

JIS

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

☞ JIS C 2521 : 1999

**Copper-nickel alloy wires,
rolled wires, ribbons and sheets
for electrical resistance**

ICS 29.060.10

Descriptors : resistors, electric wires, sheet materials, non-ferrous alloys, copper alloys, nickel alloys, filaments, strips, electrical resistance materials

Reference number : JIS C 2521 : 1999 (E)



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C 2521 : 1999

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS C 2521 : 1986** is replaced with **JIS C 2521 : 1999**.

Date of Establishment: 1953-08-21

Date of Revision: 1999-12-20

Date of Public Notice in Official Gazette: 1999-12-20

Investigated by: Japanese Industrial Standards Committee
Divisional Council on Non-Ferrous Metals

JIS C 2521 : 1999, First English edition published in 2001-01

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

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Printed in Japan

Copper-nickel alloy wires, rolled wires, ribbons and sheets for electrical resistance

Introduction This Japanese Industrial Standard has been prepared based on the first edition of IEC 60182-4 *Basic dimensions of winding wires—Part 4 : Diameters of conductors for round resistance wires* issued in 1971 without modifying its technical contents. The items not specified in the relevant IEC Standard are added as Japanese Industrial Standard (in the clauses 3 to 5 and 7 to 12). The portions underlined with dots in this Standard (Attached Table 2) are not specified in the corresponding International Standard.

In addition, IEC 60182-4 was withdrawn in 1990 and replaced by IEC 60317-0-1 *Specifications for particular types of winding wires—Part 0 : General requirements—Section 1 : Enamelled round copper wire*. This Standard has no corresponding relations with the said International Standard, since its scope is different from the scope of this Standard.

1 Scope This Standard specifies copper-nickel alloy wires, rolled wires, ribbons and sheets for electrical resistance (hereafter referred to as “wires, rolled wires, ribbons and sheets”) of alloys mainly composed of copper and nickel, and have small temperature coefficient of electrical resistance (hereafter referred to as “temperature coefficient”).

Remarks : The corresponding International Standard is as follows.

IEC 60182-4 : 1971 *Basic dimensions of winding wires—Part 4 : Diameters of conductors for round resistance wires*

2 Normative references The standards given in Attached Table 1 contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards shall be applied.

3 Definitions The definitions of the major terms in this Standard shall be as follows:

- a) **rolled wire** The resistance materials made in such a process that raw rod materials are rolled or drawn after rolling, and then wound.
- b) **ribbon** The resistance materials made in such a process that raw sheet materials are cut in its longitudinal direction and then wound.
- c) **volume resistivity** Electrical resistance per unit cross section and unit length (Ωm).
- d) **linear temperature coefficient and quadric temperature coefficient** If the relative variation of electrical resistance of an electrical conductor is expressed in the form of a quadric function of temperature, the linear temperature coefficient is denoted coefficient on the linear term of the function and the quadric temperature coefficient is denoted coefficient on the quadric term of the function.

Generally, the temperature coefficients are denoted as follows:

Linear temperature coefficient: α

Quadric temperature coefficient: β

Linear temperature coefficient at t °C: α_t

- e) **mean temperature coefficient** The relative variation in electrical resistance of an electrical conductor due to temperature between two given temperatures (t_a °C, t_b °C) divided by the temperature difference Δt .

Generally, the mean temperature coefficient is denoted as α , and that between temperature t_a °C and t_b °C ($t_a < t_b$) is denoted as α_{ab} .

- f) **effective cross section** The sectional area, in a rolled wire, obtained from the thickness and width multiplied by a constant factor.

- g) **conductor resistance** The electrical resistance per unit length in longitudinal direction of a conductor having a uniform cross section (Ω).

Unit length is usually 1 m or 1 km and the conductor resistance is respectively given in Ω/m or Ω/km .

- 4 **Class, grade and symbol** The classes, grades and symbols shall be as shown in Table 1.

Table 1 Class, grade and symbol

Class	Grade	Symbol	Property and usage (informative)
Copper-nickel alloy wire for electrical resistance	Grade AA	CNWAA	These have resistance to corrosion and oxidation. The grade AA can be used at 55 °C or lower, and Grade A and B can be used at 200 °C or lower.
	Grade A	CNWA	
	Grade B	CNWB	
Copper-nickel alloy rolled wire for electrical resistance	—	CNRW	
Copper-nickel alloy ribbon for electrical resistance	—	CNR	
Copper-nickel alloy sheet for electrical resistance	—	CNP	

5 Quality

5.1 Appearance The wires, rolled wires, ribbons and sheets shall have smooth surface and be free from scratches, twists, cracks, adhesive substances and other defects detrimental to use.

5.2 Chemical composition The chemical ingredients of the wires, rolled wires, ribbons and sheets shall comply with Table 2.

Table 2 Chemical composition

%(m/m)

Chemical composition		
Ni ⁽¹⁾	Mn	Cu+Ni+Mn
42.0 to 48.0	0.5 to 2.5	99.0 min.

Note (1) Nickel may contain a small amount of cobalt.

5.3 Volume resistivity The wires, rolled wires, ribbons and sheets shall be tested according to 8.2.2 and comply with the specifications of Table 3.

However, this specification shall not apply to the wires of diameter less than 0.355 mm, and the rolled wires, ribbons and sheets of thickness less than 0.5 mm.

Table 3 Volume resistivity

Volume resistivity $\mu\Omega\text{m}$	
Standard value	Tolerance
0.490	± 0.030

5.4 Linear temperature coefficient and quadric temperature coefficient The wires shall be tested according to 8.2.3 and shall comply with the specifications in Table 4.

5.5 Mean temperature coefficient The wires shall be tested according to 8.2.4 and shall comply with the specifications in Table 4.

Table 4 Linear, quadric and mean temperature coefficient

Class	Grade	Temperature coefficient			
		Temperature at measuring point °C	Linear temperature coefficient $\alpha_{23} \times 10^{-6}/\text{K}$	Quadric temperature coefficient $\beta \times 10^{-6}/\text{K}$	Mean temperature coefficient $\alpha \times 10^{-6}/\text{K}$
Copper-nickel alloy wire for electrical resistance	Grade AA	23 $\pm$ 2 38 $\pm$ 2 53 $\pm$ 2	-10 to +10	-1.5 to +0	—
	Grade A	23 $\pm$ 2 53 $\pm$ 2	—	—	-20 to +20
	Grade B		—	—	-40 to +40
Copper-nickel alloy rolled wire for electrical resistance	—				
Copper-nickel alloy ribbon for electrical resistance	—				
Copper-nickel alloy sheet for electrical resistance	—				

5.6 Mechanical property The wires, rolled wires, ribbons and sheets shall be tested according to 8.2.5 and comply with the specifications of Table 5.

However, this specification shall not apply to the wires having diameter less than 0.20 mm, and the rolled wires, ribbons and sheets having a thickness less than 0.5 mm.

Table 5 Mechanical property

Tensile strength MPa	Elongation %
410 to 540	25 min.

5.7 Conductor resistance and its tolerance

5.7.1 Conductor resistance The wires, rolled wires, ribbons and sheets shall be tested according to 8.2.6, and the conductor resistance of the specified size of wires and rolled wires shall be respectively as given in Attached Table 2 for wires and Attached Table 4 for rolled wires. No conductor resistance of ribbons and sheets is specified.

The conductor resistance with dimensions other than specified in the Tables shall comply with the value derived from the formula in 8.2.6 using the dimensions subject to the agreement between the parties concerned.

5.7.2 Tolerances of conductor resistance The tolerance of conductor resistance of a wire shall comply with the specifications in Attached Table 2 and the tolerance of conductor resistance of a rolled wire shall comply with the specifications in Attached Table 4.

The tolerances of conductor resistance with dimensions other than specified shall comply with the specifications in Attached Table 7 for wires, and Attached Table 8 for rolled wires.

6 Dimensions and tolerances Dimensions and tolerances of the wires, rolled wires, ribbons and sheets shall be tested according to 8.2.7 and comply with the specifications in Attached Tables 2, 3, 5 and 6 respectively. However, the diameter of wire, and the thickness and width of rolled wire, ribbon and sheet with dimensions other than specified may be determined, for the time being, by an agreement between the parties concerned. In this case, the dimensional tolerances shall comply with the specifications in Attached Tables 9 and 10.

7 Manufacturing method Wires, rolled wires, ribbons and sheets shall, after drawn or rolled, be annealed at appropriate temperature and in appropriate atmosphere.

8 Tests

8.1 Standard atmospheric conditions for testing The tests of 8.2.2, 8.2.5, 8.2.6 and 8.2.7 shall be carried out at ordinary temperature as specified in JIS Z 8703.

8.2 Testing methods

8.2.1 Chemical analysis The chemical analysis of chemical composition shall be carried out in accordance with JIS H 0321 and JIS H 1413.