UDC 669.35'5'4

Cu Zn36 Pb2

Common names: Clock Brass
Engraving Brass
High-Leaded Brass—Riveting Brass

A copper–zinc–lead alloy with a duplex alpha-plus-beta phase structure containing a dispersion of fine lead particles. The alloy, which is fairly readily cold formed and easily machined, is typically used in the production of headed components and for clock manufacture.

COMPOSITION (weight %)

Cu	61.0–64.0
Pb	1.0– 2.0
Zn	rem.

1 SOME TYPICAL USES

Mechanical

Parts requiring good machinability with limited cold forming; nuts, rivets, screws and other headed components; tyre valves and nipples; instrument parts and end plates; clock and watch components; key blanks.

Electrical

Sparking plug and battery terminals.

Miscellaneous

Dials and other mechanically engraved work; printers' matrices.

2 PHYSICAL PROPERTIES

		Metric Units	English Units
2.1	Density at 20 °C *68 °F*	8.5 g/cm³	0.305 lb/in³
2.2	Melting range	885–910 °C	1 625–1 670 °F
2.3	Coefficient of thermal expansion (linear) at:		
	20 to 100 °C *68 to 212 °F*	0.000 019 per °C	0.000 011 per °F
	20 to 300 °C *68 to 572 °F*	0.000 020 „ „	0.000 011 „ „
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*	0.28 cal cm/cm² s °C	68 Btu ft/ft² h °F
2.6	Electrical conductivity (volume) at:		
	20 °C *68 °F* (annealed)	15 m/ohm mm²	26% IACS
2.7	Electrical resistivity (volume) at:		
	20 °C *68 °F* (annealed)	0.066 ohm mm²/m 6.6 microhm cm	40 ohms (circ mil/ft) 2.6 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 5 per °C (26% IACS)	0.000 8 per °F (26% IACS)
2.9	Modulus of elasticity (tension) at 20 °C *68 °F* (annealed or cold worked)	10 200 kg/mm²	14 500 000 lb/in²
2.10	Modulus of rigidity (torsion) at 20 °C *68 °F* (annealed or cold worked)	3 800 kg/mm²	5 400 000 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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DATA SHEET No. E 3
Cu Zn36 Pb2

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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	1 020–1 070 °C	1 870–1 960 °F
3.2 Annealing temperature range	450– 650 °C	840–1 200 °F
Stress relieving temperature range	250– 350 °C	480– 660 °F
3.3 Hot working temperature range	700– 800 °C	1 290–1 470 °F
3.4 Hot formability	Fair	
3.5 Cold formability	Fair	
3.6 Cold reduction between anneals	50% max.	
3.7 Machinability:	See General Data Sheet No. 2	
Machinability rating (free-cutting brass = 100)	75	
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 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	34	15	45	$5.65\sqrt{S_o}$	70	74	26	—
	Typical Cold Worked Tempers	42	30	28	$5.65\sqrt{S_o}$	105	110	30	1–10 mm thick
		50	45	10	$5.65\sqrt{S_o}$	125	130	35	1–4 mm thick
Rod	Annealed	34	15	45	$5.65\sqrt{S_o}$	70	74	26	—
	Hot Worked	36	20	35	$5.65\sqrt{S_o}$	75	79	27	10–60 mm diam. or equivalent area
	Typical Cold Worked Tempers	40	30	30	$5.65\sqrt{S_o}$	100	105	28	6–40 mm diam. or equivalent area
		50	46	12	$5.65\sqrt{S_o}$	125	130	35	6–12 mm diam. or equivalent area
Wire	Annealed	38	—	35	100 mm	—	—	29	1.5–6 mm diam.
	Typical Cold Drawn Tempers	48	—	15	100 mm	—	—	34	1.5–6 mm diam.
		70	—	2	100 mm	—	—	40	0.5–1.5 mm diam.
Tube	Annealed	34	15	45	$5.65\sqrt{S_o}$	70	74	26	—
	Typical Cold Drawn Tempers	40	27	30	$5.65\sqrt{S_o}$	100	105	28	over 3 mm wall
		48	40	12	$5.65\sqrt{S_o}$	125	130	34	up to 3 mm wall

(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.

5.1.2 Typical Tensile Properties and Hardness Values—English Units

This table is based on British practice. For other European and American practices, see tables 5.1.1 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[a]	Tensile Strength ton/in²	Proof Stress 0.1% offset ton/in²	Elongation %	Elongation gauge length	Vickers Hardness	Shear Strength ton/in²	Typical Size Related to Properties Shown[b]
Strip	Annealed	22	8	50	2 in.	75	17	—
	Cold Worked							
	Half Hard	26	18	25	2 in.	125	18	0.01–0.20 in. thick
	Hard	31	25	12	2 in.	155	20	0.01–0.125 in. thick
	Extra Hard	35	30	7	2 in.	175	22	,,
Rod	Annealed	22	7	45	$5.65\sqrt{S_o}$	80	17	—
	Cold Worked							
	As-Manufactured	24	10	40	$5.65\sqrt{S_o}$	100	17	1-2 in. diam. or equivalent area
		26	14	35	$5.65\sqrt{S_o}$	120	18	0.375-1 in. diam. or equiv. area
		28	18	25	$5.65\sqrt{S_o}$	140	20	0.125-0.375 in. diam. or equiv. area
Wire	Annealed	22	—	50	2 in.	—	17	0.06–0.25 in. diam.
	Cold Drawn							
	Half Hard	26	—	25	2 in.	—	18	0.125–0.25 in. diam.
	Hard	32	—	—	—	—	21	,,
	Half Hard	27	—	20	2 in.	—	19	0.06–0.125 in. diam.
	Hard	33	—	—	—	—	21	,,
Tube[c]	Annealed	22	—	—	—	80	17	—
	Cold Drawn or Temper Annealed							
	Temper Annealed	26	—	—	—	120	18	1–2.5 in. O.D., 0.12–0.25 in. wall
	As-Drawn	27	—	—	—	140	19	,,
	Temper Annealed	29	—	—	—	125	20	0.3–1 in. O.D., 0.04–0.12 in. wall
	As-Drawn	30	—	—	—	150	20	,,

(a) The recognised temper designations used in the relevant or nearest British Standards are also given, to clarify the cold-worked tempers shown.

(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.

(c) Intermediate tempers may be obtained by temper annealing. Drawn tubes are usually stress relieved after the final draw.

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 British and other European countries' practices, see tables 5.1.2 and 5.1.1, 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 psi	Yield Strength 0.5% extension under load psi	Elongation %	Elongation gauge length	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30 T	Shear Strength psi	Typical Size Related to Properties Shown[a]
First Products (Sheet, Strip and Bar)	Annealed (grain size 0.035 mm)	49 000	17 000	50	2 in.	68	—	31	30 000	0.040 in. thick
	Cold Worked									
	Quarter Hard	54 000	40 000	35	2 in.	—	55	54	39 000	0.040 in. thick
	Half Hard	61 000	50 000	20	2 in.	—	70	65	43 000	,,
	Hard	74 000	60 000	7	2 in.	—	80	69	48 000	,,
Rod	Annealed	48 000	17 000	53	2 in.	66	—	—	30 000	1.0 in. diam.
	Cold Worked									
	Half Hard (20%)	58 000	45 000	25	2 in.	—	75	—	34 000	1.0 in. diam.

(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.

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
Strip[1][a] 0.8 mm 0.032 in.	Annealed (grain size 0.035 mm)	100	34.5	10.5[b]	22	6.5[b]	**49 000**	**15 000[b]**
	Cold Worked 21%	100	45.5	11[b]	29	7[b]	**64 500**	**16 000[b]**
	37%	100	53	13.5[b]	33.5	8.5[b]	**75 500**	**19 000[b]**
Rod[2] 13.5 mm diam. 0.531 in. diam.	Annealed (grain size 0.035 mm)	100	34.5	10[c]	22	6[c]	**49 200**	**14 000[c]**
	Cold Worked 28%	100	49.5	19.5[c]	31.5	12.5[c]	**70 600**	**27 500[c]**

[a] Alloy containing Cu 64.09%, Pb 2.03%, Zn remainder (i.e. just outside composition range of Cu Zn36 Pb2).

[b] Reversed-bending test.

[c] Rotating-beam test.

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

REFERENCES

MECHANICAL PROPERTIES (SECTION 5)

(1) Burghoff, H.L. and Blank, A.I. Fatigue Properties of Some Coppers and Copper Alloys in Strip Form. Proc. ASTM, Vol. 48 (1948), pp.709–736.

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