Cu Zn5

Common names: 95/5 Brass
95/5 Gilding Metal

A copper–zinc alloy with an alpha phase structure. The alloy has excellent cold-working properties and is generally not susceptible to dezincification and stress corrosion. It is widely used for small-arms ammunition and, due to its attractive golden colour, for decorative applications.

COMPOSITION (weight %)

Cu	94.0–96.0
Zn	rem.

1 SOME TYPICAL USES

Coinage
Coins, medals and tokens.

Decorative
Emblems, costume jewellery, plaques; good base material for gold plate and vitreous enamel.

Munitions
Small arms ammunition including bullet envelopes (clad on steel), fuse caps and primer caps.

2 PHYSICAL PROPERTIES

		Metric Units	English Units
2.1	Density at 20 °C *68 °F*	8.85 g/cm³	0.320 lb/in³
2.2	Melting range	1 055–1 070 °C	1 930–1 960 °F
2.3	Coefficient of thermal expansion (linear) at:		
	20 to 100 °C *68 to 212 °F*	0.000 017 per °C	0.000 010 per °F
	20 to 300 °C *68 to 572 °F*	0.000 018 ,, ,,	0.000 010 ,, ,,
2.4	Specific heat (thermal capacity) at:		
	20 °C *68 °F*	0.09 cal/g °C	0.09 Btu/lb °F
2.5	Thermal conductivity at:		
	—200 °C *—328 °F*	0.31 cal cm/cm² s °C	74 Btu ft/ft² h °F
	20 °C *68 °F*	0.56 ,,	135 ,,
	200 °C *392 °F*	0.65 ,,	157 ,,
2.6	Electrical conductivity (volume) at:		
	—196 °C *—321 °F* (annealed)	71 m/ohm mm²	123 % IACS
	20 °C *68 °F* (,,)	32 ,,	56 ,, ,,
	200 °C *392 °F* (,,)	23 ,,	40 ,, ,,
	—196 °C *—321 °F* (fully cold worked)	67 ,,	115 ,, ,,
	20 °C *68 °F* (,, ,, ,,)	31 ,,	53 ,, ,,

continued overleaf

INDEX NUMBERS RELATE TO LITERATURE REFERENCES (see page 8); INDEX LETTERS RELATE TO FOOTNOTES AT END OF TABLE

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DATA SHEET No. D1
Cu Zn5
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2 **PHYSICAL PROPERTIES** (continued)	**Metric Units**	**English Units**
2.7 Electrical resistivity (volume) at:		
—196 °C *—321 °F* (annealed)	0.014 ohm mm²/m 1.4 microhm cm	8.4 ohms (circ mil/ft) 0.55 microhm in
20 °C *68 °F* („)	0.031 ohm mm²/m 3.1 microhm cm	19 ohms (circ mil/ft) 1.2 microhm in
200 °C *392 °F* („)	0.043 ohm mm²/m 4.3 microhm cm	26 ohms (circ mil/ft) 1.7 microhm in
—196 °C *—321 °F* (fully cold worked)	0.015 ohm mm²/m 1.5 microhm cm	9.0 ohms (circ mil/ft) 0.59 microhm in
20 °C *68 °F* („ „ „)	0.032 ohm mm²/m 3.2 microhm cm	20 ohms (circ mil/ft) 1.3 microhm in
2.8 Temperature coefficient of electrical resistance at: 20 °C *68 °F* (annealed) applicable over range from 0 to 100 °C *32 to 212 °F*	0.002 3 per °C (56% IACS)	0.001 3 per °F (56% IACS)
20 °C *68 °F* (fully cold worked) applicable over range from 0 to 100 °C *32 to 212 °F*	0.002 2 „ „ (53% IACS)	0.001 2 „ „ (53% IACS)
2.9 Modulus of elasticity (tension) at 20 °C *68 °F*:		
annealed	13 000 kg/mm²	18 500 000 lb/in²
cold worked	12 300–13 000 kg/mm²	17 500 000–18 500 000 lb/in²
2.10 Modulus of rigidity (torsion) at 20 °C *68 °F*:		
annealed	4 750 kg/mm²	6 750 000 lb/in²
cold worked	4 500–4 750 kg/mm²	6 400 000–6 750 000 lb/in²

N.B.: The values shown in Section 2, which have been appropriately rounded in view of the composition range involved, are based on selected literature references.

3 FABRICATION PROPERTIES

The information given in this table is for general guidance only, since many factors influence fabrication techniques.
The values shown are approximate only, since those used in practice are dependent upon form and size of metal, equipment available, techniques adopted and properties required in the material.

	Metric Units	**English Units**
3.1 Casting temperature range	1 140–1 200 °C	2 085–2 190 °F
3.2 Annealing temperature range	425– 600 °C	795–1 110 °F
Stress relieving temperature range	200– 300 °C	390– 570 °F
3.3 Hot working temperature range	750– 900 °C	1 380–1 650 °F
3.4 Hot formability	Good	
3.5 Cold formability	Excellent	
3.6 Cold reduction between anneals	90% max.	
3.7 Machinability:	See General Data Sheet No. 2	
Machinability rating (free-cutting brass = 100)	25	
3.8 Joining methods:	See General Data Sheet No. 3.4	
Soldering	Excellent	
Brazing	Excellent	
Oxy-acetylene welding	Good	
Carbon-arc welding	Not recommended	
Gas-shielded arc welding	Good	
Coated metal-arc welding	Not recommended	
Resistance welding: spot and seam	Not recommended	
butt	Good	

5.1 MECHANICAL PROPERTIES AT ROOM TEMPERATURE[a]

5.1.1 Typical Tensile Properties and Hardness Values—Metric Units

This table is representative of practice in many European countries. For British and American practices, see tables 5.1.2 and 5.1.3, respectively.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.

For a given temper, individual elongation values may show some variation above or below the typical values indicated.

Form	Temper	Tensile Strength kg/mm²	Proof Stress 0.2% offset kg/mm²	Elongation		Hardness		Shear Strength kg/mm²	Typical Size Related to Properties Shown[b]
				%	gauge length	Brinell	Vickers		
Plate Sheet Strip	Annealed (grain size 0.015 mm)	27	10	45	50 mm	65	68	20	0.2–1.5 mm thick
	Typical Cold Worked Tempers	34 39 43	24 32 38	20 8 4	50 mm 50 mm 50 mm	85 105 120	89 110 125	24 25 26	0.2–3 mm thick 0.2–2 mm thick 0.2–1.5 mm thick
Wire	Annealed	27 30	— —	33 30	100 mm 100 mm	— —	— —	20 23	1.5–6 mm diam. 0.2–1.5 mm diam.
	Typical Cold Drawn Tempers	45 55	— —	3 —	100 mm —	— —	— —	26 28	0.2–1.5 mm diam. ,,

(a) It will be noted that tables 5.1.1, 5.1.2 and 5.1.3, giving typical tensile properties and hardness values in Metric, English and American units, respectively, are not directly comparable. This is because the properties quoted reflect to some extent the metalworking techniques, specification practices, and testing procedures in the countries concerned, and in view of the different sizes of products referred to in these tables. Individual manufacturers of semi-fabricated products can, however, normally meet the requirements of any national standard.

(b) It is possible to obtain sizes outside the ranges given in this column, but information on their mechanical properties should be obtained from the metal manufacturers.

5.2 MECHANICAL PROPERTIES AT LOW TEMPERATURE

5.2.1 Tensile Properties

Form	Temper	Testing Temperature		Tensile Strength			Proof Stress 0.2% offset kg/mm²
		°C	°F	kg/mm²	ton/in²	psi	
Rod[1](a)	Annealed (grain size 0.023 mm)	−195	−319	38	24	**54 000**	9.60 [b]

[a] These values were determined on material just outside the composition range of the alloy and are presented for guidance only, since no other information is available.

[b] This value was originally reported in psi; in this table it is given in kg/mm² to 3 significant figures.

N.B. :—Original values are printed in **bold type**; other values are converted.
—Data not available:
Proof stress, 0.1% offset
Yield strength, 0.5% extension under load
Elongation
Reduction of area
Impact strength.

5.3 MECHANICAL PROPERTIES AT ELEVATED TEMPERATURE

5.3.1 Short-Time Tensile Properties

Form	Temper	Testing Temperature		Tensile Strength			Proof Stress		Elongation % on $5.65\sqrt{S_o}$
		°C	°F	kg/mm²	ton/in²	psi	0.2% offset kg/mm²	0.1% offset ton/in²	
Rod[2] (a) 10.5 mm diam. 0.41 in. diam.	Cold Worked 51%	20	68	**37.0**	23.5	52 500	**35.4**	**20.3**[b]	**19.2**
		200	392	**31.6**	20	45 000	**30.0**	**17.1**[b]	**17.4**
		300	572	**27.3**	17.5	39 000	**25.0**	**14.6**[b]	**13.0**
Rod[3] 12.7 mm diam. 0.5 in. diam.	Annealed	25	77	23.5	15	**33 500**	**4.85**[c]	—	—
		300	572	16.5	10.5	**23 500**	**3.71**[c]	—	—
		500	932	9.5	6	**13 380**	**3.16**[c]	—	—

[a] These values were determined on material just outside the composition range of the alloy and are presented for guidance only, since no other information is available.

[b] This value was originally reported in kg/mm²; in this table it is given in ton/in² to 3 significant figures.

[c] This value was originally reported in psi; in this table it is given in kg/mm² to 3 significant figures.

N.B. :—Original values are printed in **bold type**; other values are converted.
—The 0.5% extension under load yield strength values are not available.

5.3.2 Creep Properties

5.3.2.1 Original Creep Data

Form	Temper	Testing Temperature		Stress			Duration h	Total Extension %[(a)]
		°C	°F	kg/mm²	ton/in²	psi		
Rod[(2)(b)] **10.5 mm diam. 0.41 in. diam.**	Cold Worked 51%	200	392	**10.0**	6.3	14 200	**3 305**	**0.123**
				12.0	7.6	17 100	**1 995**	**0.21**
				14.0	8.9	19 900	**1 989**	**0.38**
				14.3	9.1	20 300	**2 011**	**0.51**

(a) Total creep; does not include the initial elastic extension.

(b) These values were determined on material just outside the composition range of the alloy and are presented for guidance only, since no other information is available.

N.B.:—Original values are printed in **bold type**; other values are converted.

—Data not available:
Intercept,
Minimum creep rate.

5.3.2.2 Stress for Designated Extension

Form	Temper	Testing Temperature		Stress for Designated Extension											
		°C	°F	0.1% in 1 000 h			0.2% in 1 000 h			0.1% in 2 000 h			0.2% in 2 000 h		
				kg/mm²	ton/in²	psi	kg/mm²	ton/in²	psi	kg/mm²	ton/in²	psi	kg/mm²	ton/in²	psi
Rod[(2)(a)] **10.5 mm diam. 0.41 in. diam.**	Cold Worked 51%	200	392	**10.0**	6.3	14 200	**12.8**	8.1	18 200	**9.3**	5.9	13 200	**11.9**	7.5	16 900

(a) These values were determined on material just outside the composition range of the alloy and are presented for guidance only, since no other information is available.

N.B.: Original values are printed in **bold type**; other values are converted.

5.4 FATIGUE PROPERTIES

5.4.1 Fatigue Strength at Room Temperature

Data has recently been published in the following paper:

■ France, W.D., Trout, D.E. and Mulholland, J.A. Fatigue Characteristics of Five Copper-Base Strip Alloys Commonly Used for Spring Applications. J. Materials, Vol. 4 (1969), No. 3, Sept., pp. 633–646.

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(1) Roberson, J.A. and Grosskreutz, J.C. Fatigue of Copper-Zinc Alloys at 100 K. Acta Metall., Vol. 11 (1963) July, pp. 795–798.

(2) Dies, K. and Jung-König, W. Zeitstandverhalten einiger technischer Kupferlegierungen in der Wärme. Metall, Vol. 16 (1962) No. 11, pp. 1097–1102.

(3) Crowe, C.H. Properties of Some Copper Alloys at Elevated Temperatures. ASTM Bull. No. 250, (1960) Dec., pp. 30–31.