UDC 669.35'24'5

Cu Ni18 Zn20

Common names: 18% Nickel Silver
Nickel Silver 65-18

A copper-nickel-zinc alloy with an alpha phase structure. The alloy has good corrosion resistance to many organic products, waters and corrosive atmospheres. The material has good cold formability and spring properties and is widely used for telecommunications equipment in European practice; because of its attractive silver-blue-white colour, it is also widely used for decorative applications. The most commonly used wrought forms are sheet, strip, rod and wire.

COMPOSITION (weight %)

Cu	60.0–64.0
Ni	17.0–19.0
Mn	0– 0.7
Zn	rem.

1 SOME TYPICAL USES

Decorative
Holloware, flatware (spoons and forks), pressed, spun and deep-drawn articles usually silver plated; lighting fittings; medals and medallions; jewellery; architectural panels and trim (including marine service); "objets d'art".

Electrical
Relay and contact springs, wiper blades, cross-bar switches, control parts and uniselector components in telecommunications equipment; contacts, connectors, connector pins and terminals; resistance wire and strip for moderately elevated temperatures; lamp caps.

Mechanical
Springs and clips; rivets; bellows and pressure-sensitive devices.

Miscellaneous
Instrument and camera parts; etching stock, nameplates and dials; musical instruments; side wires of spectacle frames; slide fasteners; medical instruments; model construction.

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	1 060–1 110 °C	1 940–2 030 °F
2.3	Coefficient of thermal expansion (linear) at:		
	20 to 100 °C *68 to 212 °F*	0.000 015 per °C	0.000 008 per °F
	20 to 300 °C *68 to 572 °F*	0.000 016 „ „	0.000 009 „ „
2.4	Specific heat (thermal capacity) at:		
	20 °C *68 °F*	0.10 cal/g °C	0.10 Btu/lb °F
2.5	Thermal conductivity at:		
	20 °C *68 °F*	0.06 cal cm/cm² s °C	15 Btu ft/ft² h °F
	200 °C *392 °F*	0.07 „	17 „
2.6	Electrical conductivity (volume) at:		
	20 °C *68 °F* (annealed or cold worked)	3.5 m/ohm mm²	6% IACS
2.7	Electrical resistivity (volume) at:		
	20 °C *68 °F* (annealed or cold worked)	0.29 ohm mm²/m 29 microhm cm	173 ohms (circ mil/ft) 11 microhm in
2.8	Temperature coefficient of electrical resistance at:		
	20 °C *68 °F* (annealed or cold worked)	0.000 3 per °C (6% IACS)	0.000 2 per °F (6% IACS)
	applicable over range from 0 to 100 °C *32 to 212 °F*		
2.9	Modulus of elasticity (tension) at 20 °C *68 °F:*		
	annealed	13 300 kg/mm²	18 900 000 lb/in²
	cold worked	13 700 kg/mm²	19 500 000 lb/in²
2.10	Modulus of rigidity (torsion) at 20 °C *68 °F:*		
	annealed	4 900 kg/mm²	7 000 000 lb/in²
	cold worked	5 000 kg/mm²	7 200 000 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. The melting range covers the highest liquidus and lowest solidus temperatures over the composition range quoted.

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. L 4

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	1 175–1 250 °C	2 145–2 280 °F
3.2	Annealing temperature range	625– 775 °C	1 155–1 425 °F
	Stress relieving temperature range	250– 350 °C	480– 660 °F
3.3	Hot working temperature range	900– 975 °C	1 650–1 785 °F
3.4	Hot formability	Very limited	
3.5	Cold formability	Good	
3.6	Cold reduction between anneals	70% 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. 3.10	
	Soldering	Very good	
	Brazing	Excellent	
	Oxy-acetylene welding	Good	
	Carbon-arc welding	Not recommended	
	Gas-shielded arc welding	Fair	
	Coated metal-arc welding	Not recommended	
	Resistance welding: spot and seam	Good	
	butt	Good	

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	NS106	—	H77	—	—	—	—	—
Belgium	NBN	—	—	—	—	—	—	—	—
Canada	CSA	HC.ZN 1817 752	—	HC.4.4	—	—	—	—	—
Chile	NCh (INDITECNOR)	—	NCh 251 of. 68	—	—	—	—	—	—
France	NF	U-Z22 N18	—	A53-605	—	—	—	—	—
Germany	DIN	Cu Ni18 Zn20	17 663	1780 17 670	17 672	17 677 17 682	17 671	—	—
India	IS	NS18	—	2283	—	—	—	—	—
Italy	UNI	—	—	—	—	—	—	—	—
Japan	JIS	NSP 2 NSB 2 NSR 2 NSW 2	—	H3701	H3711	H3721	—	—	—
Netherlands	N or NEN [b]	Cu-Ni18 Zn20	NEN 6030	NEN 6033	—	—	—	—	—
South Africa	SABS	—	—	—	—	—	—	—	—
Spain	UNE	Cu Zn Ni18	—	37 103	—	—	—	—	—
Sweden	SIS	52 46 Cu Ni18 Zn20	—	14 52 46	—	—	—	—	—
Switzerland	VSM	Cu Ni18 Zn20	10 804	10 804	10 804	10 804	10 804	—	—
United Kingdom	BS	NS106	—	2870	—	2873	—	—	—
United States [c]	ASTM	No. 752	—	B 122 B 151	B 151	B 206	—	—	—
International Organization for Standardization	ISO	Cu Ni18 Zn20	R430	—	—	—	—	—	—

[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 and flat wire are 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)	,, 2.10

5.2 Mechanical properties at low temperature

Tensile properties	see table 5.2.1
Impact properties	no data

5.3 Mechanical properties at elevated temperature

Short-time tensile properties	see table 5.3.1
Impact properties	,, ,, 5.3.1
Creep properties	no data

5.4 Fatigue properties

Fatigue strength at room temperature	see table 5.4.1

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		
Sheet Strip	Annealed (grain size 0.035 mm)	42	19	45	50 mm	90	95	32	0.2–2 mm thick
	Annealed (grain size 0.015 mm)	45	22	40	50 mm	100	110	34	0.2–2 mm thick
	Typical Cold Worked Tempers	48	36	25	50 mm	125	130	33	0.5–2 mm thick
		54	46	15	50 mm	155	165	35	0.2–2 mm thick
		62	55	9	50 mm	185	195	37	0.1–1 mm thick
		70	67	3	50 mm	200	210	38	0.1–1 mm thick
Rod [c]	Annealed	41	17	43	$5.65\sqrt{S_o}$	85	90	31	5–25 mm diam. or equivalent area
	Typical Cold Worked Tempers	50	38	25	$5.65\sqrt{S_o}$	140	145	35	5–25 mm diam. or equivalent area
		60	55	10	$5.65\sqrt{S_o}$	175	185	36	5–15 mm diam. or equivalent area
Wire	Annealed	42	—	38	100 mm	—	—	32	0.5–3 mm diam.
	Typical Cold Drawn Tempers	58	—	9	100 mm	—	—	35	0.5–3 mm diam.
		70	—	2	100 mm	—	—	38	0.2–1 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, SI and 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.

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

5.1.2 Typical Tensile Properties and Hardness Values—SI and 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		Proof Stress 0.1% offset		Elongation		Vickers Hardness	Shear Strength		Typical Size Related to Properties Shown [b]
		hbar	ton/in²	hbar	ton/in²	%	gauge length		hbar	ton/in²	
Sheet Strip	Annealed										
	(grain size 0.030 mm)	42	27	17	11	40	50 mm (2 in.)	100	31	20	0.2–3 mm (0.008–0.12 in.) thick
	(grain size 0.015 mm)	45	29	23	15	35	50 mm (2 in.)	105	34	22	0.2–3 mm (0.008–0.12 in.) thick
	Cold Worked										
	Half Hard	51	33	37	24	12	50 mm (2 in.)	155	36	23	0.2–3 mm (0.008–0.12 in.) thick
	Hard	59	38	48	31	6	50 mm (2 in.)	180	39	25	0.2–3 mm (0.008–0.12 in.) thick
	Extra Hard	68	44	59	38	~2	50 mm (2 in.)	205	45	29	0.2–3 mm (0.008–0.12 in.) thick
Rod [c]	Annealed	40	26	15	10	40	$5.65\sqrt{S_o}$	95	29	19	—
	Typical Cold Worked Temper	54	35	42	27	8	$5.65\sqrt{S_o}$	165	37	24	4–12 mm (0.16–0.5 in.) thick or equivalent area
Wire	Annealed	42	27	—	—	35	100 mm (4 in.)	—	31	20	0.5–2.5 mm (0.02–0.10 in.) diam.
	Cold Drawn										
	Half Hard	63	41	—	—	<5	100 mm (4 in.)	—	—	—	0.5–2.5 mm (0.02–0.10 in.) diam.
	Hard	77	50	—	—	—	—	—	—	—	0.5–2.5 mm (0.02–0.10 in.) diam.

(a) The recognised temper designations used in the relevant British Standards are also given.

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

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		Rockwell Hardness			Shear Strength psi	Typical Size Related to Properties Shown [a]
				%	gauge length	F	B	30 T		
Flat Products (Sheet, Strip, Bar Flat Wire)	Annealed									
	(grain size 0.035 mm)	58 000	25 000	40	2 in.	85	40	—	44 000	0.040 in. thick
	(grain size 0.015 mm)	60 000	30 000	32	2 in.	90	55	—	45 000	0.040 in. thick
	Cold Worked									
	Quarter Hard	65 000	50 000	20	2 in.	—	73	65	43 000	0.040 in. thick
	Half Hard	74 000	62 000	8	2 in.	—	83	72	44 000	0.040 in. thick
	Hard	85 000	74 000	3	2 in.	—	87	75	51 000	0.040 in. thick
	Extra Hard	92 000	—	—	—	—	92	—	55 000	0.020 in. thick
	Spring	97 000	—	—	—	—	94	—	58 000	0.020 in. thick
Rod [b]	Annealed									
	(grain size 0.035 mm)	56 000	25 000	42	2 in.	—	40	—	42 000	0.50 in. diam.
	Cold Worked									
	Half Hard	70 000	60 000	20	2 in.	—	78	—	47 000	0.50 in. diam.
Wire	Annealed									
	(grain size 0.035 mm)	58 000	25 000	45	10 in.	—	—	—	44 000	0.080 in. diam.
	(grain size 0.015 mm)	60 000	30 000	35	10 in.	—	—	—	45 000	0.080 in. diam.
	Cold Worked									
	Quarter Hard	73 000	65 000	16	10 in.	—	—	—	47 000	0.080 in. diam.
	Half Hard	86 000	80 000	7	10 in.	—	—	—	55 000	0.080 in. diam.
	Hard	103 000	90 000	3	10 in.	—	—	—	61 000	0.080 in. diam.
Tube	Annealed	60 000	24 000	40	2 in.	—	45	—	45 000	1.0 in. O.D. × 0.065 in. wall
	Cold Worked									
	Hard Drawn	80 000	65 000	5	2 in.	—	88	—	52 000	1.0 in. O.D. × 0.065 in. wall

[a] It is possible to obtain sizes different from those given in this column, but information on their mechanical properties should be obtained from 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

Form	Temper	Testing Temperature		Tensile Strength			Yield Strength psi	Elongation % on 2 in.	Reduction of Area %
		°C	°F	kg/mm²	ton/in²	psi			
Rod [1]	Annealed	20	68	45.5	29	**64 900**	**29 500** [a]	**46.8**	**62.3**
		—183	—297	58.5	37	**83 100**	**38 200** [a]	**56.8**	**69.5**
	Cold Rolled	20	68	52	33	**73 800**	**69 300** [a]	**21.5**	**54.3**
		—183	—297	66	42	**93 700**	**80 500** [a]	**35.5**	**62.6**

(a) Quoted as yield point, but offset strain not defined.

N.B.: Original values are printed in **bold type**; other values are converted.
Data not available:
Proof stress, 0.1% and 0.2% offset and yield strength (0.5% extension under load).
Impact Strength.

5.3 MECHANICAL PROPERTIES AT ELEVATED TEMPERATURE

5.3.1 Short-Time Tensile Properties—Impact Properties

Form	Temper	Testing Temperature		Tensile Strength			Proof Stress 0.2% offset kg/mm²	Elongation		Reduction of Area %	Impact Strength [b]	
		°C	°F	kg/mm²	ton/in²	psi		%	gauge length		kg m/cm²	ft lb
Strip [2]	Cold Worked [a]	20	68	**71**	45	101 000	**65**	**5**	50 mm	—	—	—
		100	212	**70**	44.5	99 500	**65**	—	—	—	—	—
		200	392	**68**	43	96 500	**63**	—	—	—	—	—
Rod [3] **6 mm diam. 0.24 in. diam.**	Annealed	20	68	**38.0**	24	54 000	—	**40**	30 mm	**79**	**17.3**	93.8
		250	482	**37.5**	24	53 500	—	**38**	30 mm	**69**	**13.3**	72.1
		300	572	**37.0**	23.5	52 500	—	**38**	30 mm	**64**	**12.4**	67.2
		330	626	—	—	—	—	—	—	—	**12.3**	66.7
		340	644	**35.0**	22	50 000	—	**36**	30 mm	**65**	—	—
		380	716	—	—	—	—	—	—	—	**12.1**	65.6
		450	842	**29.0**	18.5	41 000	—	**50**	30 mm	**73**	—	—

(a) Quoted as "hard, 208 HV" in original document, but amount of cold work not defined.
(b) Charpy test, V notch; cross sectional area at the notch 0.75 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 kg m/cm² to ft lb taking into account the cross-sectional area of the specimen at the notch.
Data not available: Proof stress, 0.1% offset.
Yield Strength, 0.5% extension under load.

5.4 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 [4] **0.30–0.35 mm 0.012–0.014 in.**	Cold Rolled 50%	10	**68**	**19** [f]	43	12 [f]	96 500	27 000 [f]
Strip [5] **1 mm 0.04 in.**	Cold Worked [g] 37%	100	64.5	19.5 [h]	41	12.5 [h]	**92 000**	**28 000** [h]
	60.5%	100	70.5	22 [h]	44.5	14 [h]	**100 000**	**31 000** [h]
Rod [6] [d] **13 mm diam. 0.5 in. diam.**	Cold Worked 21% [c]	300	51.5	16	32.5	10.5	**72 900**	**23 000**
— [e] [7]	Cold Drawn	100 [a]	44	15.5 [b]	28	10 [b]	**62 400**	**22 000** [b]

(a) Estimated.
(b) Rotating-cantilever test.
(c) Ready-to-finish grain size 0.030 mm.
(d) Composition: Cu 64.64%; Zn 16.22%; Ni 18.90%,; Mn 0.21%; Fe 0.03%.
(e) Form not stated in original document but probably rod (Composition: Cu 65.30%, Ni 17.63%, Zn 17.15%, Fe 0.23%).
(f) Flexural-alternating test.
(g) Ready-to-finish grain size 0.015 mm.
(h) Reversed-bending test.

N.B.:— Original values are printed in **bold type**; other values are converted.
— Further data can be obtained from the following paper:
■ Weldon, B.A., Towers, J.A. and Patton, A.M. Nickel Silver as an Engineering Material. Metals & Materials, Vol. 4 (1970), pp. 299-303 (data for 1 mm strip, hardness 205 HV. deflected to maximum and returned to zero position).

REFERENCES

MECHANICAL PROPERTIES (SECTION 5)

(1) Strauss, J. Metals and Alloys for Industrial Applications Requiring Extreme Stability. Trans. ASST, Vol. 16, (1929), pp. 191-226.
(2) Weldon, B.A., Towers, J.A. and Patton, A.M. Nickel Silver as an Engineering Material. Metals & Materials, Vol. 4 (1970), pp. 299-303.
(3) Isler, P. and Form, W. The Mechanism of Fire-Cracking. J. Inst. Metals, Vol. 100 (1972), pp. 107-113.
(4) Kirchberg, K. Richtungsabhängigkeit der mechanischen Eigenschaften von Federwerkstoffen. Neue Hütte. Vol. 11, (1966), pp. 160-162.
(5) France, W.D. and Trout, D.E. Selecting Copper Alloys for Fatigue Applications. Metal Progress, Vol. 101 (1972), No. 6, pp. 69, 71-72.
(6) 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.
(7) McAdam, D.J., Jr. Fatigue and Corrosion-Fatigue of Spring Material. Trans. ASME, No. 51, (1929), pp. 45-58.

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