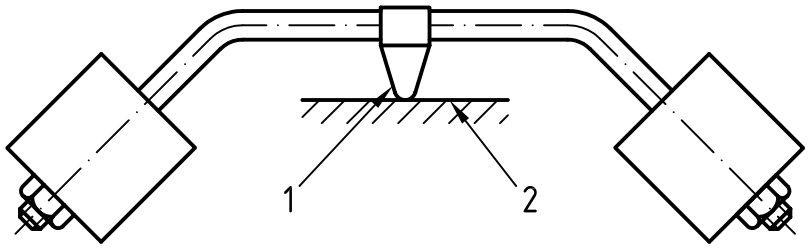
NOTE For the purpose of this test, a protective conductor, PE, is not considered as a current-carrying part.

The test shall be made in a heating cabinet at a temperature as follows.

- Parts necessary to retain current-carrying parts in position: (125 ±2) °C.
- Other parts of insulating material not necessary to retain current-carrying parts in position, even if they are in contact with them: (70 ±2) °C.

After 1 h, the ball shall be removed. The sample shall then be cooled, within 10 s, to approximately room temperature by immersion in cold water. The diameter of the impression caused by the ball shall be measured.

Figure 5 **Ball pressure test apparatus**



Key

1 Spherical radius (SR) 2.5 mm

2 Specimen

8.2.1.4 Resistance to tracking

Specimens of the material shall be tested in accordance with BS EN 60112.

8.2.2 Equipment

Impact test.

This test shall be performed on two batches of new fuse-units by means of the impact test apparatus described and illustrated in Figure 6.

The fuse-unit shall be held firmly against a rigid frame and mounted so that the point of impact lies in the vertical plane containing the suspension axis of the pendulum.

a) Test 1. The test shall be carried out at an ambient air temperature between 15 °C and 35 °C after the fuse-units to be tested have been kept within these temperatures for not less than 18 h.

b) Test 2. The test shall be carried out at an ambient air temperature between 15 °C and 35 °C immediately after the fuse-units have been kept at a maximum temperature of –25 °C for a period of not less than 18 h.

A striking head of 0.15 kg weight shall be released from a preset height of 170 mm, under free fall through an arc (impact energy 0.25 J). Each test shall consist of three blows aimed at the approximate centre of the considered weaker spots of the insulating integral enclosure.

The impact tests on the insulating integral enclosure of the fuse-unit shall be made with all barriers, baffles or plugs removed. A separate test on the barriers, baffles or plugs of all main phase and neutral conductor ports in position on the fuse-unit shall be performed using the same apparatus but with the free fall height adjusted to 34 mm so as to provide an impact energy of 0.05 J.

The fuse-units shall be inspected for significant damage and accessible live parts, ignoring the appearance of small dents. If there are associated cracks visible to a person with normal or corrected vision without additional magnification, the test given in **8.3.3.4.1** shall be performed.

8.2.3 Enclosures for equipment

The fuse-unit shall be tested for the degree of protection in accordance with BS EN 60529.

8.2.4 Mechanical properties of terminals

Terminal torque test.

The test shall be carried out on a batch of six new terminals of each type. The terminals and screws shall be unplated and the screws shall be free running in the terminals before the commencement of the test. Terminals shall be tightened on to a hard drawn copper rod of 6 mm diameter, for a period of 1 h, using a clamping torque of 3.5 N·m.

*NOTE See **7.1.8.1.1** for the pass criteria for this test.*

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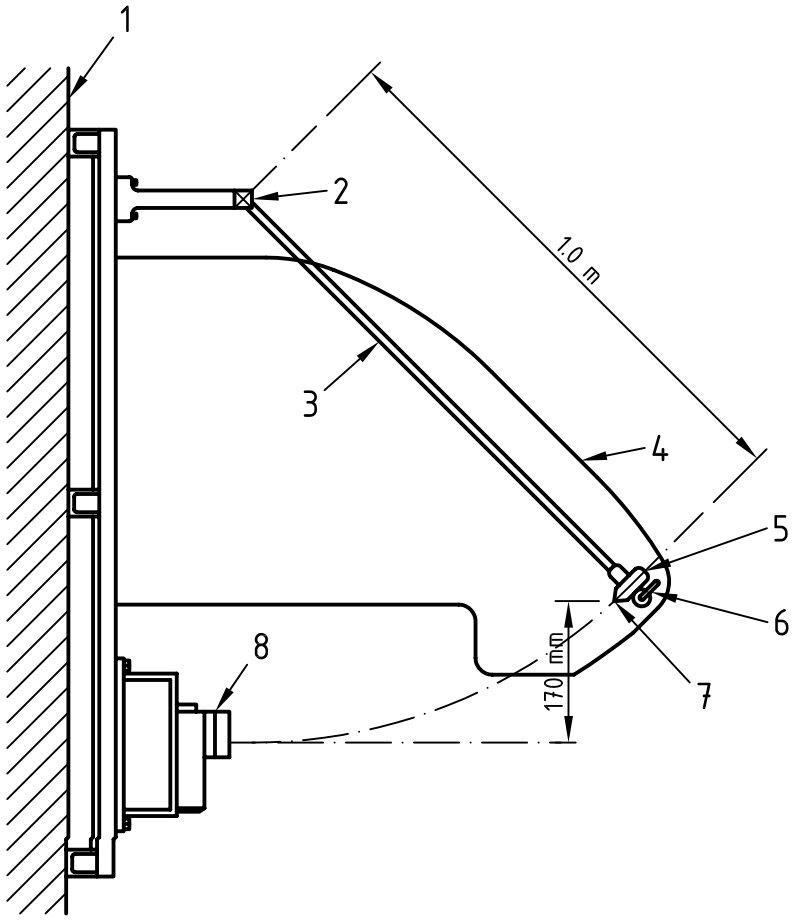
Figure 6 **Apparatus for impact test**



Key

1 Rigid support structure
2 Pendulum suspended to swing in vertical plane only
3 Pendulum
4 Mounting plate for release mechanism
5 Hammer 0.15 kg
6 Release mechanism
7 Radius of head 12.5 mm
8 Fuse under test

Materials:

Hammer head – Hornbeam or European Ash; Pendulum arm – steel tube (9 mm diameter, 0.5 mm wall thickness)

NOTE This drawing is not intended to govern design except as regards the dimensions shown.

8.3 Performance

8.3.1 Vacant

8.3.2 General test conditions

8.3.2.1 General requirements

BS EN 60947-1:2007, **8.3.2.1**, applies with the following additions.

The pinching screws of all connected pillar type terminals shall be tightened to a torque of (2.25 ±0.2) N·m.

For tests of **8.3.3.3.4.1**, **8.3.3.3.4.2**, **8.3.3.3.4.3** and **8.3.3.3.4.4**, the fuse-units shall be mounted in a vertical position on a mounting board in accordance with **6.3**. No part of the edge of any fuse-unit shall lie within 150 mm of the edge of the mounting board.

Fuse-units shall be complete with cable termination cover for the tests of **8.3.3.3.4.1** and **8.3.4**.

Where fuse-links are required to be fitted to the fuse-units for a particular test, they shall:

- conform to **7.1.3**a);
- have the same current rating as the fuse-carriers;
- have a power dissipation not less than 2.5 W at rated current.

8.3.2.2 Test quantities

8.3.2.2.1 Values of test quantities

BS EN 60947-1:2007, **8.3.2.2.1**, applies amplified as follows.

Values of the test current shall be as stated in the appropriate test of this standard.

8.3.2.2.2 Tolerances on test quantities

The wave forms of alternating currents or voltages shall be approximately sinusoidal with a frequency of (50 ±5) Hz. Currents for tests, except **8.3.4**, are r.m.s. quantities and shall be measured to an accuracy of ±1%. Temperature change shall be measured to an accuracy of ±1 K. Wattage values are r.m.s. quantities and shall be measured to an accuracy of ±5%.

8.3.2.3 Vacant

8.3.2.4 Test reports

BS EN 60947-1:2007, **8.3.2.4**, applies.

8.3.3 Performance under no load, normal load and overload conditions

8.3.3.1 Vacant

8.3.3.2 Vacant

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8.3.3.3 Temperature-rise

8.3.3.3.1 Ambient air temperature

The ambient air temperature shall be not less than 20 °C and shall vary by no more than 3 K/h during any temperature-rise test.

The test environment shall be substantially draught free.

The ambient air temperature is considered to be the average of the temperatures of two or more unheated bodies having thermal characteristics similar to those of the test piece(s). The unheated bodies shall be positioned symmetrically around the test piece(s) at a distance of 1 m and at the median height. They shall be protected from air currents and heat radiation and their temperatures shall differ by no more than 2 K. The temperatures shall be measured by means of thermocouples.

8.3.3.3.2 Measurement of the temperature of parts

BS EN 60947-1:2007, **8.3.3.3.2**, applies with the following addition.

The temperature of any test piece shall be within 3 K of ambient air temperature at the commencement of each test unless otherwise specified.

8.3.3.3.3 Temperature-rise of a part

BS EN 60947-1:2007, **8.3.3.3.3**, applies.

8.3.3.3.4 Temperature-rise of the fuse-unit

8.3.3.3.4.1 Tests for temperature-rise at rated uninterrupted current

The tests for temperature-rise at rated uninterrupted current shall be as follows.

a) Test 1. A batch of new fuse-units shall be tested for temperature-rise at rated uninterrupted current.

   The following test connections shall apply.

   The cable connected to the bottom phase and neutral terminals shall be a single-phase concentric service cable conforming to BS 7870-3.10, with a copper conductor of cross-section 4 mm^2. This cable shall be at least 2 m in length. The top phase terminal shall be connected to the top neutral terminal by a 300 mm length of PVC-insulated and PVC-sheathed cable conforming to BS 6004, having a conductor cross-section of 2.5 mm^2.

   The steady state temperature-rises shall be recorded and the test of **8.3.3.3.4.2** performed immediately.

b) Test 2. Two batches of new fuse-units, cabled (looped) together in pairs using copper conductor service cable, shall be tested for temperature-rise.

   The following test connections shall apply.

   The incoming cable connected to the bottom terminals of the right-hand fuse-unit shall be a single-phase concentric service cable conforming to BS 7870-3.10, with a copper conductor of cross-section 4 mm^2. This cable shall be at least 2 m in length. The incoming terminals of the right-hand side fuse-unit shall be connected to the bottom terminals of the left-hand fuse-unit by a 2 m length of the same cable.

The top phase terminal of the right-hand fuse-unit shall be connected to its top neutral terminal by a suitable length of PVC-insulated and PVC-sheathed cable conforming to BS 6004, having a conductor cross-section of 2.5 mm^2. The length of this test connection shall be adjusted to give current balance to the test circuit.

The top phase and neutral terminals of the left-hand fuse-unit shall be connected by a 300 mm length of the same cable.

The circuit shall be arranged so that a current of 25 A is flowing in the right-hand fuse-unit and 17 A in the left-hand fuse-unit.

The steady state temperature-rises of the right-hand fuse-unit shall be recorded.

c) Test 3. Two batches of new fuse-units cabled (looped) together in pairs using aluminium conductor service cable shall be tested for temperature-rise.

*NOTE This test is optional, subject to the discretion of the manufacturer, on the basis that if it is omitted, Test 6 given in **8.3.3.3.4.4** becomes mandatory.*

The following test connections shall apply.

A single-phase concentric service cable conforming to BS 7870-3.10 with an aluminium conductor of cross-section 25 mm^2 shall be connected to the bottom terminals of the right-hand fuse-unit. This cable shall be at least 2 m in length. The incoming terminals of the right-hand side fuse-unit shall be connected to the bottom terminals of the left-hand fuse-unit by a 2 m length of the same cable.

The top phase terminal of the right-hand fuse-unit shall be connected to its top neutral terminal by a suitable length of PVC-insulated and PVC-sheathed cable conforming to BS 6004, having a conductor cross-section of 2.5 mm^2. The length of this test connection shall be adjusted to give current balance to the test circuit. The top phase and neutral terminals of the left-hand fuse-unit shall be connected by a 300 mm length of the same cable.

The circuit shall be arranged so that a current of 25 A is flowing in both left-hand and right-hand fuse-units, thus providing a total current of 50 A in the bottom terminal of the right-hand fuse-unit.

The steady state temperature-rises of the right-hand fuse-unit shall be recorded.

8.3.3.3.4.2 Mechanical endurance test

The test circuit of **8.3.3.3.4.1**, Test 1, shall be switched off. The fuse-carriers shall then be disengaged and re-engaged 20 times before any significant cooling takes place, after which **8.3.3.3.4.1**, Test 1, shall be repeated.

The current shall be switched off and the test batch allowed to cool to ambient temperature. No adjustments of any kind shall be made before the overload test of **8.3.3.3.4.3** is carried out.

The temperature-rise shall be recorded.

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8.3.3.3.4.3 Overload test

The test circuit of **8.3.3.3.4.1**, Test 1, shall be switched on and the current maintained at 30 A for 4 h. The current shall then be increased to 35 A and maintained for 30 min. Then, if any fuse-link has not operated, the current shall be increased to 40 A until all fuse-links have operated.

NOTE In order to allow for the probable sequential operation of the fuse-links, the test circuit may be arranged with shorting switches to permit the continued passage through those fuse-links to remain intact until the last fuse-link has operated. A momentary interruption of the test current following the operation of each fuse-link is acceptable.

After the fuse-units have been allowed to cool to ambient temperature, all fuse-links shall be replaced by new fuse-links conforming to **8.3.2.1**. No other adjustments shall be made. Subclause **8.3.3.3.4.1**, Test 1, shall be repeated.

The connected cables shall be removed and the impulse withstand voltage dry tests and power frequency withstand voltage dry tests of **8.3.3.4** shall be performed on the test pieces only.

The test pieces shall be inspected for signs of deterioration and the temperature-rises shall be recorded.

8.3.3.3.4.4 Electrical cyclic loading temperature rise tests

The tests for cyclic loading temperature-rise shall be as follows.

a) Test 4, using copper conductor service cable.

A batch of new fuse-units shall be tested for not fewer than 2 000 cycles for stability of temperature-rise, using the circuit as stated in **8.3.3.3.4.1**, Test 1.

The test conditions shall be as follows.

1) Each cycle shall be of 2 h duration (1 h on and 1 h off).

2) Full tests for temperature-rise at the rated uninterrupted current shall be performed initially after 100 cycles and at every sequence of (100 ±25) cycles thereafter. The temperature-rises for all terminals and fuse-carrier contacts shall be recorded.

3) The current shall not fall below the rated current at any time while the fuse-units are on load and shall be sufficient to ensure that the minimum temperature-rises attained at each point of measurement for every cycle shall at least equal those recorded for the corresponding point (see test condition 2), subject to a tolerance of $^{0}_{-1}$ K.

*NOTE For this test, fuse-links conforming to **8.3.2.1**, but without eutectic zones on the elements, are acceptable.*

b) Test 5, using aluminium phase conductor service cable.

*NOTE This test is mandatory only when **8.3.3.3.4.1**, Test 3, is performed.*

A batch of new fuse-units shall be tested to prove the stability of temperature-rise of the incoming terminals at the maximum in air current rating (58 A) of the connected cables.

The following test connections shall apply.

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The fuse-units shall be cabled (looped) together through the incoming terminals with a single-phase concentric service cable conforming to BS 7870-3.10, having an aluminium conductor of cross-section 25 mm^2. Each cable shall be at least 2 m in length.

There shall be no fuse-links in the fuse-carriers and no fuse-carrier contacts in the incoming terminals. The fuse-carrier shall be in its normal position, held in place, if necessary, with a tie.

The test shall be carried out in accordance with test conditions 1), 2) and 3) of Test 4 except that the temperature rises of the incoming terminals only shall be recorded.

The test pieces shall be inspected for signs of deterioration that could affect the normal operation of the fuse-unit and the temperature-rises shall be recorded.

c) Test 6.

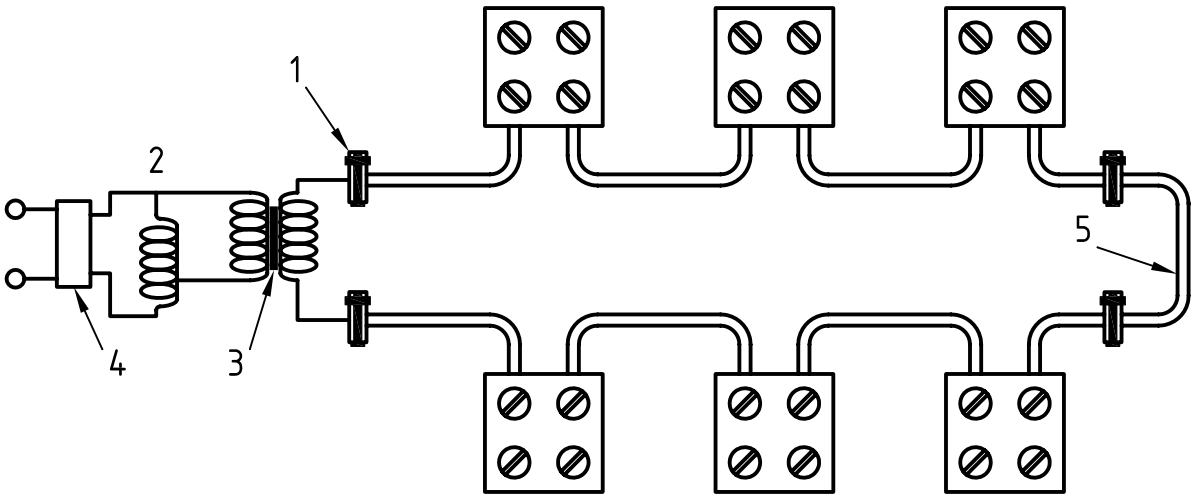
*NOTE 1 This test is mandatory when **8.3.3.3.4.1**, Test 3, is omitted.*

A batch of six new terminals of each design shall be tested in accordance with the initial resistance measurements and load electrical cycling tests specified in BS EN 61238-1:2003, **6.1**, **6.2**, **6.3.1**, **6.3.2** and **6.3.3**.

For the purpose of this standard, the specimen terminals shall be Class B terminations classified in accordance with BS EN 61238-1 and shall be tested on 25 mm^2 size conductor only.

NOTE 2 The electrical load cycling test rigs and the potential test points A and B are shown in Figure 7.

Figure 7 **Electrical load cycling test rigs for Test 6**

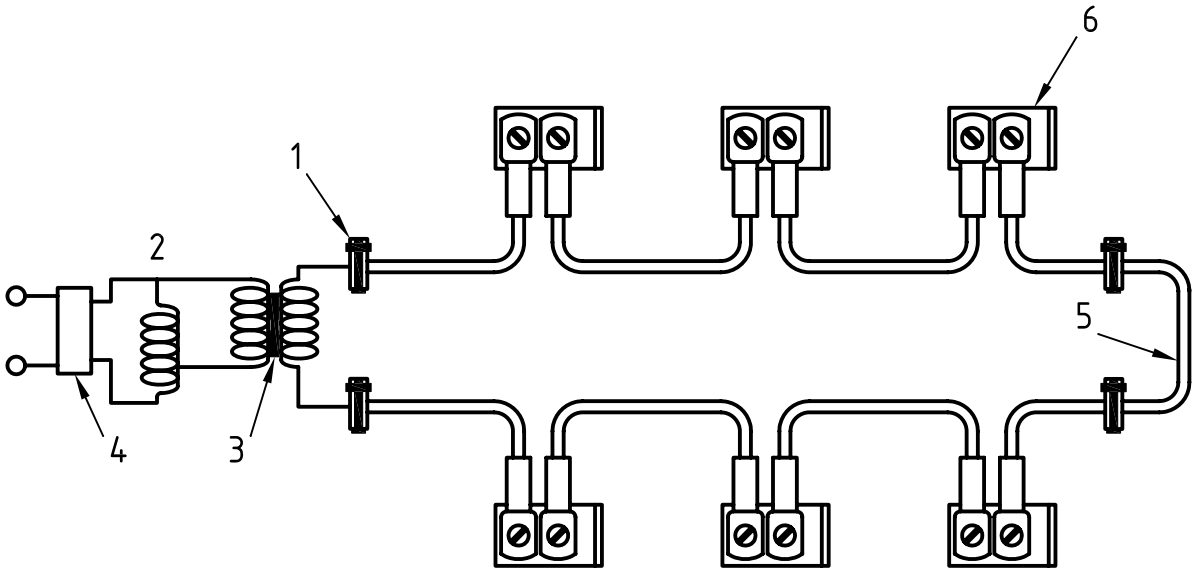


a) Electrical load cycling test rig for pillar terminals

Key

1 Connecting points
2 Variable transformer
3 Transformer
4 Contactor and timing device for automatic control
5 Control conductor

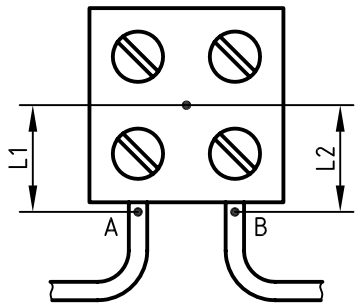
Figure 7 **Electrical load cycling test rigs for Test 6** *(continued)*



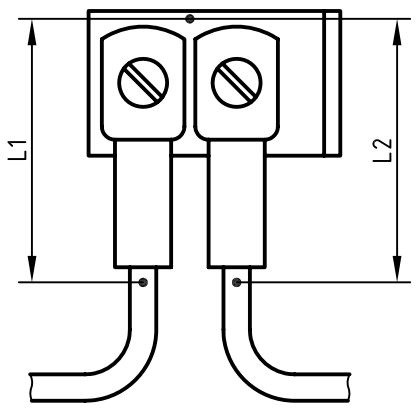
b) Electrical load cycling rig for lug terminals

Key

1 Connecting points
2 Variable transformer
3 Transformer
4 Contactor and timing device for automatic control
5 Control conductor
6 Terminal bar



c) Potential points for resistance measurement for pillar terminals



d) Potential points for resistance measurement for lug terminals

8.3.3.4 Dielectric properties

8.3.3.4.1 Type tests

One batch of each type of fuse-unit shall be subjected to impulse withstand voltage dry tests and 1 min power frequency (alternating) withstand voltage dry tests in accordance with BS 923-1. The tests shall be carried out immediately after each complete fuse-unit has been exposed to a relative humidity of 95% at a temperature of (25 ±2) °C for at least 24 h.

NOTE Any surface moisture may be removed before the commencement of the test.

Each fuse-unit shall be placed on an earthed, unpainted metal plate and fixed by means of metal bolts and nuts in all normal fixing holes.

One pole of the test supply shall be earthed and all terminals on the test piece which are not effectively connected to the live pole shall be connected to the earthed pole. The metal foil referred to in **8.3.3.4.1**a) shall be in contact with the metal plate. The live pole shall be connected to the first named component in **8.3.3.4.1**a) and b).

Impulse withstand voltage tests shall be performed with voltages of both positive and negative polarity, using the standard impulse 1.2/50. Ten consecutive impulses having a peak value of 6 kV shall be applied for each test condition and each polarity at intervals of not less than 3 s.

Power frequency voltage withstand tests shall be performed with a test voltage raised to 3.75 kV r.m.s. and maintained for 1 min.

Impulse withstand voltage tests and power frequency withstand voltage tests shall be performed with the test voltages applied as follows.

a) Without fuse-links fitted.

   1) Test point 1: to the electrically separate terminals connected together.

      Test point 2: to the metal foil completely enclosing, and in contact with, all external surfaces of the fuse-unit.

   2) Test point 1: to the incoming phase terminal.

      Test point 2: to the outgoing phase terminal.

b) With fuse-links fitted in the fuse-carrier.

   The fuse-carrier shall be inserted and sealed to the test piece fuse-base with sealing wire effectively connected to the metal plate.

   1) Test point 1: a phase terminal.

      Test point 2: the metal plate.

   2) For Type 1 fuse-units only:

      test point 1: the neutral terminal;

      test point 2: the earth terminal.

After completing the power frequency withstand voltage test for each condition, the insulation resistance shall be measured between the same points, using a d.c. voltage of not less than 500 V.

8.3.3.4.2 Routine tests

Routine testing is not required.

8.3.4 Test for mechanical strength of the electrical components

In a fuse-unit which relies on spring pressure alone for the effectiveness of its contact, one test shall be performed at any convenient value of voltage on a fuse-unit with the fuse-link replaced by a copper link. The test current shall have a prospective value of not less than 16 kA and shall be such that the peak value caused to flow through the fuse-carrier and fuse-base shall be not less than 6 kA for a period of not more than 0.02 s.

NOTE The intended duration of the current flow is the minimum necessary to allow the current to rise to the specified peak value and should be no more than 0.02 s. This limitation can, for example, be achieved by a series-connected fuse.

Each test connection length shall be at least 1 m. They shall be arranged either side of the fuse-unit in the plane of the connecting device and in the direction of the axis of the fuse-unit for a length of approximately 200 mm, then bent at right angles in a direction such as to produce maximum blow-out force on the fuse-carrier.

The fuse-carrier contacts and fuse-base contacts shall be inspected for significant damage to the contacts and for the level of engagement of the contacts.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-441:1984+A1:2000, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*

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