Cu Zn9 Pb2

Common name: Leaded Commercial "Bronze"

A copper–zinc–lead alloy with an alpha phase structure containing a dispersion of fine lead particles. It is generally supplied as extruded rod or sections. The alloy has good machining properties with relatively good electrical conductivity and is mainly used for electrical components requiring extensive machining operations.

COMPOSITION (weight %)

Cu	87.5–90.5
Pb	1.3–2.5
Zn	rem.

1 SOME TYPICAL USES

Electrical
Screws and threaded machine parts for electrical devices; male and female connectors for computer and other electrical circuits.

2 PHYSICAL PROPERTIES

		Metric Units	English Units
2.1	Density at 20 °C *68 °F*	8.8 g/cm³	0.320 lb/in³
2.2	Melting range	1 010–1 040 °C	1 850–1 905 °F
2.3	Coefficient of thermal expansion (linear) at:		
	20 to 100 °C *68 to 212 °F*	0.000 018 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: 20 °C *68 °F*	0.43 cal cm/cm² s °C	104 Btu ft/ft² h °F
2.6	Electrical conductivity (volume) at: 20 °C *68 °F* (annealed)	24 m/ohm mm²	42% IACS
2.7	Electrical resistivity (volume) at: 20 °C *68 °F* (annealed)	0.041 ohm mm²/m 4.1 microhm cm	25 ohms (circ mil/ft) 1.6 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*	0.001 8 per °C (42% IACS)	0.001 0 per °F (42% IACS)
2.9	Modulus of elasticity (tension) at 20 °C *68 °F* (annealed or cold worked)	11 900 kg/mm²	16 900 000 lb/in²
2.10	Modulus of rigidity (torsion) at 20 °C *68 °F* (annealed or cold worked)	4 400 kg/mm²	6 300 000 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.

INDEX NUMBERS RELATE TO LITERATURE REFERENCES (see page 6); INDEX LETTERS RELATE TO FOOTNOTES AT END OF TABLE

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Distributed by
Copper Development Association
55, South Audley Street—London WIY 6BJ

DATA SHEET No. E 1
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1970 Edition

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	1 120–1 170 °C	2 050–2 140 °F
3.2 Annealing temperature range	425– 600 °C	795–1 110 °F
Stress relieving temperature range	200– 320 °C	390– 610 °F
3.3 Hot working temperature range	775– 850 °C	1 425–1 560 °F
3.4 Hot formability	Limited	
3.5 Cold formability	Good	
3.6 Cold reduction between anneals	75% max.	
3.7 Machinability:	See General Data Sheet No. 2	
Machinability rating (free-cutting brass = 100)	80	
3.8 Joining methods:	See General Data Sheet No. 3.5	
Soldering	Excellent	
Brazing	Good	
Oxy-acetylene welding	Not recommended	
Carbon-arc welding	Not recommended	
Gas-shielded arc welding	Not recommended	
Coated metal-arc welding	Not recommended	
Resistance welding: spot and seam	Not recommended	
butt	Fair	

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 American practice, see table 5.1.3.

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		
Rod	Annealed	27	7	45	$5.65\sqrt{S_o}$	55	58	20	—
	Typical Cold Worked Tempers	33	24	28	$5.65\sqrt{S_o}$	85	89	23	6–40 mm diam. or equivalent area
		40	35	12	$5.65\sqrt{S_o}$	105	110	26	6–12 mm diam. or equivalent area

(a) It will be noted that tables 5.1.1 and 5.1.3, giving typical tensile properties and hardness values in Metric 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.

5.1.2 Typical Tensile Properties and Hardness Values—English Units

Tensile properties and hardness values in English units are omitted from this data sheet, since alloys within the composition range concerned are not normally produced by British manufacturers.

5.2 MECHANICAL PROPERTIES AT LOW TEMPERATURE

5.2.1 Tensile Properties—Impact Properties

At the date of publication of this sheet, no data relating to this material have been traced.

5.3 MECHANICAL PROPERTIES AT ELEVATED TEMPERATURE

5.3.1 Short-Time Tensile Properties—Impact Properties.

At the date of publication of this sheet, no data relating to this material have been traced.

5.3.2 Creep Properties

At the date of publication of this sheet, no data relating to this material have been traced.

5.4 FATIGUE PROPERTIES

5.4.1 Fatigue Strength at Room Temperature

Form	Temper	Number of Cycles $\times 10^6$	Metric Units kg/mm²		English Units ton/in²		American Units psi	
			Tensile Strength	Fatigue Strength	Tensile Strength	Fatigue Strength	Tensile Strength	Fatigue Strength
Rod [1] [a] **12.7 mm diam. 0.5 in. diam.**	Cold Worked 30%	300	38.5	16.5 [b]	24.5	10.5 [b]	**54 900**	**23 500** [b]
Rod [2] **16 mm diam. 0.625 in. diam.**	Cold Worked 17%	100	31.5	14 [b]	20	9 [b]	**45 000**	**20 000** [b]

[a] Alloy containing Cu 85.16%, Zn 13.0%, Pb 1.82% (i.e. just outside composition range of Cu Zn9 Pb2).

[b] Rotating-beam test.

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

REFERENCES

MECHANICAL PROPERTIES (SECTION 5)

[1] Anderson, A.R., Swan, E.F. and Palmer, E.W. Fatigue Tests on Some Additional Copper Alloys. Proc. ASTM, Vol. 46 (1946), pp. 678–692.

[2] Burghoff, H.L. and Blank, A.I. Fatigue Characteristics of Some Copper Alloys. Proc. ASTM, Vol. 47 (1947), pp. 695–712.