

BS 5467:2016

Incorporating Corrigendum No. 1



BSI Standards Publication

Electric cables – Thermosetting insulated, armoured cables of rated voltages of 600/1 000 V and 1 900/3 300 V for fixed installations – Specification

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 April 2016. It was prepared by Subcommittee GEL/20/17, *Low voltage cables*, under the authority of Technical Committee GEL/20, *Electric cables*. A list of organizations represented on these committees can be obtained on request to their secretary.

Supersession

This British Standard supersedes BS 5467:1997+A3:2008, which will be withdrawn on 30 April 2017.

Information about this document

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

- a) The range of cables types is restricted to cables with copper conductors.
- b) The marking requirements have been updated and clarified.
- c) Test methods have been updated in accordance with the latest BS EN standards.
- d) 48-core auxiliary cables have been removed as they are no longer market relevant.

The new edition takes account of:

- BS EN 50395 (replacing Annex K of BS 5467:1997) on electrical tests;
- BS EN 50396 (replacing Annex D of BS 5467:1997) on thickness measurement;
- BS EN 60332-1-2 (replacing BS EN 50265-2-1); and
- BS EN 62230 (replacing BS EN 50356 and BS 5099) on spark testing.

Product certification/inspection/testing

Users of this British Standard are advised to consider the desirability of third-party certification/inspection/testing of product conformity with this British Standard. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

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.

Text introduced or altered by Corrigendum No. 1 is indicated in the text by tags C1 C1. Minor editorial corrections are not tagged.

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

This British Standard specifies requirements for the construction and performance of thermosetting insulated, armoured cables of rated voltages of 600/1 000 V and 1 900/3 300 V.

This British Standard is applicable to cables for use in fixed installations in industrial areas, buildings or similar applications.

This British Standard specifies requirements for the following types of cables:

- a) 600/1 000 V cables, wire armoured and oversheathed, having single-core, two-, three-, four- and five-core stranded copper conductor;
- b) 600/1 000 V multicore auxiliary cables, wire armoured and oversheathed, stranded copper conductor; and
- c) 1 900/3 300 V cables, wire armoured and oversheathed, having single-core or three-core stranded copper conductor.

This British Standard is applicable to cables that are designed for a maximum sustained conductor temperature of 90 °C and for a maximum short-circuit conductor temperature of 250 °C (for a maximum of 5 s).

NOTE 1 Limitation on the temperature of the cables may be imposed in situations where they might be touched or where they could touch other materials.

NOTE 2 Annex A gives a guide to the use and installation of cables, Annex B gives armour wire tests, Annex C gives a compatibility test, Annex D gives an abrasion resistance test, Annex E gives an insulation resistance constant test on oversheath, Annex F gives the resistance of conductor and armour, Annex G gives the gross cross-sectional area of armour, Annex H gives a test for shrinkage of oversheath on cable, Annex I gives guidance on type tests and Annex J gives the standard United Kingdom reference codes.

2 Normative references

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

BS 7655-1.2, *Specification for insulating and sheathing materials for cables – Part 1: Cross-linked elastomeric insulating compounds – Section 1.2: General 90 °C application*

BS 7655-1.3, *Specification for insulating and sheathing materials for cables – Part 1: Elastomeric insulating compounds – Section 1.3: XLPE*

BS 7655-4.2, *Specification for insulating and sheathing materials for cables – Part 4: PVC sheathing compounds – Section 4.2: General application*

BS EN 10244-2:2009, *Steel wire and wire products – Non-ferrous metallic coatings on steel wire – Part 2: Zinc or zinc alloy coatings*

BS EN 50395, *Electrical test methods for low voltage energy cables*

BS EN 50396, *Non electrical test methods for low voltage energy cables*

BS EN 60228, *Conductors of insulated cables*

BS EN 60229, *Electric cables – Tests on extruded oversheaths with a special protective function*

BS EN 60332-1-2:2004+A1:2015, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

BS EN 60811-401, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven*

BS EN 60811-501, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds*

BS EN 60811-502, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 502: Mechanical tests – Shrinkage test for insulation*

BS EN 62230, *Electric cables – Spark-test method*

BS EN ISO 6892-1, *Metallic materials – Tensile testing – Method of test at ambient temperature*

IEC 60050-461, *International electrotechnical vocabulary – Part 461: Electric cables*

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in IEC 60050-461 and the following apply.

3.1 cable manufacturer

organization that has the capability to both produce and control the conformity of cable made to this British Standard

NOTE See 12.1a) for information on marking the cable with the cable manufacturer's name and identifier.

3.2 length of lay

axial length of one complete turn of the helix formed by one cable component

3.3 tests

3.3.1 routine tests, R

tests made on all production cable lengths to demonstrate their integrity

3.3.2 sample tests, S

tests made on samples of completed cable, or components taken from a completed cable, adequate to verify that the product meets the design specifications

3.3.3 type tests, T

tests made before supplying, on a general commercial basis, a type of cable covered by this British Standard, in order to demonstrate satisfactory performance characteristics to meet the intended application

NOTE Type tests are of such a nature that after they have been made, they need not be repeated unless changes are made in the cable materials, design or type of manufacturing process, which might change the performance characteristics.

3.4 values

3.4.1 approximate value

value which is only indicative

NOTE Values described as "approximate" do not constitute requirements to be checked by measurement.

3.4.2 nominal value

value by which a quantity is designated

NOTE Nominal values usually give rise to values to be checked by measurements taking into account specified tolerances.

3.5 voltages**3.5.1 maximum voltage, U_m**

maximum sustained power-frequency voltage between phase conductors for which the cable is suitable

3.5.2 rated voltage, U_0

nominal power-frequency voltage between conductor(s) and earth for which the cable is suitable

3.5.3 rated voltage, U

nominal power-frequency voltage between phase conductors for which the cable is suitable

4 Rated voltage

The cables shall be designated by the rated voltages, U_0 and U , expressed in the form U_0/U .

The rated voltages recognized for the purpose of this standard shall be 600/1 000 V and 1 900/3 300 V.

NOTE The maximum permitted operating voltages of the system are stated in Table 1.

Table 1 Maximum permitted voltages against rated voltage of cable

Rated voltage of cable	Maximum permitted operating voltage of the system			
	a.c.		d.c.	
	Conductor-earth, U_0 max	Conductor-conductor, U_m	Conductor-earth	Conductor-conductor
U_0/U				
V	V	V	V	V
600/1 000	700	1 200	900	1 800
1 900/3 300	2 100	3 600	2 700	5 400

NOTE Guidance on the selection of cables of appropriate voltage designations for particular systems is given in A.4.

In an alternating current system, the rated voltage of the cable shall be at least equal to the nominal voltage of the system for which it is intended.

5 Conductors

The conductors shall be annealed copper, circular or shaped, as given in Table 4 to Table 11 inclusive, and shall conform to the requirements of BS EN 60228, Class 2.

6 Insulation

6.1 Type of insulation

The insulation shall be type GP 8 conforming to BS 7655-1.3, or type GP 6 conforming to BS 7655-1.2. The manufacturer shall declare which insulation type the insulation meets.

6.2 Application

The insulation shall be applied by an extrusion process and cross-linked. The insulation shall be applied either in a single layer, or in a number of layers. Each individual layer shall be compact and homogeneous.

Where more than one layer is used, the complete insulation shall be tested as though it were a single layer.

NOTE 1 The manufacturer should demonstrate that all insulated cores are, as a continuous and ongoing part of the manufacturing process, subject to spark testing in accordance with BS EN 62230, using only a.c. or d.c. methods.

NOTE 2 Insulation applied in more than one layer does not conform to the definition of "double insulation" given, for instance, in BS 7671.

The manufacturer shall have the option to apply a tape or tapes under and/or over the insulation. These tapes shall not be considered as part of the insulation for the purposes of testing or measurement.

It shall be possible to remove the insulation without damage to the insulation itself or to the conductor. This shall be checked by visual examination.

6.3 Thickness of insulation

The mean value of the radial thickness of the insulation, when measured in accordance with BS EN 50396, 4.1, shall be not less than the relevant value given in Table 4 to Table 11. The smallest value measured, t_m , shall not fall below 90% of the relevant value given in Table 4 to Table 11 by more than 0.1 mm, i.e.:

$$t_m \geq 0.9t_n - 0.1$$

where:

t_m is the smallest value measured, in millimetres (mm);

t_n is the radial thickness given in Table 4 to Table 11, in millimetres (mm).

The thickness of any tape(s) over either the conductor or the insulation shall not be included in the measurement of the thickness of the insulation.

7 Identification of cores

7.1 General

The cores of all cables shall be identified either by:

- a) colour; or
- b) numbers.

7.2 Coloured cores

Unless otherwise agreed between the manufacturer and the purchaser, the colour coding shall be in accordance with the following standard sequence.

- a) Single-core: brown or blue.
- b) Two core: brown, blue.
- c) Three-core: brown, black, grey.
- d) Four-core: blue, brown, black, grey.
- e) Five-core: green-and-yellow, blue, brown, black, grey.

It shall be permitted to use other identification colours subject to agreement with the manufacturer, taking into account core colour requirements specified in BS 7671 or other standards. Where alternative identification colours are used, the marking requirement as stated in 12.4 shall not be applicable.

NOTE Attention is to drawn to BS 7671, Appendix 7, where other core colours that are still required outside the EU are given.

The colour shall be applied:

- 1) throughout the insulation; or
- 2) throughout the outermost layer of insulations that comprise more than one layer; or
- 3) via a dedicated colouring layer.

Conformity shall be checked by visual examination.

7.3 Numbered cores

Numbers shall be marked sequentially starting with the number 1.

All cores that are numbered shall be of the same insulation colour.

Numbers on each core shall be printed in a colour contrasting with that of the insulation and shall be legible. Each number shall be repeated at intervals not greater than 70 mm.

Conformity shall be checked by visual examination and measurement.

7.4 Bi-colour combination

On the core marked with the bi-colour combination green-and-yellow, the distribution of the colours shall be such that for any 15 mm length of core, one of these colours shall cover not less than 30% and not more than 70% of the surface of the core, while the other colour shall cover the remainder of the surface. Conformity shall be checked by measurement.

NOTE 1 In the case of shaped cores, one colour may be applied as one or more stripes, provided that both colours remain readily visible.

NOTE 2 In cases of dispute, and where appropriate to the method of colour marking of the insulation, a suitable test for checking conformity is given in BS EN 50396, 5.2, for circular cores, and in BS 8573:2012, Annex F, for shaped cores.

7.5 Clarity and durability

The colour or number used for core identification shall be clearly identifiable and durable such that it cannot be removed, when tested in accordance with BS EN 50396, 5.1.

8 Laying-up

The cores of cables having two, three, four or five cores shall be laid up with a uni-directional lay or right-hand-left-hand alternating direction of lay. Where standard colour coding of cores has been used, the cores shall be laid up in the sequence given in 7.2.

Auxiliary cables having up to and including seven cores shall be laid-up with a uni-directional lay or with a right-hand-left-hand alternating direction of lay.

For multicore auxiliary cables of greater than seven cores the direction of lay shall alternate for each successive layer.

Numbered cores shall be laid-up in number sequence.

Conformity shall be checked by visual examination.

The maximum length of lay for core with circular conductors shall not exceed 65 times the diameter of the laid-up cores, and the maximum length of lay for core with shaped conductors shall not exceed 80 times the diameter of the laid-up cores.

Conformity shall be checked by the method given in 17.2.

It shall be permitted for the manufacturer to apply synthetic fillers or binder tapes.

It shall be possible to remove the fillers and/or tape(s), if any, from the cable without damaging the insulation of the cores.

Conformity shall be checked by visual examination.

9 Bedding

9.1 General

The bedding shall consist of an extruded layer of polymeric material consistent with the operating temperature of the cable. When tested in accordance with BS EN 60811-501, it shall have a tensile strength of not less than 4 N/mm² and elongation at break of not less than 50%.

It shall be possible to remove the bedding without damaging the insulation of the core(s). This shall be checked by visual examination.

9.2 Thickness of bedding

When measured in accordance with BS EN 50396, 4.2, the smallest value, t_m , of the radial thickness of bedding shall not fall below 80% of the relevant nominal value given in Table 4 to Table 11, as applicable, by more than 0.2 mm, i.e.:

$$t_m \geq 0.8 t_n - 0.2$$

where:

t_m is the smallest value measured, in millimetres (mm);

t_n is the nominal thickness, given in Table 4 to Table 11, in millimetres (mm).

10 Armour

10.1 General

The armour shall consist of a single layer of wires having nominal dimensions as given in Table 4 to Table 11, as appropriate. The armour shall be applied helically with a left-hand lay for cables having up to and including five cores. For multicore auxiliary cables the armour shall be applied helically with a direction of lay opposite to that of the final layer of cores, except when the cores of the cable have been laid-up with alternating right-hand-left-hand lay in which case the armour shall be applied with either a right-hand or a left-hand lay.

The manufacturer shall have the option to apply a tape or tapes under and/or over the armour.

The maximum length of lay for the armour wires of nominal wire diameter up to and including 1.6 mm shall not exceed 20 times the diameter over the armour.

The maximum length of lay for the armour wires of nominal wire diameter 2.0 mm and greater shall not exceed 15 times the diameter over the armour.

Conformity shall be checked by the test method given in 17.3.

10.2 Armour wire

Armour wire for cables having two or more cores shall consist of a single layer of galvanized steel wires. Armour wire for single-core cables shall consist of a single layer of aluminium wires.

The armour wire shall conform to the following.

- a) When determined in accordance with B.1, the diameter of the round armour wires, whether of galvanized steel or plain aluminium, shall fall within the minimum and the maximum wire diameters given in Table 2.
- b) When determined in accordance with B.2, the mass of zinc coating of galvanized steel armour wire shall be not less than the relevant value given in Table 2.
- c) When tested in accordance with B.3, the mechanical characteristics of galvanized armour wires shall be such that none of the wires shall break.
- d) When tested in accordance with B.4, the tensile strength of aluminium armour wires shall be not less than 125 N/mm².

Table 2 Diameter of steel armour wire and mass of zinc coating

Nominal wire diameter mm	Wire diameter		Minimum mass of zinc coating g/m ²
	Minimum mm	Maximum mm	
0.9	0.85	0.95	112
1.25	1.18	1.32	150
1.6	1.51	1.69	172
2.0	1.90	2.10	180
2.5	2.37	2.63	195
3.15	2.99	3.31	206

10.3 Joints

Joints in steel wire armour shall be brazed or welded and any surface irregularity shall be removed carefully.

Joints in aluminium wire shall be made by cold pressure or fusion welding and all surface irregularities shall be removed.

A joint in any armour wire shall be not less than 1 m from the nearest joint in any other armour wire in the complete cable.

10.4 Armour resistance

When measured and corrected to 20 °C in accordance with B.5, the d.c. resistance of the armour of the completed cable shall not exceed the relevant value given in Table F.1, Table F.2 or Table F.3, as applicable.

NOTE For the purposes of calculating maximum fault current, it is also necessary to know the gross cross-sectional area of armour wires. This information is given in Annex G.

11 Oversheath

11.1 General

The oversheath shall be an extruded layer of PVC material conforming to the requirements of Type 9 specified in BS 7655-4.2.

NOTE Oversheaths are normally black and, when properly formulated and compounded, this provides good resistance to deterioration from outdoor exposure to light. Oversheaths with colours other than black can be provided by agreement between the manufacturer and the purchaser but, unless such oversheaths also include additives to protect the cable from UV, the cables are not suitable for all exposure conditions.

11.2 Application

The oversheath shall be applied in a single layer over the armour.

Conformity shall be checked by visual examination.

11.3 Thickness of oversheath

When measured in accordance with BS EN 50396, 4.2, the smallest value, t_m , of the radial thickness of oversheath shall not fall below 80% of the relevant nominal value given in Table 4 to Table 11 by more than 0.2 mm, i.e.:

$$t_m \geq 0.80 t_n - 0.2$$

where:

t_m is the smallest value measured, in millimetres (mm);

t_n is the nominal thickness, given in Table 4 to Table 11, in millimetres (mm).

11.4 Spark testing of oversheath

When tested in accordance with the a.c. or d.c. test methods and the test voltages specified in BS EN 62230, there shall be no breakdown of the oversheath.

12 Cable marking and additional information

12.1 External marking

The external surface of all cables conforming to this British Standard shall be legibly marked with the following elements.

Element	Example of marking
a) Cable manufacturer	Manufacturer's name and their unique factory identifier

NOTE 1 A simplified version of the manufacturer's name, or a trading name of the manufacturer, may be used in place of the full name.

NOTE 2 Any suitable method may be used to unambiguously identify the manufacturer's factory.

NOTE 3 The manufacturer's own trademark or equivalent may be added but this cannot be used instead of the manufacturer's name or identifier.

b) Electric cable	ELECTRIC CABLE
c) Voltage designation	600/1 000 V 600/1 000 V AUX 1 900/3 300 V

NOTE 4 See 12.2.

d) British Standard number	BS 5467 ¹⁾
e) Number of cores and nominal area of conductor	4 × 70

NOTE 5 See 12.3.

f) Year of manufacture	ZZZZ
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NOTE 6 The year of manufacture may take the form of the actual year (e.g. 2016) or a coded year identifier assigned by the manufacturer.

g) Standard core colour identifier	H
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NOTE 7 See 12.4.

The marking of items a) to g) shall be by embossing or indenting on the oversheath.

For cables with overall diameters greater than 15 mm, items a) to d) inclusive shall appear, in any sequence that is deemed neither to confuse nor conflict, on two or more primary lines along the axis of the cables, approximately equally spaced around the circumference of the cable. Items e), f) and g) shall appear on either one of the primary lines, or on a secondary line or lines, in any sequence that is deemed neither to confuse nor conflict.

¹⁾ Marking BS 5467 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.