

JIS

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

④ JIS C 2532 : 1999

Electrical resistance wires, ribbons and sheets for general use

ICS 29.060.10

Descriptors : sheet materials, resistors, electric wires, electrical resistance materials,
alloys, filaments, materials by form

Reference number : JIS C 2532 : 1999 (E)

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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:

Date of Establishment: 1976-11-01

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 2532:1999, 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

Electrical resistance wires, ribbons and sheets for general use

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. Particular requirements not specified in the relevant IEC Standard are given as JIS requirements in the clauses (2 to 5 and 7 to 12). The dotted-underlined descriptions (Attached Tables 2 and 3) are not contained 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In addition, **IEC 60182-4** was withdrawn in 1990 and replaced by **IEC 60317-0-1** *Specifications for particular types of winding wires—Part 0 : General requirements—Section 1 : Enamelled round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, in order that the scope is different from that of this Standard.

1 Scope This Standard specifies alloy wires, ribbons and sheets for electrical resistance (hereafter referred to as “wires, ribbons and sheets”) having volume resistivity of $1.5 \mu\Omega \cdot m$ or under.

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 used in this Standard shall be as follows:

- a) **ribbon** Coiled metals obtained by cutting sheets in longitudinal direction.
- b) **volume resistivity** Electrical resistance per unit cross section and unit length ($\Omega \cdot m$).
- c) **mean temperature coefficient** The value obtained in a manner which relative variation in electrical resistance of an electrical conductor due to temperature is divided by the temperature difference between two given temperatures. Generally, it is given in $\bar{\alpha}$.
- d) **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 Classification and symbol The classifications and symbols shall be as shown in Table 1.

Table 1 Classification and symbol

Classification			Symbol	Property and usage (informative)
Type	Class	Shape		
Electrical resistance iron-chromium for general use	142 123 111	Wire	GFC142W GFC123W GFC111W	Ferromagnetic and high resistance material suitable for general use (resistance element), having good resistance to heat and oxidation. Material is hard and cold bending workability is slightly inferior, but this can be improved by heating. GFC123 is lower than GFC142 on electric resistance, but better on workability. Electric resistance of GFC111 is lower than GFC123, whilst its workability is best so that the ribbons and sheets of GFC111 are suitable for press working. Attention is required that any classes have inferior brazing property. Maximum temperature for use is 500 °C.
	111	Ribbon	GFC111R	
	111	Sheet	GFC111P	
Electrical resistance nickel-chromium for general use	112 108 101 69	Wire	GNC112W GNC108W GNC101W GNC69W	GNC108 is the highest class of resistance material having small temperature coefficient of resistance, and enough toughness and resistance to heat and corrosion. GNC112 is inferior to GNC108 on temperature coefficient of resistance, toughness and resistance to heat and corrosion, etc. GNC101 has better resistance to heat and corrosion next to GNC112 and suits high resistive material. The temperature coefficient of resistance of GNC101 is bigger than that of GNC108 and GNC112. Any of them has inferior brazing property. GNC108 and GNC69 are non-magnetic. Maximum temperature for use is 500 °C.
	112 108 101	Ribbon	GNC112R GNC108R GNC101R	
	112 108 101	Sheet	GNC112P GNC108P GNC101P	
	72	Wire	GSU72W	
	44	Wire	GCM44W	
	44	Sheet	GCM44P	
Electrical resistance copper-nickel for general use	49 30 15 10 5	Wire	GCN49W GCN30W GCN15W GCN10W GCN5W	GCN49, GCN30 Middle resistance material having fairly better resistance to corrosion, smaller temperature coefficient of resistance and good property to work and weld which is easy to use. The temperature coefficient of resistance and mechanical property of GCN30 is inferior to those of GCN49. The thermoelectromotive force to copper of any materials is large and GCN49 is also available to a thermocouple. GCN15, GCN10, GCN5 Low resistance material having good property to work and braze but relatively larger temperature coefficient of resistance. The resistance to corrosion of these materials is better than electrical copper materials. Pertaining to temperature coefficient of resistance and mechanical property, GCN5 is inferior to GCN10 and GCN10 is inferior to GCN15. Maximum temperature of GCN15, GCN10 and GCN5 are respectively 250 °C, 220 °C and 200 °C.
	49 30 15 10 5	Ribbon	GCN49R GCN30R GCN15R GCN10R GCN5R	
	49 30 15 10 5	Sheet	GCN49P GCN30P GCN15P GCN10P GCN5P	
	72	Wire	GSU72W	
	44	Wire	GCM44W	
	44	Sheet	GCM44P	
	49 30 15 10 5	Wire	GCN49W GCN30W GCN15W GCN10W GCN5W	
	49 30 15 10 5	Ribbon	GCN49R GCN30R GCN15R GCN10R GCN5R	
	49 30 15 10 5	Sheet	GCN49P GCN30P GCN15P GCN10P GCN5P	

Table 1 (concluded)

Classification			Symbol	Property and usage (informative)
Type	Class	Shape		
Electrical resistance nickel-aluminium for general use	28	Wire	GNA28W	Ferromagnetic middle resistance material having relatively small electric resistance, relatively larger temperature coefficient of resistance, fairly good mechanical property and resistance to corrosion and heat, but slight difficulty to braze. Maximum temperature for use is 500 °C.
Electrical resistance nickel for general use	9.6	Wire	GN9.6W	Ferromagnetic low resistance material having large temperature coefficient of resistance, good mechanical property to work and braze, resistance to corrosion and heat, and special property of resistance against alkali. This suits heat resistive lead wire (conductor) due to low resistance. Maximum temperature for use is 500 °C.

5 Quality

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

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

Table 2 Chemical composition

Type	Symbol	Chemical composition % (m/m)							
		C	Si	Mn	Ni ⁽¹⁾	Cr	Al	Fe	Others
Electrical resistance iron-chromium for general use	GFC142	0.10 max.	1.5 max.	1.0 max.	—	23 to 26	4 to 6	Re-mainder	—
	GFC123	0.10 max.	1.5 max.	1.0 max.	—	17 to 21	2 to 4	Re-mainder	—
	GFC111	0.10 max.	1.5 max.	1.0 max.	—	13 to 17	2 to 3	Re-mainder	—
Electrical resistance nickel-chromium for general use	GNC112	0.15 max.	0.75 to 1.6	1.5 max.	57 min.	15 to 18	—	Re-mainder	—
	GNC108	0.15 max.	0.75 to 1.6	2.5 max.	77 min.	19 to 21	—	1.0 max.	—
	GNC101	0.15 max.	1.0 to 3.0	1.0 max.	34 to 37	18 to 21	—	Re-mainder	—
	GNC69	—	1.0 max.	1.5 max.	—	9.0 to 10.5	—	—	Ni + Cr + Si 99.0 min.
Electrical resistance iron-nickel-chromium for general use	GSU72	0.08 max.	1.0 max.	2.0 max.	8.0 to 10.5	18.0 to 20.0	—	Re-mainder	—
Electrical resistance copper-manganese for general use	GCM44	—	—	10.0 to 13.0	1.0 to 4.0	—	—	—	Cu + Mn + Ni 98.0 min.
Electrical resistance copper-nickel for general use	GCN49	—	—	0.5 to 2.5	42.0 to 48.0	—	—	—	Cu + Ni + Mn 99.0 min.
	GCN30	—	—	1.5 max.	20.0 to 25.0	—	—	—	
	GCN15	—	—	1.0 max.	8.0 to 12.0	—	—	—	
	GCN10	—	—	1.0 max.	4.0 to 7.0	—	—	—	
	GCN5	—	—	1.0 max.	0.5 to 3.0	—	—	—	
Electrical resistance nickel-aluminium for general use	GNA28	—	2.5 max.	2.5 max.	—	—	3.0 max.	—	Ni + Al + Si + Mn 98.5 min.
Electrical resistance nickel for general use	GN9.6	0.05 max.	0.2 max.	0.10 to 0.50	99.0 min.	—	—	0.20 max.	—

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

5.3 Volume resistivity The volume resistivity of wires, ribbons and sheets shall be as given in Table 3. However, this article does not apply to the wires of diameter less than 0.135 5 mm and the ribbons and sheets of thickness less than 0.50 mm.

Table 3 Volume resistivity and characteristics

Classification			Symbol	Volume resistivity $\mu\Omega \cdot m$		Property and usage (informative)		
Type	Class	Shape		Standard value	Tolerance	Mean temperature coefficient 10 ⁻⁶ /K (23 to 100 °C)	Thermo-electromotive force to copper $\mu V/K$ (0 to 100 °C)	Maximum operation temperature °C
Electrical resistance iron-chromium for general use	142	Wire	GFC142W	1.42	± 0.06	100	-4	400
	123		GFC123W	1.23	± 0.06	150	-3	400
	111		GFC111W	1.11	± 0.06	300	-2	400
	111	Ribbon	GFC111R					
	111	Sheet	GFC111P					
Electrical resistance nickel-chromium for general use	112	Wire	GNC112W	1.12	± 0.05	150	+1	500
	112	Ribbon	GNC112R					
	112	Sheet	GNC112P					
	108	Wire	GNC108W	1.08	± 0.05	50	+5	500
	108	Ribbon	GNC108R					
	108	Sheet	GNC108P					
	101	Wire	GNC101W	1.01	± 0.05	400	-2	500
	101	Ribbon	GNC101R					
	101	Sheet	GNC101P					
Electrical resistance iron-nickel-chromium for general use	69	Wire	GNC69W	0.690	± 0.030	350	+20.5	500
	72	Wire	GSU72W	0.720	± 0.030	1 200	-4	300
Electrical resistance copper-manganese for general use	44	Wire	GCM44W	0.440	± 0.030	± 50	± 2	150
	44	Sheet	GCM44P					