UDC 669.35'5

Cu Zn15

Common names: 85/15 Brass
85/15 Gilding Metal
Red Brass

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. Due to this combination of properties and its attractive colour, the alloy is used for decorative purposes as well as for a wide variety of drawn and formed parts.

COMPOSITION (weight %)

Cu	84.0–86.0
Zn	rem.

1 SOME TYPICAL USES

Architectural
Trim, weatherstrip, cold-formed angles and channels.

Chemical
Flexible hose and wide range of process piping.

Decorative
Badges, cosmetic compacts, costume jewellery, instrument and clock dials, etched articles, lipstick containers and engraved nameplates.

Hardware
Eyelets and fasteners.

Mechanical
Miscellaneous components required to be brazed; numerous drawn and formed parts; bellows; flexible hose; slide (zip) fasteners.

Plumbing
Water service lines and traps.

2 PHYSICAL PROPERTIES

		Metric Units	English Units
2.1	Density at 20 °C *68 °F*	8.75 g/cm³	0.315 lb/in³
2.2	Melting range	1 000—1 025 °C	1 830–1 875 °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*	0.000 019 ,, ,,	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*	0.38 cal cm/cm² s °C	92 Btu ft/ft² h °F
	200 °C *392 °F*	0.44 ,,	106 ,,
2.6	Electrical conductivity (volume) at:		
	—196 °C *—321 °F* (annealed)	31 m/ohm mm²	54 % IACS
	20 °C *68 °F* (,,)	21 ,,	37 ,, ,,
	200 °C *392 °F* (,,)	16 ,,	27 ,, ,,
	—196 °C *—321 °F* (fully cold worked)	27 ,,	47 ,, ,,
	20 °C *68 °F* (,, ,, ,,)	19 ,,	32 ,, ,,

continued overleaf

INDEX NUMBERS RELATE TO LITERATURE REFERENCES (see page 12); INDEX LETTERS RELATE TO FOOTNOTES AT END OF TABLE

Prepared by
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DATA SHEET No. D 3

1970 Edition

2 PHYSICAL PROPERTIES (continued)	Metric Units	English Units
2.7 Electrical resistivity (volume) at:		
—196 °C —*321 °F* (annealed)	0.032 ohm mm²/m 3.2 microhm cm	19 ohms (circ mil/ft) 1.3 microhm in
20 °C *68 °F* (,,)	0.047 ohm mm²/m 4.7 microhm cm	28 ohms (circ mil/ft) 1.8 microhm in
200 °C *392 °F* (,,)	0.064 ohm mm²/m 6.4 microhm cm	38 ohms (circ mil/ft) 2.5 microhm in
—196 °C —*321 °F* (fully cold worked)	0.037 ohm mm²/m 3.7 microhm cm	22 ohms (circ mil/ft) 1.5 microhm in
20 °C *68 °F* (,, ,, ,,)	0.054 ohm mm²/m 5.4 microhm cm	32 ohms (circ mil/ft) 2.1 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 6 per °C (37% IACS)	0.000 9 per °F (37% IACS)
20 °C *68 °F* (fully cold worked) applicable over range from 0 to 100 °C *32 to 212 °F*	0.001 4 ,, ,, (32% IACS)	0.000 8 ,, ,, (32% IACS)
2.9 Modulus of elasticity (tension) at 20 °C *68 °F*		
annealed	12 400 kg/mm²	17 600 000 lb/in²
cold worked	11 400–12 400 kg/mm²	16 200 000–17 600 000 lb/in²
2.10 Modulus of rigidity (torsion) at 20 °C *68 °F*		
annealed	4 550 kg/mm²	6 450 000 lb/in²
cold worked	4 300–4 550 kg/mm²	6 100 000–6 450 000 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	1 100–1 160 °C	2 010–2 120 °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	Fair	
3.5 Cold formability	Excellent	
3.6 Cold reduction between anneals	85% 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	Fair	
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)	31	13	40	50 mm	80	84	23	0.2–1.5 mm thick
	Typical Cold Worked Tempers	34	25	30	50 mm	85	89	24	0.2–3 mm thick
		38	30	22	50 mm	105	110	25	"
		48	42	10	50 mm	135	140	31	0.2–2 mm thick
Rod	Annealed	28	10	50	$5.65\sqrt{S_o}$	60	63	21	—
	Typical Cold Worked Tempers	36	28	28	$5.65\sqrt{S_o}$	90	95	25	6–40 mm diam. or equivalent area
		42	34	16	$5.65\sqrt{S_o}$	120	125	27	6–12 mm diam. or equivalent area
Wire	Annealed	30	—	35	100 mm	—	—	23	1.5–6 mm diam.
		32	—	32	100 mm	—	—	24	0.2–1.5 mm diam.
	Typical Cold Drawn Tempers	42	—	8	100 mm	—	—	27	1.5–6 mm diam.
		50	—	4	100 mm	—	—	28	1.5–3 mm diam.
		60	—	—	—	—	—	30	0.2–1.5 mm diam.
Tube	Annealed	28	11	50	$5.65\sqrt{S_o}$	60	63	21	—
	Typical Cold Drawn Tempers	36	28	25	$5.65\sqrt{S_o}$	95	100	25	10–50 mm O.D. over 2 mm wall
		44	38	12	$5.65\sqrt{S_o}$	125	130	29	up to 25 mm O.D. up to 2 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.

5.2 MECHANICAL PROPERTIES AT LOW TEMPERATURE

5.2.1 Tensile Properties—Impact Properties

Form	Temper	Testing Temperature		Tensile Strength			Proof Stress 0.2% offset kg/mm²	Elongation % on $4.52\sqrt{S_o}$	Reduction of Area %	Impact Strength	
		°C	°F	kg/mm²	ton/in²	psi				kg m/cm²	ft lb
Rod[1] **19 mm diam. 0.75 in. diam.**	Cold Worked 14%	22	72	28.5	18	**40 400**	**9.14**[a]	**48**	**74**	16.6[b]	**96**[b]
		- 78	-108	32.5	21	**46 500**	**9.84**[a]	**63**	**79**	14.2[b]	**82**[b]
		-197	-323	43.5	27.5	**62 000**	**11.5**[a]	**83**	**77**	13.5[b]	**78**[b]
		-253	-423	55.5	35.5	**79 200**	**14.7**[a]	**80**	**75**	13.1[b]	**76**[b]
		-269	-452	50	31.5	**71 000**	**12.9**[a]	**82**	**71**	—	—
Rod[2]	Annealed (grain size 0.020 mm)	-195	-319	46.5	29.5	**65 800**	**13.7**[a]	—	—	—	—
Rod[3]	Annealed	10	50	—	—	—	—	—	—	14.4[c]	**52**[c]
		- 18	0	—	—	—	—	—	—	14.7[c]	**53**[c]
		- 29	- 20	—	—	—	—	—	—	15.2[c]	**55**[c]
		- 51	- 60	—	—	—	—	—	—	15.5[c]	**56**[c]
		- 79	-110	—	—	—	—	—	—	15.5[c]	**56**[c]
		-118	-180	—	—	—	—	—	—	16.6[c]	**60**[c]

(a) This value was originally reported in psi; in this table it is given in kg/mm² to 3 significant figures.

(b) Charpy test, 10 × 10 × 55 mm specimen, 45° V-notch, 2 mm deep; cross-sectional area at the notch 0.8 cm².

(c) Charpy specimen, keyhole notch; cross-sectional area at the notch 0.5 cm².

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

—All converted values for impact strength are to be taken as indicative only; the impact energy has been converted from ft lb into kg m/cm² taking into account the actual cross-sectional area of the specimen at the notch.

—Data not available:
Proof stress, 0.1% offset,
Yield strength, 0.5% extension under load.

5.3 MECHANICAL PROPERTIES AT ELEVATED TEMPERATURE

5.3.1 Short-Time Tensile Properties

Form	Temper	Testing Temperature		Tensile Strength			Proof Stress			Elongation % on 2 in.
		°C	°F	kg/mm²	ton/in²	psi	0.2% offset kg/mm²	0.1% offset ton/in²	Yield Strength 0.5% ext. under load psi	
Plate[4]	Annealed	20	68	30	**19.2**	43 000	**8.66**[a]	**5.1**	—	**50**
		66	150	28	**17.7**	39 500	**8.19**[a]	**4.9**	—	**51**
		121	250	26.5	**16.8**	37 500	**8.50**[a]	**5.1**	—	**45**
		177	350	25.5	**16.1**	36 000	**7.87**[a]	**4.8**	—	**45**
		232	450	24.5	**15.4**	34 500	**7.87**[a]	**4.8**	—	**36**
Rod[5] **3.2 mm diam 0.125 in. diam.**	Annealed (grain size 0.060 mm)	24	75	29	18.5	**41 000**	—	—	**10 000**	**47.0**
		149	300	—	—	—	—	—	**9 700**	—
		204	400	—	—	—	—	—	**9 500**	—
		260	500	—	—	—	—	—	**8 500**	—
	Cold Worked 37%	24	75	47.5	30	**67 500**	—	—	**59 000**	**10.5**
		204	400	—	—	—	—	—	**47 000**	—
	Cold Worked 84%	24	75	68	43	**96 500**	—	—	**67 000**	**7.0**
		204	400	—	—	—	—	—	**52 000**	—
Rod[6] **12.7 mm diam. 0.5 in. diam.**	Annealed	25	77	28	17.5	**39 500**	**8.79**[b]	—	—	—
		300	572	21.5	13.5	**30 600**	**7.56**[b]	—	—	—
		500	932	10	6.5	**14 500**	**5.28**[b]	—	—	—
Rod[7] **19 mm diam. 0.75 in. diam.**	Hot Worked (grain size 0.030 mm)	24	75	31	19.5	**43 800**	—	—	—	**47.0**
		204	400	27	17	**38 525**	—	—	—	**35.5**
		316	600	21	13.5	**29 950**	—	—	—	—
		427	800	14	9	**20 250**	—	—	—	**4.2**
Rod[8]	Cold Worked 37%	200	392	41.5	26	**58 800**	—	—	**54 800**	**7.3**
		300	572	36.5	23	**51 800**	—	—	**49 000**	**4.5**
		400	752	22	14	**31 400**	—	—	**24 500**	**17.0**
		500	932	11	7	**15 800**	—	—	**10 500**	**25.7**
		600	1 112	6.5	4	**9 200**	—	—	**7 600**	**27.7**
		700	1 292	4	2.5	**5 600**	—	—	**4 700**	**62.0**
Tube[9]	Annealed	Room	Room	28	18	**40 000**	—	—	**12 000**	—
		66	150	28	18	**40 000**	—	—	**12 000**	—
		121	250	27.5	17.5	**39 000**	—	—	**12 000**	—
		149	300	26.5	17	**38 000**	—	—	**12 000**	—
		177	350	26	16.5	**37 000**	—	—	**12 000**	—
		204	400	25.5	16	**36 000**	—	—	**12 000**	—
		232	450	24.5	15.5	**35 000**	—	—	**11 500**	—
		260	500	23	14.5	**33 000**	—	—	**11 000**	—

(a) This value was originally reported in ton/in²; in this table it is given in kg/mm² to 3 significant figures.
(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.

5.3.2 Creep Properties

5.3.2.1 Original Creep Data

Form	Temper	Testing Temperature		Stress			Duration h	Total Extension %[a]	Intercept %	Min. Creep Rate % per 1 000 h
		°C	°F	kg/mm²	ton/in²	psi				
Rod[5] 3.2 mm diam. 0.125 in. diam.	Annealed (grain size 0.060 mm)	149	300	3.2	2.0	**4 500**	**4 500**	**0.031**	**0.006**	**0.000 7**
				4.9	3.1	**6 960**	**5 100**	**0.087**	**0.024**	**0.002 9**
				6.9	4.4	**9 800**	**4 500**	**1.07**	**0.44**	**0.026**
		204	400	0.70	0.45	**1 000**	**4 400**	**0.022**	**0.008**	**0.000 8**
				1.4	0.92	**2 050**	**5 060**	**0.042**	**0.013**	**0.001 9**
				2.5	1.6	**3 500**	**5 100**	**0.092**	**0.040**	**0.003 3**
				3.5	2.3	**5 040**	**5 400**	**0.097**	**0.015**	**0.005 9**
				4.9	3.1	**6 940**	**6 600**	**0.482**	**0.187**	**0.034**
				6.3	4.0	**8 940**	**2 000**	**1.060**	**0.390**	**0.10**
				8.1	5.1	**11 500**	**4 130**	**3.620**	**0.750**	**0.283**
		260	500	0.60	0.38	**850**	**5 140**	**0.042**	**0.010**	**0.004 0**
				1.4	0.89	**2 000**	**5 000**	**0.091**	**0.026**	**0.008 0**
				2.5	1.6	**3 520**	**5 300**	**0.241**	**0.037**	**0.030**
				3.5	2.2	**4 980**	**5 000**	**0.507**	**0.083**	**0.073**
				4.2	2.7	**6 000**	**5 140**	**0.958**	**0.180**	**0.138**
				4.9	3.1	**6 950**	**1 600**	**1.100**	**0.510**	**0.32**
	Cold Worked 37%	149	300	3.5	2.3	**5 040**	**5 200**	**0.050**	**0.018**	**0.000 4**
				7.0	4.4	**9 900**	**4 800**	**0.110**	**0.037**	**0.002 4**
				9.2	5.8	**13 050**	**5 050**	**0.138**	**0.044**	**0.002 8**
				12.4	7.9	**17 650**	**5 100**	**0.227**	**0.083**	**0.006 7**
				16.8	10.6	**23 850**	**6 050**	**0.366**	**0.153**	**0.011**
				21.2	13.5	**30 200**	**4 800**	**0.628**	**0.220**	**0.043**
		204	400	3.5	2.2	**4 980**	**5 200**	**0.077**	**0.039**	**0.002 6**
				5.7	3.6	**8 100**	**5 400**	**0.135**	**0.054**	**0.006 9**
				8.3	5.3	**11 850**	**5 200**	**0.283**	**0.146**	**0.013**
				11.0	7.0	**15 650**	**4 420**	**0.422**	**0.151**	**0.041**
		260	500	0.37	0.23	**520**	**5 100**	**0.042**	**0.008**	**0.005 6**
				0.69	0.44	**980**	**10 370**	**0.179**	**0.055**	**0.011**
				2.1	1.4	**3 050**	**10 000**	**0.967**	**0.073**	**0.086**
				4.3	2.7	**6 050**	**4 800**	**1.114**	**−0.70**	**0.37[b]**
	Cold Worked 84%	149	300	7.0	4.4	**9 960**	**4 400**	**0.096**	**0.029**	**0.000 7**
				13.9	8.8	**19 800**	**5 100**	**0.197**	**0.054**	**0.002 6**
				27.9	17.7	**39 700**	**4 500**	**0.445**	**0.108**	**0.011**
				37.8	24.0	**53 800**	**5 100**	**0.860**	**0.250**	**0.033**
		204	400	0.73	0.46	**1 040**	**5 160**	**0.040**	**0.029**	**0.001 1**
				2.2	1.4	**3 190**	**5 000**	**0.163**	**0.061**	**0.017**
				3.8	2.4	**5 400**	**5 160**	**0.461**	**0.110**	**0.063**
				4.2	2.7	**6 040**	**5 000**	**0.505**	**0.120**	**0.069**
		260	500	0.42	0.27	**600**	**5 540**	**0.096**	**0.038**	**0.010**
				0.67	0.43	**960**	**5 300**	**0.270**	**0.080**	**0.034**
				1.4	0.87	**1 940**	**2 950**	**0.678**	**0.104**	**0.19**
				2.1	1.3	**2 990**	**3 650**	**2.715**	**−0.045**	**0.76[b]**

[a] Total extension = Initial extension + Total creep = Initial extension + Intercept + (Minimum creep rate × Duration).
[b] Accelerating creep rate.

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

5.3.2.2 Stress for Designated Creep Rate

Form	Temper	Testing Temperature		Stress for Designated Creep Rate								
				0.001% per 1 000 h			0.01% per 1 000 h			0.1% per 1 000 h		
		°C	°F	kg/mm²	ton/in²	psi	kg/mm²	ton/in²	psi	kg/mm²	ton/in²	psi
Rod[5] **3.2 mm diam. 0.125 in. diam.**	Annealed (grain size 0.060 mm)	149	300	3.7	2.3	**5 200**	6.0	3.8	**8 600**	> 7.0	> 4.5	> **10 000**
		204	400	0.88	0.56	**1 250**	3.9	2.5	**5 500**	6.3	4.0	**9 000**
		260	500	—	—	—	1.6	1.0	**2 250**	3.7	2.3	**5 200**
	Cold Worked 37%	149	300	5.5	3.5	**7 800**	15.5	9.8	**22 000**	> 21.0	> 13.4	> **30 000**
		204	400	2.0	1.3	**2 800**	7.0	4.5	**10 000**	13.1	8.3	**18 700**
		260	500	—	—	—	0.60	0.38	**850**	2.3	1.5	**3 300**
	Cold Worked 84%	149	300	8.4	5.5	**12 000**	26.0	16.5	**37 000**	> 38.7	> 24.6	> **55 000**
		204	400	0.70	0.44	**1 000**	1.8	1.2	**2 600**	4.8[a]	3.0[a]	**6 800**[a]
		260	500	—	—	—	0.42	0.27	**600**	1.0	0.65	**1 450**

[a] Extrapolated value.

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

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[10] **0.81 mm 0.032 in.**	Annealed (grain size 0.020 mm)	100	31	11.5[a]	19.5	7.5[a]	**44 000**	**16 500**[a]
	Annealed (grain size 0.025 mm)	100	29.5	10[a]	18.5	6.5[a]	**42 000**	**14 500**[a]
	Annealed (grain size 0.075 mm)	100	27.5	7.5[a]	17.5	4.5[a]	**39 000**	**10 500**[a]
	Annealed (grain size 0.090 mm)	100	27	7.5[a]	17	5[a]	**38 500**	**11 000**[a]
	Cold Worked 21 %[b]	100	39.5	16[a]	25	10[a]	**56 500**	**22 500**[a]
	Cold Worked 21 %[c]	100	35	10.5[a]	22.5	6.5[a]	**50 000**	**15 000**[a]
	Cold Worked 37 %[d]	100	48.5	15[a]	31	9.5[a]	**69 000**	**21 000**[a]
	Cold Worked 37 %[e]	100	45	13.5[a]	28.5	8.5[a]	**64 000**	**19 000**[a]
	Cold Worked 60 %[f]	100	55.5	17[a]	35.5	10.5[a]	**79 000**	**24 000**[a]
	Cold Worked 60 %[e]	100	55.5	16.5[a]	35.5	10.5[a]	**79 000**	**23 500**[a]
Strip[11] **1 mm 0.04 in.**	Cold Worked[g]	100	59	10.5[a]	37.5	6.5[a]	**84 000**	**15 000**[a]
Rod[12] **12.7 mm diam. 0.5 in. diam.**	Cold Worked 4 %	300	31.5	14[h]	20	9[h]	**44 700**	**20 000**[h]
Rod[13]	Cold Worked and Stress Relieved[i]	60	37.5	11[h]	23.5	7[h]	**53 000**	**16 000**[h]
	Cold Worked and Annealed[j]	100	28.5	11[h]	18	7[h]	**40 500**	**15 500**[h]

[a] Reversed-bending test. [b] Ready-to-finish grain size 0.020 mm. [c] Ready-to-finish grain size 0.060 mm. [d] Ready-to-finish grain size 0.030 mm. [e] Ready-to-finish grain size 0.070 mm. [f] Ready-to-finish grain size 0.025 mm. [g] Quoted as "spring" in original document, but amount of cold work not defined. [h] Rotating-beam test. [i] Stress relieved for 3 h at 232 °C (*450 °F*) [j] Annealed for 3 h at 482 °C (*900 °F*).

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