Conductor resistance test

Conductor resistance test is performed according to JIS C2525. Standard temperature shall be 23℃.

Conductor resistance whose dimension is out of specified dimension is calculated by calculation formula below, and rounded to three significant figures according to JIS Z 8401.

$$Rc = \rho / A$$

- **Rc** conductor resistance (Ω/m)
- **ρ** volume resistivity of Table1 (μΩ・m)
- **A** Cross-sectional area calculated by agreed dimensions between shipping and receiving parties. In case of strip, the value is calculated by the formula listed below and according to JIS Z 8401, rounded to four significant figures.

Width: less than 10mm ▶ thickness × width × 0.96 = cross-sectional area

Width: more than 10mm ▶ thickness × width × 0.98 = cross-sectional area

■ Volume resistivity, life value and elongation ■

Materials	Volume resistivity μΩ・m		Life value		Elongation
	Standard value	Toerance	Test type	Times	
Nickel-chrome for electric heating type1	1.08	±0.05	I method 1200℃	more than 300	more than 20
Nickel-chrome for electric heating type2	1.12	±0.05	I method 1200℃	more than 200	more than 20
Nickel-chrome for electric heating type3	1.01	±0.05	I method 1200℃	more than 100	more than 20

※extracted from JIS C2532 normal electric resistance wire, strip and sheet

Characteristic value of resistance materials

Material (Symbol)		NCH-1	NCH-2	NCH-3	Evanohm R®	NRH50	CN5	CN10
Manufacturer					Carpenter Technology	Hitachi Metals Neomaterial		
Main chemical composition		Ni 78.0 Cr 20.0 Si 1.2	Ni 58.0 Cr 16.5 Fe 23.0	Ni 38.0 Cr 18.0 Fe	Ni 73.5 Cr 20.0 Al 2.5 Cu 2.0		Ni 2.0 Cu 98.0	Ni 6.0 Cu 94.0
Specification	J I S	C2520 C2532	C2520 C2532				C2532	C2532
	ASTM				B267 Class1A,1B,1C			
Density g/cm³		8.43	8.26	7.9	8.11		8.9	8.9
Hardness(Hv)	H：Hard							
	A：Annealed							
Temperature coefficient of resistance（T C R）		100		265			1,500	700
Volume resistivity $\times 10^{-8} \Omega \cdot m$		108	112	101	133	133	5	10
Tensile strength MPa				>60			20～40	25～40
Elongation %				>20			>30	>25
Usable temperature ℃		1100	1000	950			200	220

Material (Symbol)		CN15	CN20	CN30	CN40	CN49	CM44	CuMnSn7
Manufacturer								
Main chemical composition		Ni 9.0 Cu 91.0	Ni 14.0 Cu 86.0	NI 23.0 Cu 77.0	Ni 33.0 Cu 67.0	Ni 45.0 Cu 55.0	Cu Mn 10～13 Ni 1～4	Cu Mn 7 Sn 2
Specification	J I S	C2532	C2532	C2532	C2532	C2532	C2532	
	ASTM							
Density g/cm³		8.9	8.9	8.9	8.9	8.9	8.4	
Hardness(Hv)	H：Hard							
	A：Annealed							
Temperature coefficient of resistance（T C R）		500		200	100	±80		
Volume resistivity $\times 10^{-8} \Omega \cdot m$		15	20	30	40	49	44	29
Tensile strength MPa		25～40	30～45	30～45	35～50	40～55	34～59	
Elongation %		>25	>25	>25	>25	>25		
Usable temperature ℃		250	300	300	350	400	200	

※Characteristic value is central value, not certified value.

Distribution map of volume resistivity and the highest service temperature for resistance materials

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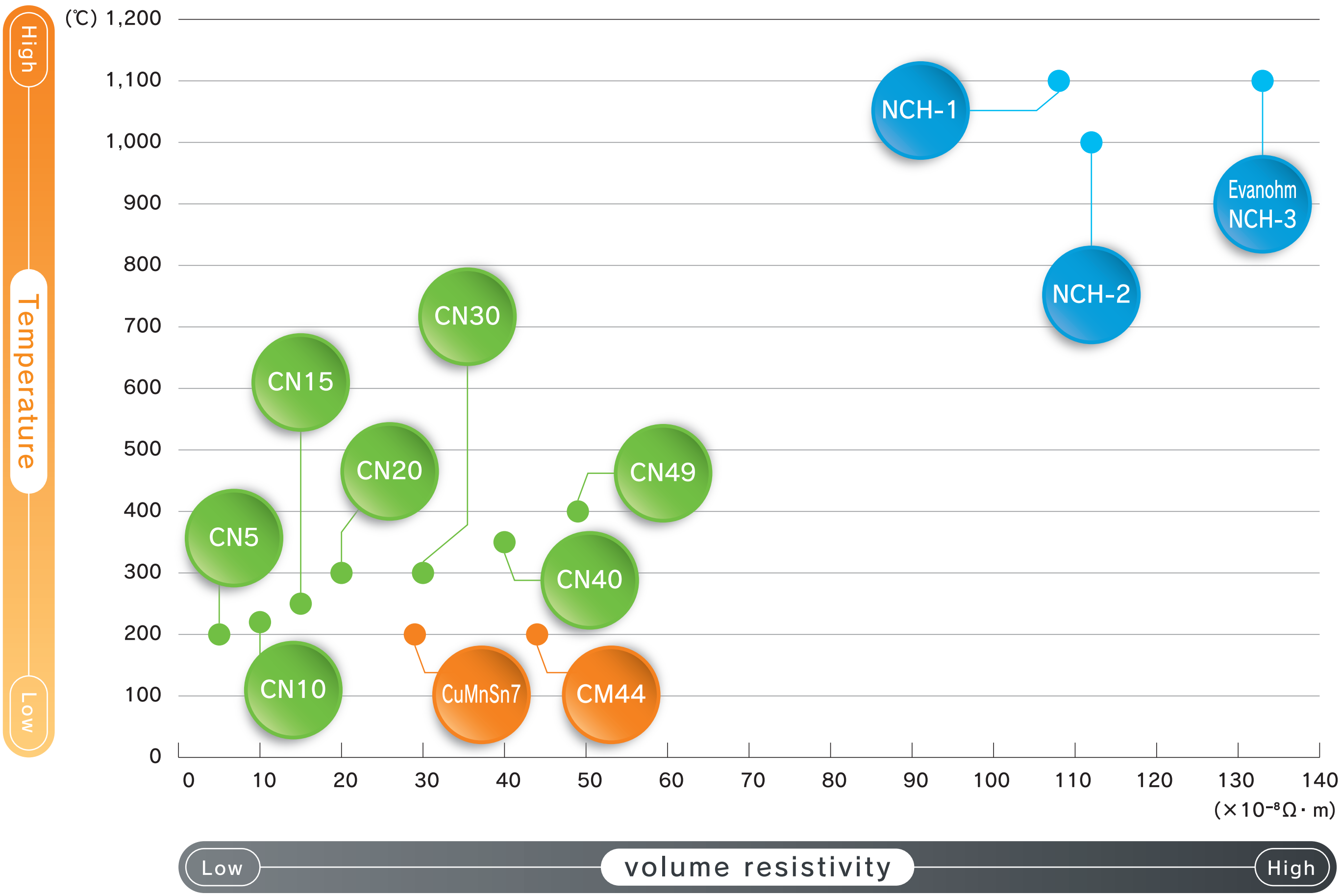

Materials	NCH-1	NCH-2	NCH-3	Evanohm	NRH50	CN5	CN10	CN15	CN20	CN30	CN40	CN49	CM44	CuMnSn7
Volume resistivity (×10-8Ω・m)	108	112	101	133	133	5	10	15	20	30	40	49	44	29
The highest service temperature(℃)	1100	1000				200	220	250	300	300	350	400	200	200

※Characteristic value is central value, not certified value.

Change of resistance by temperature

Generally, electric resistance of materials changes along with temperature.

Normally, resistance of metallic conductors increases along with rise of temperature. To the contrary, resistance decreases as for semiconductor, electrolyte, carbon, nonconductor and so on along with rise of temperature.

Temperature coefficient of resistance

"Temeperature coefficient of resitance at specific temperature" is expressed by an increased resistance value from specific temperature to certain increased temperature, and which is devided by the the resistance value at the increased temerature.

From 20℃ to 200℃ the relationship between resistance value and temperature coefficient shows linearly change, so practically we can understand like the follwoing.

If the resistance value rises by every r 【Ω】 as the temperature rises every 1℃, the temperature coefficient $\alpha 0$ at 0℃, temperature coefficient $\alpha 20$ at 20℃ and temperature coefficient αt at t℃ are shown in formula below.

$$\alpha_0 = \frac{r}{R_0} \qquad \alpha_{20} = \frac{r}{R_{20}} \qquad \alpha_t = \frac{r}{R_t}$$

Resistance value of metallic conductor Rt at t℃ is calculated in formula below

$$Rt = R_0 + rt = R_0 + \alpha_0 R_0 t$$
$$= R_0 (1 + \alpha_0 t)$$

R_0 resistance value at 0℃

α_0 temperature coefficient at 0℃

Likewise, resistance value of metallic conductor Rt at 20℃ is calculated in formula below

$$Rt = R_{20} + r(t-20)$$
$$= R_{20} + \alpha_{20} R_{20} (t-20)$$
$$= R_{20} \{1 + \alpha_{20} (t-20)\}$$

R_{20} resistance value at 20℃

α_{20} temperature coefficient at 20℃

Hence, this relationship between resistance value and temperature coefficient is formed below.

$$RT = Rt \{1 + \alpha_t (T - t)\}$$

RT resistance value at T℃

αt temperature coefficient at t℃

Rt resistance value at t℃

Materials	Temperature coefficient at 20℃
Silver	0.0038
Copper	0.00393
Gold	0.0034
Aluminum	0.0039
Magnesium	0.0044
Molybdenum	0.0047
Tungsten	0.0045
Zinc	0.0037
Cobalt	0.0066

Materials	Temperature coefficient at 20℃
Nickel	0.006
Cadmium	0.0038
Ferrum	0.005
Platinum	0.003
Tin	0.0042
Lead	0.0039
Mercury	0.0089
Constantan	0.000015
Manganin	0.00001