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**Copper-manganese alloy wires,
bars and sheets for electrical
resistance**

ICS 29.060.10

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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 2522 : 1986** is replaced with **JIS C 2522 : 1999**.

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Copper-manganese alloy wires, bars 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 for the corresponding part without modifying its technical contents. Particular requirements not specified in the relevant IEC Standard are additionally included as the Japanese Industrial Standard. The dotted-underlined descriptions (see Attached Table 2) are not contained in the corresponding International Standard.

Further, IEC 60182-4 was withdrawn in 1990 and replaced by IEC 60317-0-1 *Specifications for particular types of winding wires—Part 0 : General requirements—Section 1 : Enamelled round copper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 to the said International Standard, since the scope is different from that of this Standard.

1 Scope This Standard specifies copper-manganese alloy wires, bars and sheets for electrical resistance (hereafter referred to as “wires, bars and sheets”), which are mainly composed of copper, manganese and nickel and have small temperature coefficient of electrical resistance (hereafter referred to as “temperature coefficient”) and small thermoelectromotive force to copper.

Remarks : The corresponding International Standard is as follows.

IEC 60182-4 : 1971 *Basic dimensions of winding —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 used in this Standard shall be as follows:

- a) **volume resistivity** Electrical resistance per unit cross section and unit length (Ωm).
- b) **conductor resistance** The electrical resistance per unit length in longitudinal direction of a conductor having a uniform cross section (Ω).

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

- c) **linear temperature coefficient and quadric temperature coefficient** If the change 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 by the following symbols:

Linear temperature coefficient: α

Quadric temperature coefficient: β

Linear temperature coefficient at t °C: α_t

- d) **mean thermoelectromotive force to copper** The value $1/t$ ($\mu\text{V/K}$) obtained by a division that thermoelectromotive force, generated by a thermocouple composed from a wire specimen and the standard copper wire specified in 4.2 of JIS C 2527 when the reference junction temperature is maintained at 0°C and the measuring junction temperature at $t^\circ\text{C}$, is divided by t .
- e) **electrical resistance stability** The relative variation (%) in electrical resistance which is measured before and after a given heat treatment is applied in order to detect whether the material has been well annealed or not.

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-manganese alloy wire for electrical resistance	Grade AA	CMWAA	It is recommended to use these materials after applying a coating against moisture and oxidation due to their poor resistance to corrosion and oxidation. The Grade B or C with a positive temperature coefficient should be used for the apparatus in which temperature rise is anticipated.
	Grade A	CMWA	
	Grade B	CMWB	
	Grade C	CMWC	
Copper-manganese alloy bar for electrical resistance	—	CMB	
Copper-manganese alloy sheet for electrical resistance	—	CMP	

5 Quality

5.1 Appearance The wires, bars and sheets shall have smooth surface and be free from scratches, twists, cracks, demanganese layers, adhesive substances or other defects detrimental to service.

5.2 Chemical composition The chemical composition of the wires, bars and sheets shall be as given in Table 2.

Table 2 Chemical composition

Chemical composition % (m/m)		
Ni ⁽¹⁾	Mn	Cu + Ni + Mn
1.0 to 4.0	10.0 to 13.0	98.0 min.

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

5.3 Volume resistivity The wires, bars and sheets shall be tested according to 8.2.2 and comply with the specifications given in Table 3. However, this article does not apply to the wires with diameter of less than 0.355 mm.

Table 3 Volume Resistivity

Volume resistivity $\mu\Omega\text{m}$	
Standard value	Tolerance
0.440	± 0.030

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

5.5 Electrical resistance stability The wires shall be tested according to 8.2.4 and shall comply with the specifications in Table 4.

5.6 Mean thermoelectromotive force to copper The wires shall be tested according to 8.2.5 and shall comply with the specifications in Table 4. Mean thermoelectromotive force to copper given in the table shall be the absolute value.

Table 4 Temperature coefficient, mean thermoelectromotive force to copper and electrical resistance stability

Class	Grade	Temperature coefficient				Electrical resistance stability %	Mean thermoelectromotive force to copper $\mu\text{V/K}$
		Applicable temperature range $^{\circ}\text{C}$	Temperature at measuring point $^{\circ}\text{C}$	Linear temperature coefficient $\alpha_{23} \times 10^{-6}/\text{K}$	Quadric temperature coefficient $\beta \times 10^{-6}/\text{K}^2$		
Copper-manganese alloy wire for electrical resistance	Grade AA	5 to 45	13 $\pm$ 2	- 4 to + 8	-0.7 to 0	0.10 max.	2 max.
	Grade A		23 $\pm$ 2	-10 to +20	-1.0 to 0		
	Grade B		33 $\pm$ 2	-20 to +40	-1.0 to 0		
	Grade C		43 $\pm$ 2	-40 to +80	-1.0 to 0		
Copper-manganese alloy bar for electrical resistance	—			-40 to +80 ⁽²⁾	-1.0 to 0 ⁽²⁾	0.10 ⁽²⁾ max.	2 ⁽²⁾ max.
Copper-manganese alloy sheet for electrical resistance	—						

Note ⁽²⁾ Informative values.

5.7 Mechanical property The wires, bars and sheets shall be tested according to 8.2.6 and comply with the specifications of Table 5.

However, this article does not apply to the wires having diameter of less than 0.20 mm.