BRITISH STANDARD

BS 4808-1:
1972

Specification for

L.F. cables and wires with PVC insulation and PVC sheath for telecommunication —

Part 1: General requirements and tests

UDC 621.315.2/3:678.743.22:621.39

Co-operating organizations

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

British Broadcasting Corporation
British Electrical and Allied Manufacturers' Association
British Radio Equipment Manufacturers' Association
British Radio Valve Manufacturers' Association
British Railways Board*
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The scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committees entrusted with the preparation of this British Standard:

British Non-Ferrous Metals Federation
Copper Development Association
Department of the Environment
Electric Cable Makers' Confederation
High Conductivity Copper Group
Home Telephone Cable Makers' Association

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The following BSI references relate to the work on this standard:
Committee references TLE/6 and TLE/6/7
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Contents

Foreword

This standard makes reference to the following British Standards:

BS 18, *Methods for tensile testing of material.*

BS 205, *Glossary of terms used in electrical engineering.*

BS 2011, *Methods for the environmental testing of electronic components and electronic equipment.*

BS 2782, *Methods of testing plastics.*

BS 6004, *PVC-insulated cables (non-armoured) for electric power and lighting.*

BS 6360, *Copper conductors in insulated cables and cords.*

BS 6746, *PVC insulation and sheath of electric cables.*

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

This British Standard, which has been prepared under the authority of the Telecommunication Industry Standards Committee, covers L.F. cables and wires for telecommunication. It is important to note that this British Standard takes into account IEC Publication 189, "Low frequency cables and wires with p.v.c. insulation and p.v.c. sheath", and the requirements of the Ministry of Defence and the Post Office, for the classes concerned.

The standard is divided into a number of parts. Part 1 specifies general requirements and test methods. The subsequent parts cover the detailed requirements.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 5 and a back cover.

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

1 Scope

This British Standard gives the requirements for a range of low frequency cables and equipment wires for use inside telephone and telegraph exchanges and for the internal wiring of electronic and other equipment.

The range includes:

1) single equipment wires, with solid or stranded conductors, which may be screened;

2) multiple equipment wires made by twisting together 2, 3, 4 or 5 single equipment wires, which may be screened;

3) cables made by sheathing one or more equipment wires.

The individual cables and wires covered by this specification are insulated and where applicable sheathed with polyvinylchloride (PVC).

Owing to the many applications, varied conditions of use and different expectations of life, it is not possible to give precise figures for working voltage and operating temperature limits.

Some guidance can however be gained from the test temperatures and voltages specified.

NOTE The titles of the British Standards referred to in this standard are listed on page ii.

2 Cable and wire construction and dimensions

2.1 Conductor

2.1.1 All conductor wires shall be circular in cross section and shall consist of standard annealed copper, smoothly drawn, uniform in quality, free from defects and uniformly coated with pure tin.

The mechanical requirements of BS 6360 shall be satisfied and all conductors shall meet the test for soldering given in BS 2011, Test 2T, Method 1.

2.1.2 The conductor shall conform to the requirements of the relevant part of this specification.

A stranded conductor shall consist of a number of wires assembled by concentric lay or bunching and without insulation between them.

2.1.3 Joints in solid conductors or individual wires of a stranded conductor may be brazed or hard soldered. Complete stranded conductors shall not be jointed.

Joints in a solid conductor shall comply with the requirements of **3.1.1**.

2.1.4 A solid conductor is designated by its nominal diameter. A stranded conductor is designated by its nominal cross-sectional area and its make-up is indicated by the nominal number and nominal diameter of wires.

2.2 Insulation

2.2.1 ***Material and application.*** The insulation shall consist of PVC compound complying with the requirements of BS 6746 and of type, thickness, overall diameter and colour as specified in the relevant part of this specification. It shall also meet the requirements of **3.2.1** and **3.2.2**.

The thickness and overall diameter shall be determined in accordance with the method described in **3.1.2**.

The insulation shall be applied by an extrusion process and shall fit closely on but not adhere to the conductor. It shall be possible to strip the insulation from the conductor without damage to either, leaving the conductor in such a condition that immediate satisfactory connections to terminations may be made.

2.2.2 ***Colours of insulation.*** The colours of the insulated conductor shall be unaffected by compliance with the test requirements of BS 6746 or BS 2011, Test 2T, Method 1.

2.2.2.1 *Single colour wire.* The colour shall be incorporated in the insulation compound.

2.2.2.2 *Two- and three-colour wire.* Two- and three-colour wires shall have uniform colours in the form of either continuous spiral markings or ring markings which, when viewed from any side, shall be readily identifiable in every 15 mm of length.

Spiral markings shall be effected by the application of one or more ink stripes on a base colour or by direct extrusion.

Ring markings shall consist of ink lines applied on a base colour and encircling the insulated wire.

2.2.3 ***Surface resistivity***. Surface resistivity of black ink used for markings shall be in accordance with the requirements of **3.3.5**.

2.3 Equipment wires and cabling elements. Equipment wires and cabling elements shall be one of the following:

1) a single insulated conductor;

2) two insulated conductors uniformly twisted together to form a pair;

3) three insulated conductors uniformly twisted together to form a triple;

4) four insulated conductors uniformly twisted together to form a quad;

5) five insulated conductors uniformly twisted together to form a quintuple.

The maximum length of lay in the completed wire or cable shall be:

100 mm for pairs and triples

120 mm for quads and quintuples.

2.4 Lay-up of cabling elements

2.4.1 The cabling elements shall be laid up to form a compact and circular cable.

2.4.1.1 The colours of the wires in the various sizes of cable shall be as specified in the relevant part of this specification.

2.4.1.2 The sequence of stranding shall be as specified in the relevant part of this specification, the first element being in the centre.

2.5 Fillers and binders

2.5.1 Fillers made of non-hygroscopic material may be provided at the discretion of the manufacturer unless otherwise specified in the relevant part of this specification.

2.5.2 Binders shall be provided as specified in the relevant part of this specification and shall be applied by one of the following methods:

1) a single lapping tape having an overlap of not less than 20 %,

2) two tapes breaking joint[1)],

3) one tape applied longitudinally with an overlap of not less than 10 mm or 30 % of the tape width, whichever is the smaller,

4) a single whipping of non-hygroscopic material.

2.6 Screens

2.6.1 Screens shall be of braided, lapped or taped construction as specified in the relevant part of this specification and shall conform to the following requirements.

The braided screens and lapped screens shall be formed of tinned annealed copper as required. The nominal diameter of the individual screen wires shall be as specified in the relevant part of this specification.

2.6.1.1 *Braided screens.* The braided screen shall be close fitting but wherever the cable or wire is cut, it shall be possible to slide back the screen by hand a distance of 100 mm on a 600 mm length of cable or wire, the other end of which shall be clamped during the test.

Where a break in a screen wire occurs, or renewal of a bobbin is necessary, the loose ends of screen wire shall be soldered or tucked out of the braid. There shall be not more than one such break or renewal in any 25 mm length of braid.

The complete screen shall not be jointed.

Braid construction shall be as follows:

ends per spindle (minimum)	3
filling factor (minimum):	
for individual screens	0.5
for collective screens	0.7
limiting factor (maximum), when specified	0.09

where the following definitions apply:

$$\text{filling factor } (Kf) \text{ is defined as: } \frac{mnd}{2\pi D} \times \left[1 + \frac{\pi^2 D^2}{L^2}\right]^{\frac{1}{2}}$$

$$\text{limiting factor} = Kf - \frac{mnd}{2\pi D}$$

D = mean diameter of braid in millimetres

d = nominal diameter of braid wire in millimetres

L = lay of braid wire in millimetres

m = total number of spindles

n = total number of ends per spindle.

2.6.1.2 *Lapped screens.* The lapped screen shall consist of a close lapping of at least sixteen wires laid side by side. The filling factor defined as:

$$\frac{Nd}{\pi D} \times \left[1 + \frac{\pi^2 D^2}{L^2}\right]^{\frac{1}{2}}$$

shall be not less than 0.9 where N = the total number of wires.

2.6.1.3 *Taped screens.* The taped screen shall be formed of aluminium or copper tape or an approved laminate tape as required. The tape shall be as specified in the relevant part of this specification.

The thickness of tape shall be at least 0.04 mm unless specified otherwise in the relevant part of this specification.

A continuity conductor consisting of tinned annealed copper of suitable diameter shall be provided unless specifically excluded in the relevant part of this specification. This conductor shall be laid longitudinally and in contact with the screening tape.

[1)] This means two layers of tape having the same direction of lay, applied helically so that the outer tape is approximately central over the gap of the inner tape.

2.7 Manufacturer's identification. A means of identifying the manufacturer shall be provided when required by the relevant part of this specification. This may be done by coloured threads or name tapes.

If coloured identification threads are used the colours shall comply with the register[2)] maintained by BSI.

2.8 Rip cords. A rip cord shall be laid under the sheath when specified in the relevant part of this specification. The rip cord shall be non-metallic and may incorporate the manufacturer's identification colours.

2.9 Sheath

2.9.1 ***Material and application.*** The sheath shall consist of PVC compound complying with the requirements of BS 6746, the type, thickness and overall diameter to be as specified in the relevant part of this specification; it shall also meet the requirements of **3.2.2**.

The thickness and overall diameter shall be determined as described in **3.1.3**

The sheath shall be perfectly continuous, annular and of a thickness as uniform as possible, it shall be applied to fit closely over the cable or screened wire without adhesion.

2.9.2 The colour of the sheath shall be grey or cream as specified by the purchaser.

3 Tests

Tests shall be made to prove compliance with all requirements of this standard.

It is not intended or recommended that complete tests shall be made on every length of wire or cable unless otherwise stated in the relevant part of this specification.

Tests on samples shall be carried out when specified by the purchaser at the time of ordering. The sampling procedure shall be agreed between the purchaser and the manufacturer.

Since the thermal endurance test (**3.2.3**) requires 42 days for completion it is not reasonable to expect that it be performed on all production. Its requirements shall be regarded as satisfied by the manufacturer certifying that the equipment wire has been made of materials and by processes that will meet the requirements of the test.

3.1 Mechanical tests. In addition to the requirements for the conductor in **2.1.1** the following conditions shall be met.

3.1.1 ***Tensile strength of jointed solid conductor.*** The tensile strength of a 250 mm length of conductor containing a joint tested in accordance with the requirements of BS 18 shall be not less than 90 % of that of an adjacent length of the conductor not containing a joint.

3.1.2 ***Measurement of insulation thickness.*** The thickness of insulation shall be determined by the following method.

The overall diameter of an insulated conductor shall be determined from a test piece of the wire about 300 mm long taken not less than 300 mm from the end of a factory length of completed wire or cable.

The diameter over insulation shall be measured at three points (80 mm or more apart) along the length of the test piece. Three measurements shall be taken at each point at approximately 60° angular displacement.

The measured conductor diameter shall be subtracted from the average of the nine measurements and the difference divided by two. The quotient shall be taken as the radial thickness of insulation and shall be not less than the nominal radial thickness specified in the relevant part of this specification.

If a visual examination reveals excessive eccentricity of the conductor, three cross sections taken not less than 80 mm apart along the test piece shall be measured by an optical method in which the error of determination does not exceed 0.01 mm. Sufficient measurements shall be made on each cross section to ensure that the minimum thickness is included.

The smallest of the measured thicknesses shall be taken for checking compliance with the minimum radial thickness requirements of the relevant part of this specification.

3.1.3 ***Measurement of sheath thickness.*** The minimum thickness of the sheath shall be as specified in the relevant part of this specification and determined as follows.

A representative sample of the cable, about 300 mm long, shall be taken not less than 300 mm from the end of a factory length.

[2)] PD 2379, "*Register of colours of manufacturers' identification threads for electric cables and cords*".

The thickness of the sheath shall be measured at three cross sections (80 mm or more apart) by a method in which the error of determination does not exceed 0.025 mm (e.g. a micrometer or an optical device). Sufficient measurements shall be made on each cross section to ensure that the minimum thickness is included. In determining minimum sheath thickness, any indentation caused by a rip cord or identification thread shall be ignored.

The average and the smallest of the measured thicknesses shall be taken for checking compliance with the relevant detail specification.

3.2 Thermal requirements. In addition to the requirements for insulation and sheath laid down in **2.2** and **2.9** the following conditions shall be met.

3.2.1 ***Shrinkage of insulation.*** The insulation shall not shrink appreciably when soldering the conductor. Compliance shall be checked in accordance with the method specified below.

A test piece of insulated conductor, approximately 150 mm in length, shall be stripped of coverings (if any) and made as straight as possible.

Approximately 25 mm of insulation shall be removed from each end of the test piece, leaving 100 ± 0.5 mm of undisturbed insulation.

The test piece shall then be placed in an oven, the atmosphere of which has the composition and pressure of ambient air and is maintained at a temperature of 150 ± 2 °C, for not less than 15 min. After this period the test piece shall be removed from the oven and cooled to ambient temperature within one hour.

The length of the insulation shall then be measured and the percentage shrinkage calculated. This value shall not exceed 3 %.

3.2.2 ***Flammability.*** Flammability tests shall be made, if specified in the relevant parts of this specification.

The test shall be in accordance with the requirements of BS 2011-2 Test Pa, and shall be made upon a test piece approximately 300 mm long in each case, by the following method.

The test piece shall be held straight by the ends at an angle of 45° to the vertical. The axis of the flame shall be at the complementary angle of 45° to the vertical so that the flame impinges normally on the test piece. The point of impingement shall be midway along the length of the test piece. The flame shall be applied for the period specified in the relevant part of this specification.

Upon removal of the flame the test piece shall cease to burn within a specified time and the total length burned or charred shall not exceed a specified length. The maximum time and length shall be as specified in the relevant part of this specification. There shall be no violent or explosive burning and no detachment or emission of burning particles or droplets.

3.2.3 ***Thermal endurance on insulated conductors***. A sample of insulated conductor shall be wound, without undue tension, for four turns around and in contact with a metal mandrel, the diameter of which is approximately four times the maximum specified overall diameter of the insulated conductor. The assembly shall be maintained at 85 ± 2 °C for not less than 1 000 h, during which period the mandrel shall be earthed and the thermal endurance test voltage, at 40 Hz to 62 Hz, shown in the relevant part of this specification shall be applied continuously between the conductor and the mandrel.

The assembly shall then be cooled to room temperature and shall withstand the voltage test (**3.3.3**) as shown in the relevant part of this specification applied between the conductor and the mandrel for a further period of not less than 5 min.

3.3 Electrical requirements. In addition to the requirements for conductor and insulation laid down in the relevant specifications already quoted, the following conditions shall be met.

Except where otherwise stated, tests shall be made on lengths taken from the completed wire or cable.

3.3.1 ***Electrical resistance of conductor.*** The resistance of the conductor corrected to a temperature of 20 °C shall not exceed the value specified in the relevant part of this specification.

The method and conditions of test shall be in accordance with the requirements of BS 6360.

3.3.2 ***Spark test.*** The spark test shall be applied during manufacture.

The insulated conductor shall withstand the appropriate r.m.s. voltage specified in the relevant part of this specification and applied in accordance with the requirements of BS 6004. Alternatively, a contact or non-contact electrode method using d.c. may be employed, in which case the test voltage shall be decided by agreement between the manufacturer and the purchaser.

Screened and sheathed insulated conductors shall be subjected to a spark test as above, but with the appropriate voltage as specified in the relevant part of this specification applied between the screen and a suitable electrode system outside the sheath.

3.3.3 ***Voltage tests.*** The insulated conductor shall withstand the appropriate r.m.s. voltage shown in the relevant part of this specification and applied in accordance with the requirements of BS 6004.

Screened insulated conductors shall be tested as described above, in a dry state, the voltage being applied for one minute between the conductor and the screen.

3.3.4 ***Insulation resistance tests***

3.3.4.1 *Equipment wires including screened wires.* The insulated conductor shall be subjected to an insulation resistance test at 20 ± 5 °C and, when called for by the purchaser, at 70 ± 2 °C. The method shall be in accordance with the requirements of BS 6004, except that the period of immersion shall be not less than 1 h.

The insulation resistance between the conductor and the water in which the wire is immersed shall be not less than that specified in the relevant part of this specification at the appropriate temperature.

For screened wires the insulation resistance test shall be made between the conductor and the screen without immersion in water.

3.3.4.2 *Cables.* Insulation resistance measurements on the completed cable shall be made with not less than 500 V d.c. After steady electrification for one minute the insulation shall be measured between each conductor in the cable and the remaining conductors connected together.

The value of insulation resistance shall be not less than 50 MΩ for 1 000 m at 20 ± 5 °C.

The manufacturer may group the cores in any convenient manner for this test.

3.3.5 ***Surface resistivity test on black ink.*** Black ink used for either spiral or ring marked cores shall be tested in the "as received" condition. A sample of the ink shall be applied without brushing, e.g. by casting, or spraying, on to a flat sheet of moulded PVC to form a uniform film. The prepared specimen shall be conditioned at 75 ± 2 % relative humidity for 24 h at 20 ± 2 °C. A surface resistivity test shall be carried out using method 203A of BS 2782. The minimum value of surface resistivity ($\log_{10}\Omega$) shall be 11. The test on the specimen shall be completed within 3 min of its removal from the controlled atmosphere.

4 Ordering information

4.1 Equipment wires. Orders for equipment wires covered by this specification shall contain the following information:

1) description, i.e. classification, conductor size and colour requirements,

2) length.

4.2 Cables. Orders for cables covered by this specification shall contain the following information:

1) description, i.e. classification, number and make-up of cabling elements, conductor size,

2) length.

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BSI
389 Chiswick High Road
London
W4 4AL