

CONFIRMED  
AUGUST 1985

Specification for

# Copper for Electrical purposes —

Wire for general electrical purposes and  
for insulated cables and flexible cords

UDC [669.3 + 669.3 -426]-621.315.3

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW



Document Sharing Hub

# Co-operating organizations

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

- Aluminium Federation
- Association of Bronze and Brass Founders
- Association of Consulting Engineers, Incorporated
- Board of Trade
- British Bronze and Brass Ingot Manufacturers' Association
- British Electrical and Allied Manufacturers' Association\*
- British Lead Manufacturers' Association
- British Non-ferrous Metals Federation\*
- British Non-ferrous Metals Research Association\*
- Copper Development Association\*
- Crown Agents for Oversea Governments and Administrations
- Electric Cable Makers' Confederation\*
- Institute of British Foundrymen
- Institute of Metals\*
- Institution of Mechanical Engineers (Automobile Division)
- Institution of Mining and Metallurgy
- Institution of Production Engineers
- Institution of Structural Engineers
- Lead Development Association
- Light Metal Founders' Association
- London Metal Exchange
- Magnesium Industry Council
- Ministry of Defence (Army Dept)
- Ministry of Defence (Navy Dept)
- National Brassfoundry Association
- Non-ferrous Metal Stockists\*
- Post Office\*
- Royal Institute of British Architects
- Society of Motor Manufacturers and Traders Limited\*
- Tin Research Institute
- Zinc Development Association
- Individual manufacturers

The Government department and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

- British Railways Board
- Electricity Supply Industry in England and Wales
- Institute of Sheet Metal Engineering
- Ministry of Technology
- Ministry of Technology (National Physical Laboratory)

This British Standard, having been approved by the Non-ferrous Metals Industry Standards Committee, was published under the authority of the Executive Board on 25 June, 1970

© BSI 12-1998

First published January, 1967  
First revision June, 1970

The following BSI references relate to the work on this standard:  
Committee reference NFE/12  
Draft for comment 69/11310

ISBN 580 06420 4

## Amendments issued since publication

| Amd. No. | Date | Comments |
|----------|------|----------|
|          |      |          |
|          |      |          |
|          |      |          |
|          |      |          |
|          |      |          |

# Contents

|                                                                                                                 | Page               |
|-----------------------------------------------------------------------------------------------------------------|--------------------|
| Co-operating organizations                                                                                      | Inside front cover |
| Foreword                                                                                                        | ii                 |
| 1 Scope                                                                                                         | 1                  |
| 2 General                                                                                                       | 1                  |
| 3 Definitions                                                                                                   | 1                  |
| 4 Information to be supplied by the purchaser                                                                   | 1                  |
| 5 Freedom from defects                                                                                          | 1                  |
| 6 Chemical composition                                                                                          | 1                  |
| 7 Condition                                                                                                     | 1                  |
| 8 Finish                                                                                                        | 1                  |
| 9 Joints                                                                                                        | 1                  |
| 10 Dimensions and tolerances                                                                                    | 1                  |
| 11 Selection of test samples                                                                                    | 2                  |
| 12 Mechanical tests                                                                                             | 2                  |
| 13 Electrical resistivity test                                                                                  | 2                  |
| 14 Tinning test                                                                                                 | 2                  |
| 15 Retests                                                                                                      | 4                  |
| 16 Certificate of compliance                                                                                    | 4                  |
| 17 Inspection                                                                                                   | 4                  |
| 18 Facilities for testing                                                                                       | 4                  |
| 19 Packaging                                                                                                    | 4                  |
| Appendix A Conversion of stress values                                                                          | 12                 |
| Appendix B Factors for correcting resistance at various temperatures                                            | 12                 |
| Table 1 — Tolerance on diameter                                                                                 | 1                  |
| Table 2 — Difference between maximum and minimum measurements                                                   | 2                  |
| Table 3 — Resistivity values                                                                                    | 2                  |
| Table 4 — Permitted increase in resistivity for tinned wire                                                     | 2                  |
| Table 5 — Test specimens for tinning test                                                                       | 3                  |
| Table 6 — Mandrel diameters for tinning test                                                                    | 3                  |
| Table 7 — Mechanical properties of copper wire                                                                  | 5                  |
| Table 8 — Plain and tinned annealed copper wire                                                                 | 6                  |
| Table 9 — Plain and tinned annealed copper wire (Cable sizes)                                                   | 8                  |
| Table 10 — Plain and tinned hard drawn copper wire                                                              | 10                 |
| Table 11 — Factors for correcting resistance. Hard-drawn high conductivity copper of conductivity 97 % I.A.C.S. | 13                 |
| Table 12 — Factors for correcting resistance. Annealed high conductivity copper of conductivity 100 % I.A.C.S.  | 14                 |

# Foreword

A complete list of British Standards, numbering over 9,000, fully indexed and with a note of the contents of each, will be found in the BSI Catalogue which may be purchased from BSI Sales Department. The Catalogue may be consulted in many public libraries and similar institutions.

This standard makes reference to the following British Standards:

BS 18, *Methods for tensile testing of metals. Part 1: Non-ferrous metals.*

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

BS 1036, *Electrolytic tough pitch high conductivity copper.*

BS 1037, *Fire refined tough pitch high conductivity copper.*

BS 1420, *Glossary of terms applicable to wrought products in copper, zinc and their alloys.*

BS 1559, *Reels and wooden drums for bare wire, stranded conductors and-trolley wire, for use in the United Kingdom.*

BS 1861, *Oxygen-free high conductivity copper.*

BS 3239, *Determination of resistivity of metallic electrical conductor materials.*

This British Standard is one of a series of standards for copper for electrical purposes, the others in the series being as follows:

BS 1432, *Copper for electrical purposes.* Strip with drawn or rolled edges.

BS 1433, *Copper for electrical purposes.* Rod and bar.

BS 1434, *Copper for electrical purposes.* Commutator bars.

BS 1977, *Copper for electrical purposes.* Tubes.

BS 4608, *Copper for electrical purposes.* Rolled sheet, strip and foil.

This British Standard is a revision in metric terms of a standard published in 1967. It was then intended to bring together in a single standard requirements for copper wires used in insulated cables and flexible cords and to replace BS 128 issued in 1929. With the publication of this metric revision, the 1967 edition in imperial units is withdrawn.

In this revision due regard has been given to the work of the International Organization for Standardization (ISO) on testing requirements, properties, etc. and wherever possible and appropriate their recommendations or expected recommendations have been followed.

This standard is not intended to apply to wires which are to be enamelled or textile covered, nor to wires for mineral insulated cables, nor to telecommunication wires or cables. Neither does it apply to wires *taken from* the conductors in insulated cables and flexible cords which are covered by BS 6360, "Copper conductors in insulated cables and cords".

The wording and general arrangement of clauses have been aligned as far as possible with BS 2873, "Copper and copper alloys. Wire".

NOTE Attention is drawn to certification facilities offered by SSI; see the back cover of this standard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their 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 14 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 specifies requirements for bare high conductivity, plain or tinned, annealed or hard copper wire in diameters from 0.05 mm up to and including 6.0 mm for general electrical purposes and for use in insulated cables and flexible cords.

## 2 General

The wire shall comply with the general requirements specified in Clauses 5 to 10, with the requirements of the tests specified in Clauses 12 to 15, if appropriate, and with the appropriate requirements of Table 1 to Table 10.

## 3 Definitions

For the purposes of this British Standard the definitions in BS 205<sup>1)</sup> and BS 1420<sup>2)</sup> apply.

## 4 Information to be supplied by the purchaser

The purchaser shall supply the following information when placing the order:

- 1) The chemical composition of the material (see Clause 6).
- 2) The condition of the material (see Clause 7).
- 3) Whether a tinned finish is required (see Clause 8).
- 4) Whether a certificate of compliance is required (see Clause 16).
- 5) Whether it is the purchaser's intention to inspect the material at the supplier's works (see Clause 17).

## 5 Freedom from defects

The wire shall be bright, clean, smooth and free from harmful defects.

## 6 Chemical composition

The wire shall be manufactured from copper complying with the requirements of BS 1036<sup>3)</sup> (designated C101), BS 1037<sup>4)</sup> (designated C102) or BS 1861<sup>5)</sup> (designated C103) as specified by the purchaser.

If no British Standard is stipulated by the purchaser, the supplier shall be at liberty to supply at his discretion material complying with the requirements of any one of the above standards.

## 7 Condition

The wire shall be supplied in either of the following conditions, as specified by the purchaser:

|          |   |
|----------|---|
| Annealed | O |
| Hard     | H |

in accordance with the mechanical properties specified in this standard.

## 8 Finish

When specified to be tinned the wire shall be coated with a smooth, uniform layer of tin, free from deleterious impurities.

## 9 Joints

There shall be no joints in the wire except those made in the base rod or wire before final drawing.

## 10 Dimensions and tolerances

The diameter of wire determined by means of a suitable micrometer and by taking the mean of two measurements at right angles made at the same cross section of a sample taken from any part of a coil, reel or drum, shall be within the limits stated in Table 1. (See also Columns 2 and 3 of Table 8 to Table 10.)

Table 1 — Tolerance on diameter

| Diameter |                     | Tolerance                  |
|----------|---------------------|----------------------------|
| over     | up to and including |                            |
| mm       | mm                  | mm                         |
| —        | 0.125               | ± 0.002                    |
| 0.125    | 0.400               | ± 0.004                    |
| 0.400    | 4.00                | ± 1 % of standard diameter |
| 4.00     | —                   | ± 0.05                     |

The difference between the maximum and minimum measurements, taken at the same cross section shall not exceed the limits stated in Table 2. (See also Column 4 of Table 8 to Table 10).

<sup>1)</sup> BS 205, "Glossary of terms used in electrical engineering".

<sup>2)</sup> BS 1420, "Glossary of terms applicable to wrought products in copper, zinc and their alloys".

<sup>3)</sup> BS 1036, "Electrolytic tough pitch high conductivity copper".

<sup>4)</sup> BS 1037, "Fire refined tough pitch high conductivity copper".

<sup>5)</sup> BS 1861, "Oxygen-free high conductivity copper".

**Table 2 — Difference between maximum and minimum measurements**

| Diameter |                     | Difference between maximum and minimum measurements |
|----------|---------------------|-----------------------------------------------------|
| over     | up to and including |                                                     |
| mm       | mm                  | mm                                                  |
| 0.315    | 0.400               | 0.004                                               |
| 0.400    | 0.400               | 1 % of standard diameter                            |
| 0.400    | —                   | 0.05                                                |

## 11 Selection of test samples

When tests are specifically called for by the purchaser the selection of test samples and the number of tests to be made shall be agreed between the supplier and the purchaser.

## 12 Mechanical tests

The following tests shall be made on test pieces selected as specified in Clause 11.

The mechanical properties shall comply with the appropriate requirements of Table 7.

**12.1 Tensile test.** This test applies only to wire in the H condition and shall be made in accordance with the methods described in BS 18-1<sup>6)</sup>. The load shall be applied gradually and uniformly.

**12.2 Elongation test.** This test applies only to wire in the O condition and shall be made in accordance with the methods described in BS 18-1<sup>6)</sup>. The load shall be applied gradually and uniformly to a straightened length of wire, having an original gauge length of 200 mm. Alternatively a gauge length of 250 mm may be used. The elongation shall be measured on the gauge length after the fractured ends have been fitted together. The determination shall be valid, whatever the position of the fracture, if the specified value is reached. If the specified value is not reached, the determination shall be valid only if the fracture occurs between the gauge marks and not closer than 25 mm to either mark.

**12.3 Wrapping test.** This test applies only to wire in the H condition. The wire shall be wrapped round a wire of its own diameter to form a close helix of eight turns. Six turns shall then be unwrapped and again closely re-wrapped in the same direction as the first wrapping. To comply with the requirements of the test the wire shall not break when thus tested.

## 13 Electrical resistivity test

The resistivity shall be determined by direct measurement on the wire in accordance with the routine method given in BS 3239<sup>7)</sup>.

The values obtained using the factors given in Table 11 and Table 12 in Appendix B as appropriate shall not exceed the values given in Table 3, except that for tinned wire in the O and H conditions increases in resistivity as shown in Table 4 shall be permitted.

**Table 3 — Resistivity values**

| Condition | Resistivity at 20 °C max. | Conductivity <sup>a</sup> |
|-----------|---------------------------|---------------------------|
| O         | microhm metre             | %                         |
|           | 0.017 241                 | 100                       |
| H         | 0.017 77                  | 97                        |

<sup>a</sup> Expressed as a percentage of the value for standard annealed copper as laid down by the International Electrotechnical Commission. Copper having a resistivity at 20 °C of 0.017 241 microhm metre is said to have a conductivity of 100 % (IEC Publication No. 28).

Maximum resistances for plain wire based on these standard resistivity values and calculated on the minimum diameter listed in Column 3 of Table 8 to Table 10 are given in Column 8 of Table 8 to Table 10.

**Table 4 — Permitted increase in resistivity for tinned wire**

| Diameter |                     | Permitted increase |             |
|----------|---------------------|--------------------|-------------|
| over     | up to and including | O condition        | H condition |
| mm       | mm                  | %                  | %           |
| —        | 1.0                 | 2                  | 1.5         |
| 1.0      | —                   | 1                  | 0.5         |

Maximum resistances for tinned wire in the O and H conditions are given in Column 9 of Table 8 to Table 10.

## 14 Tinning test

The following test shall apply only to tinned wires of diameter over 0.09 mm up to and including 3.2 mm.

<sup>6)</sup> BS 18, "Methods for tensile testing of metals" Part 1: Non-ferrous metals.

<sup>7)</sup> BS 3239, "Determination of resistivity of metallic electrical conductor materials".