

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/cm ³	0.320 lb/in ³
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/cm ² s °C	104 Btu ft/ft ² h °F
2.6 Electrical conductivity (volume) at:		
20 °C 68 °F (annealed)	24 m/ohm mm ²	42% IACS
2.7 Electrical resistivity (volume) at:		
20 °C 68 °F (annealed)	0.041 ohm mm ² /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)	0.001 8 per °C (42% IACS)	0.001 0 per °F (42% IACS)
applicable over range from 0 to 100 °C 32 to 212 °F		
2.9 Modulus of elasticity (tension) at 20 °C (annealed or cold worked) 68 °F	11 900 kg/mm ²	16 900 000 lb/in ²
2.10 Modulus of rigidity (torsion) at 20 °C (annealed or cold worked) 68 °F	4 400 kg/mm ²	6 300 000 lb/in ²

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

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

**4 NATIONAL SPECIFICATIONS FOR MANUFACTURED FORMS
and ISO Recommendation**

Country	Designation of Standards	Designation of Material in Standards	Specification for Chemical Composition ^(a)	Plate Sheet Strip	Rod	Wire	Tube	Sections / Shapes	Forgings
Australia	SAA	—	—	—	—	—	—	—	—
Belgium	NBN	—	—	—	—	—	—	—	—
Canada	CSA	HC.ZP92 (or 314)	—	—	HC.5.3	—	—	HC.5.3	—
Chile	INDITECNOR	Cu Zn9 Pb2	247 n./68	—	—	—	—	—	—
France	NF	—	—	—	—	—	—	—	—
Germany	DIN	—	—	—	—	—	—	—	—
India	IS	—	—	—	—	—	—	—	—
Italy	UNI	—	—	—	—	—	—	—	—
Japan	JIS	—	—	—	—	—	—	—	—
Netherlands . .	N or NEN ^(b)	—	—	—	—	—	—	—	—
South Africa . .	SABS	—	—	—	—	—	—	—	—
Spain	UNE	—	—	—	—	—	—	—	—
Sweden	SIS	—	—	—	—	—	—	—	—
Switzerland . .	VSM	—	—	—	—	—	—	—	—
United Kingdom	BS	—	—	—	—	—	—	—	—
United States ^(c)	ASTM	No.314	—	B140	B140	—	—	B140	—
International Organization for Standardization	ISO	—	—	—	—	—	—	—	—

(a) Applicable when the chemical composition is not given in the specifications for wrought forms.
(b) Older specifications bear prefix N; for new specifications the NEN prefix is used.
(c) In the United States, bar is covered under the Plate-Sheet-Strip column.

5 MECHANICAL PROPERTIES

5.1 Mechanical properties at room temperature

Tensile properties	see tables 5.1.1/2/3
Hardness	“ “ 5.1.1/2/3
Shear strength	“ “ 5.1.1/2/3
Modulus of elasticity (tension)	see 2.9
Modulus of rigidity (torsion)	see 2.10

5.2 Mechanical properties at low temperature

Tensile properties	no data traced
Impact properties	“ “ “

5.3 Mechanical properties at elevated temperature

Short-time tensile properties	no data traced
Impact properties	“ “ “
Creep properties	“ “ “

5.4 Fatigue properties

Fatigue strength at room temperature	see table 5.4.1
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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/mm ²	Proof Stress 0.2% offset kg/mm ²	Elongation		Hardness		Shear Strength kg/mm ²	Typical Size Related to Properties Shown ^(b)
				%	gauge length	Brinell	Vickers		
Rod	Annealed	27	7	45	$5.65\sqrt{S_0}$	55	58	20	—
	Typical Cold Worked Tempers	33	24	28	$5.65\sqrt{S_0}$	85	89	23	6–40 mm diam. or equivalent area
		40	35	12	$5.65\sqrt{S_0}$	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.

5.1.3 Typical Tensile Properties and Hardness Values—American Units

This table is based on American practice and the temper designations shown are those referred to in ASTM and other American Standards. For practice in European countries, see table 5.1.1.

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 psi	Yield Strength 0.5% extension under load psi	Elongation		Rockwell Hardness			Shear Strength psi	Typical Size Related to Properties Shown ^(a)
				%	gauge length	F	B	30 T		
Flat Products (Bar)	Annealed	37 000	12 000	45	2 in.	55	—	—	24 000	—
	Cold Worked Medium Hard Drawn	55 000	50 000	12	2 in.	61	—	—	31 000	0.250 in. thick
Rod	Soft	37 000	12 000	45	2 in.	55	—	—	24 000	1.0 in. diam.
	Cold Worked Half Hard (37%)	60 000	55 000	10	2 in.	65	—	—	32 000	0.250 in. diam.
	Half Hard (25%)	55 000	50 000	14	2 in.	61	—	—	31 000	0.50 in. diam.
	Half Hard (20%)	52 000	45 000	18	2 in.	58	—	—	30 000	1.0 in. diam.
Shapes	Annealed-Soft ^(b)	37 000	12 000	45	2 in.	55	—	—	24 000	—
	Cold Worked Half Hard (37%)	60 000	55 000	10	2 in.	65	—	—	32 000	0.250 in. thick
	Half Hard (25%)	55 000	50 000	14	2 in.	61	—	—	31 000	0.50 in. thick

^(a) It is possible to obtain sizes different from those given in this column, but information on their mechanical properties should be obtained from the metal manufacturers.

^(b) The mechanical properties will be largely dependent upon the size and cross-sectional area or complexity of the product.

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 × 10 ⁶	Metric Units kg/mm ²		English Units ton/in ²		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.