

**Electric cables —
Thermosetting
insulated,
non-armoured cables
for voltages up to and
including 450/750 V, for
electric power, lighting
and internal wiring,
and having low
emission of smoke and
corrosive gases when
affected by fire**

ICS 29.060.20

Confirmed January 2012

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee GEL/20, Electric cables, to Subcommittee GEL/20/1, Wiring cables, upon which the following bodies were represented:

- Association of Consulting Engineers
- Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)
- British Approvals Service for Cables
- British Cables Association
- British Plastics' Federation
- British Retail Consortium
- Chartered Institution of Building Services Engineers
- Department of Trade and Industry (Consumer Safety Unit, CA Division)
- Electricity Association
- ERA Technology Ltd.
- Electrical Installation Equipment Manufacturers Association (BEAMA Ltd.)
- Engineering Industries' Association
- Institution of Incorporated Executive Engineers
- Lift and Escalator Industries' Association
- London Underground Ltd.
- Portable Electric Tool Manufacturers' Association
- Transmission and Distribution Association (BEAMA Ltd.)

This British Standard, having been prepared under the direction of the Electrotechnical Sector Board, was published under the authority of the Standards Board and comes into effect on 15 October 1998

© BSI 26 April 2005

First published September 1989
Second edition March 1994
Third edition October 1998

The following BSI references relate to the work on this standard:
Committee reference GEL/20/1
Draft for comment 96/215022 DC

Amendments issued since publication

Amd. No.	Date	Comments
14201	6 February 2004	Title of standard revised and see foreword
15653	26 April 2005	See foreword

ISBN 0 580 29591 5

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
1 Scope	1
2 Normative references	1
3 Definitions	2
4 Voltage designation	3
5 Conductor	3
6 Insulation	3
7 Core identification	4
8 Fillers, tapes and extruded inner covering	5
9 Sheath	5
10 Marking	6
11 Construction and overall dimensions	7
12 Schedule of tests	8
13 Electrical requirements	9
14 Flame propagation	9
15 Smoke emission	10
Annex A (informative) Guide to the use of thermosetting insulated cables specified in this British Standard	20
Annex B (normative) Electrical tests	20
Annex C (normative) Procedure for checking the efficacy of the method of spark testing	23
Annex D (normative) Compatibility test	24
Bibliography	25
Figure C.1 — Spark test check: removal of insulation (see C.2.2)	24
Figure C.2 — Spark test check: covering with tape	24
Table 1 — Schedule of tests	8
Table 2 — Selection and arrangement of cables for the smoke emission test (cables specified in Table 7 only)	10
Table 3 — Thermosetting insulated, non-sheathed, single-core cables, 450/750 V	11
Table 4 — Thermosetting insulated, non-sheathed, single-core cables, 300/500 V	13
Table 5 — Thermosetting insulated, single-core, sheathed cables, 450/750 V	14
Table 6 — Thermosetting insulated, twin, 3-core, 4-core and 5-core circular sheathed cables, 450/750 V	15
Table 7 — Thermosetting insulated, single-core, flat twin and flat 3-core sheathed cables with circuit protective conductor, 300/500 V	17
Table 8 — List of tests applicable to the various types of cable	18
Table B.1 — Summary of electrical tests	21
Table B.2 — Spark test voltages	22

Foreword

This revised edition of BS 7211 has been prepared by Subcommittee GEL/20/1 in response to an increasing demand for cable that has reduced emission of smoke and corrosive gases when affected by fire. It supersedes BS 7211:1994, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** **A1**. Tags indicating changes to text carry the number of the amendment. For example text altered by amendment No. 1 is indicated by **A1** **A1**.

This new edition aligns with CENELEC¹⁾ HD 22.9 S2 in respect of insulated non-sheathed single-core cables. In addition, it includes requirements for insulated and sheathed cables for which there is currently no published European or International Standard. These additional cables are for operation at voltages up to and including 450/750 V.

The construction of cables specified in this British Standard closely follows that of similar cables specified in BS 6004, although the materials used may result in different installation characteristics.

The improved performance under fire conditions is assessed on the basis of tests that measure the emission of smoke and corrosive gases under defined conditions.

Amendment No.1:2004 implements the changes to the identification of cores by colours, in accordance with HD 308 S2. The principal identification colours are now:

Single phase — Green-and-yellow (Earth); blue (Neutral); brown (Live).

Three phase — Green-and-yellow (Earth); blue (Neutral); brown, black, grey (Live).

Users should ensure that any interconnection between cables with these new colours and those with the pre-existing ones is carried out safely. BS 7671, as amended in parallel with this standard, gives some guidance in this respect, but does not cover all installation conditions or cable uses.

The provisions introduced by amendment No. 1:2004 are effective from 1st April 2004. The original version of this standard remains current until 31st March 2006.

A2 *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. **A2**

Enquiries as to the availability of third-party certification schemes will be forwarded by BSI to the Association of British Certification Bodies. If a third-party certification scheme does not already exist, users should consider approaching an appropriate body from the list of Association members.

Annex A is informative. Annex B, Annex C and Annex D are normative.

WARNING. This standard calls for the use of substances and/or procedures that may 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.

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 does not of itself 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 24, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

¹⁾ European Committee for Electrotechnical Standardization.

1 Scope

This British Standard specifies requirements for non-armoured cables with thermosetting insulation of rated voltage up to and including 450/750 V which, when assessed by tests specified in the standard, produce lower levels of smoke and corrosive gases under exposure to fire compared with corresponding PVC cables made in accordance with BS 6004.

The types of cable specified in the standard, together with their respective voltage ratings, are as follows:

Thermosetting insulated, non-sheathed, single-core cable	450/750 V
Thermosetting insulated, non-sheathed, single-core cable	300/500 V
Thermosetting insulated, single-core sheathed cable	450/750 V
Thermosetting insulated, twin, 3-core, 4-core and 5-core circular sheathed cables	450/750 V
Thermosetting insulated, single-core, flat twin and flat 3-core sheathed cable with circuit protective conductor	300/500 V

In this standard, corrosive (and acid) gases are defined as those which are determined either by measurement of pH and conductivity or as HCl, as appropriate.

NOTE 1 These are indirect assessment methods, and reference should be made to IEC 60695-5-2, 5.1.5 for additional guidance.

The standard specifies construction and test requirements, and includes tests relating to performance under fire conditions.

NOTE 2 These tests are published in separate British Standards to which reference is made at the appropriate point in the text. The Scope clauses of these British Standards contain cautionary notes concerning the applicability of such tests, and these should be taken into account when assessing the suitability of cables specified in this specification for use in a particular application.

The insulation and other components are suitable to permit operation of the cables at a maximum sustained conductor temperature of 90 °C.

NOTE 3 Limitation on the temperature of the cables may be imposed in situations where they may be touched, or where they may touch other materials.

NOTE 4 In installations that include wiring accessories, junction boxes and consumer units etc., the performance of these accessories should be taken into account in deciding the maximum operating temperature of the cable.

A guide to the use of these cables for fixed installations is given in Annex A, Annex B, Annex C and Annex D give test methods.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

[A1] Text deleted **[A1]**

BS 4727-2-08, *Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms — Part 2: Terms particular to power engineering — Group 08: Electric cable terminology.*

BS 5099, *Specification for spark testing of electric cables.*

BS 6360, *Specification for conductors in insulated cables and cords.*

[A1] Text deleted **[A1]**

BS 6469-99.1:1992, *Insulating and sheathing materials of electric cables — Part 99: Test methods used in the United Kingdom but not specified in Parts 1 to 5 — Section 1: Non-electrical tests.*

[A1] Text deleted **[A1]**

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

BS 7655-5.1, *Specification for insulating and sheathing materials for cables — Part 1: Cross-linked insulating compounds having low emission of corrosive gases, and suitable for use in cables having low emission of smoke when affected by fire — Section 5.1: Harmonized cross-linked types.*

BS 7655-6.1, *Specification for insulating and sheathing materials for cables — Part 1: Thermoplastic sheathing compounds having low emission of corrosive gases, and suitable for use in cables having low emission of smoke when affected by fire — Section 6.1: General application thermoplastic types.*

PD 2379, *Register of colours of manufacturers' identification threads for electric cables and cords.*

BS EN 50265-2-1, *Common test methods for cables under fire conditions — Test for resistance to vertical flame propagation for a single insulated conductor or cable — Part 2-1: Procedures — 1 kW pre-mixed flame.*

BS EN 50265-2-2, *Common test methods for cables under fire conditions — Test for resistance to vertical flame propagation for a single insulated conductor or cable — Part 2-2: Procedures — Diffusion flame.*

BS EN 50266-2-4, *Common test methods for cables under fire conditions — Test for vertical flame spread of vertically-mounted bunched wires or cables — Part 2-4: Procedures — Category C.*

BS EN 50267-2-1, *Common test methods for cables under fire conditions — Tests on gases evolved during combustion of material from cables — Part 2-1: Procedures — Determination of the amount of halogen acid gas.*

BS EN 50267-2-2, *Common test methods for cables under fire conditions — Tests on gases evolved during combustion of material from cables — Part 2-2: Procedures — Determination of degree of acidity of gases for materials by measuring pH and conductivity.*

BS EN 50268-2, *Common test methods for cables under fire conditions — Measurement of smoke density of cables burning under defined conditions — Part 2: Procedure.* 

BS EN 60811-1-1:1995, *Insulating and sheathing materials for electric cables — General application — Measurement of thickness and overall dimensions — Tests for determining the mechanical properties.*

BS EN 60811-1-2:1995, *Insulating and sheathing materials for electric cables — General application — Thermal ageing methods.*

BS EN 60811-1-3:1995, *Insulating and sheathing materials for electric cables — General application — Methods for determining the density — Water absorption tests — Shrinkage test.*

3 Definitions

For the purpose of this British Standard, the definitions given in BS 4727-2:Group 08 apply together with the following.

3.1

rated voltage U_0

power-frequency voltage to earth for which the cable is designed

3.2

rated voltage U

power-frequency voltage between conductors for which the cable is designed

3.3

type test

test required to be made before supplying, on a general commercial basis, a type of cable covered by this 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

sample test

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

3.5

routine test

test made on all production cable lengths to demonstrate their integrity

4 Voltage designation

The rated voltage of a cable is the reference voltage for which the cable is designed, and which serves to define the electrical tests, and shall be expressed, in volts, by the following expression:

$$U_0/U$$

where

- U_0 is the r.m.s. value between any insulated phase conductor and earth, or the surrounding medium;
- U is the r.m.s. value between any two phase-conductors of a multi-core cable or of a system of single-core cables.

In an alternating current system, the rated voltage of a cable shall be at least equal to the nominal voltage of the system for which it is intended, and this applies both to the value U_0 and to the value U .

In a direct current system, the nominal voltage of the system shall be not higher than 1.5 times the rated system voltage (U) of the cable.

NOTE 1 The operating voltage of a system may permanently exceed the nominal voltage of such a system by 10 %. A cable can be used at 10 % higher operating voltage than its rated voltage if the latter is at least equal to the nominal voltage of the system.

The rated voltages recognized for the purposes of this standard are 300/500 V and 450/750 V.

NOTE 2 Cables specified in Table 3 may be suitable for a rated voltage system (U) up to 1 000 V a.c. or 1.5 times higher for d.c. usage (see A.4).

5 Conductor

5.1 The conductor shall be annealed copper conductor conforming to BS 6360. It shall be permissible for the wires to be tinned.

5.2 The class of the conductor shall be as specified in Table 3 to Table 7 inclusive. Except for constructions specified in Table 3b) and Table 4b), conductors shall be circular solid, circular stranded or compacted circular stranded.

6 Insulation

6.1 Types of insulation

For cables specified in Table 3 and Table 4, the insulation shall be type EI 5 conforming to BS 7655-5.1.

For cables specified in Table 5, Table 6 and Table 7, the insulation shall be either type GP 8, in accordance with BS 7655-1.3 but further subject to a low temperature bending test as required for EI 5, or type EI 5 in accordance with BS 7655-5.1.

Where GP 8 insulation is used, the shrinkage of the insulation on a 200 mm sample of core tested at $130\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ for 1 h in accordance with BS EN 60811-1-3, shall not exceed 4 %.

When the insulation is applied in two layers, (see 6.2), all tests shall be applied to the complete insulation, which shall be subject to the specified requirements for that insulation type.

When subjected to the compatibility test in accordance with Annex D, the insulation of cables specified in Table 5, Table 6 and Table 7 shall conform to the following requirements.

Median values after ageing:

	EI 5	GP8
a) Tensile strength		
Minimum value (N/mm ²)	10	12.5
Maximum variation (%)	30	25
b) Elongation at break		
Minimum value (%)	125	200
Maximum variation (%)	30	25

NOTE Variation is the difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.

Conformity shall be checked by performing the appropriate tests listed in Table 1. All tests shall be applied to the complete insulation.

6.2 Application

The insulation shall be applied by extrusion closely around the conductor. It shall be possible to remove the insulation without damage to the insulation itself, the conductor or the tin coating, if any.

Conformity shall be checked by visual examination and by a manual test.

NOTE The insulation may consist of one or two layers.

The core insulation shall conform to the requirements for spark testing specified in BS 5099.

6.3 Thickness

The mean value of the thickness of the insulation shall be not less than the value given in Table 3 to Table 7 for each type and cross-section of cable.

Conformity shall be checked by the method specified in BS EN 60811-1-1, 8.1. For each core to be tested, one sample of the core shall be taken from each of three places separated by at least 1 m.

The mean of all the values obtained on the three pieces of insulation shall be calculated to two decimal places and then rounded off to obtain the mean value of insulation thickness. If the calculation gives 5 or more for the second decimal figure, the first figure shall be raised to the next number; thus, for example, 1.75 shall be rounded to 1.8 and 1.74 to 1.7.

The smallest of all the values obtained, which shall not fall below the value specified in Table 5, Table 6 and Table 7, as appropriate, by more than 0.1 mm + 10 %, shall be taken as the minimum thickness of insulation at any place.

6.4 Corrosive and acid gas emission of insulation

When insulation from those cables specified in Table 3 and Table 4 is tested in accordance with **BS EN 50267-2-2**, the resulting value of pH shall be not less than 4.3. The conductivity shall not exceed 10 µS/mm.

When insulation from those cables specified in Table 5, Table 6 and Table 7 is tested in accordance with **BS EN 50267-2-1**, the level of HCl shall be not greater than 0.5 %.

7 Core identification

7.1 General

Each core shall be identified by its colour. The colour shall be either throughout the whole of the insulation or on the surface of the insulation.

7.2 Colours

The colours of the cores and the sequence of these colours shall be as given in Table 3 to Table 7 as appropriate.

7.3 Harmonized code designations

Harmonized code designations apply to the single core non-sheathed cables specified in Table 3 and Table 4. Such cables shall be permitted to bear the “Common Marking” (see 10.4), provided that the colours conform to the following provisions.

- The colours available shall include the combination green/yellow and the mono-colour blue;
- For cables specified in Table 3, combinations of colours other than green/yellow and also the colours green or yellow separately shall not be considered harmonized.
- For cables specified in Table 4, the mono-colours green and yellow shall be permitted as well as bi-colour combination of recognized colours in addition to green/yellow.

Cables specified in Table 3, for which harmonized code designations are given but which have core colours not in accordance with the above requirements, are not harmonized types and shall not bear the Common Marking.

NOTE 1 In addition to the combination green/yellow, and the mono-colour blue, the following other mono-colours are recognized as harmonized: black, brown, grey, orange, pink, red, turquoise, violet and white.

NOTE 2 According to the use to which the cables are put, it may be necessary for the colour of the cables to conform to core colour requirements specified in BS 7671 and any other applicable British Standard. Attention is drawn to any appropriate regulations or statutory requirements.

7.4 Bi-colour combination

On the core marked with the bi-colour combination green/yellow, the distribution of these colours shall be such that for every 15 mm length of core, one of these colours shall cover at least 30 % and not more than 70 % of the surface of the core, while the other colour covers the remainder of the surface.

A1 NOTE 1 In cases of dispute regarding the green/yellow combination and where appropriate to the method of colour marking of the insulation, a suitable test method for checking conformity is given in BS 6469-99.1:1992, Clause 8. **A1**

NOTE 2 The colours green and yellow when they are combined as specified above are recognized exclusively as a means of identification of the core intended for use as earth connection or similar protection.

7.5 Clarity and durability

The colours shall be clearly identifiable and durable.

Conformity shall be checked by trying to remove the colours of the cores by rubbing the core 10 times with a piece of cotton wool or cloth soaked in water.

8 Fillers, tapes and extruded inner covering

8.1 General

The twisted cores specified in Table 6 shall be covered by either:

- a) an extruded inner covering of synthetic material;
- b) a separating tape of suitable material, which may be combined with separate synthetic fillers.

The extruded inner covering shall surround the twisted cores and penetrate the space between them, giving the assembly a practically circular shape. The extruded inner covering shall not adhere to the cores.

The approximate value of thickness of the extruded inner covering shall be as given in Table 6.

8.2 Compatibility

There shall be no harmful interaction between the inner covering and the insulation.

Conformity to the requirements specified in 6.1 shall be checked by using the compatibility test given in Annex D.

8.3 Corrosive and acid gas emission

When the filler, tape or inner covering taken from the cable is tested in accordance with

A1 BS EN 50267-2-1 **A1**, the level of HCl shall be not greater than 0.5 %.

9 Sheath

9.1 Types of sheath

The sheath shall be an extruded layer of synthetic material type LTS 2 or LTS 4 conforming to BS 7655-6.1 as specified in Table 5, Table 6 and Table 7 as appropriate.

Conformity shall be checked by performing the appropriate tests specified in Table 1 and Table 8.

There shall be no harmful interaction between the sheath and insulation. Conformity to the requirements specified in 6.1 shall be checked by using the compatibility test given in Annex D.