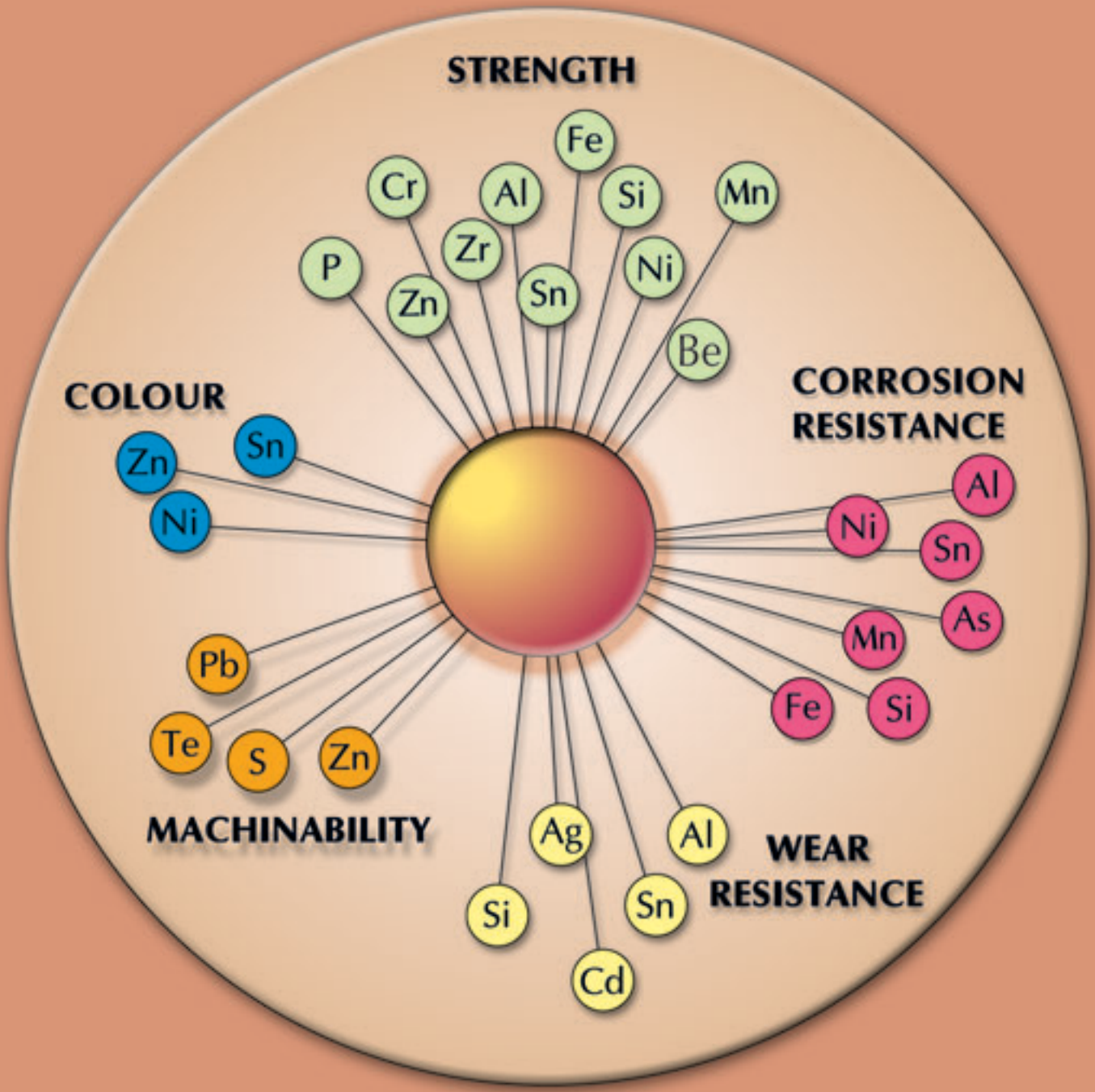
Copper and Copper Alloys

Compositions, Applications & Properties



Copper Development Association

Publication 120

Copper and Copper Alloys
Compositions, Applications and Properties

Copper Development Association
Publication No 120
April 1998, Revised and reprinted December 2004

MEMBERS, as at December 2004

BrazeTec

Codelco Services Ltd

Ecosea Ltd

IBP Conex

Mueller Europe Copper Tube & Fittings

Noranda Islandi ehf

Outokumpu Copper Metal Supplies Ltd

Rio Tinto London Ltd

Southern Peru Copper Corporation

The British Non-Ferrous Metals Federation

WMC Resources Ltd

Yorkshire Copper Tube Ltd

Yorkshire Fittings Ltd

COPPER DEVELOPMENT ASSOCIATION is a non-trading organisation sponsored by the copper producers and fabricators to encourage the use of copper and copper alloys and to promote their correct and efficient application. Its services, which include the provision of technical advice and information, are available to those interested in the utilisation of copper in all its aspects. The Association also provides a link between research and the user industries and maintains close contact with other copper development organisations throughout the world.

Acknowledgements
CDA is glad to acknowledge with thanks the compilation of the data for this publication by Eur Ing John Westlake and the helpful comments made on this revision by David Parker.

Disclaimer
Whilst this document has been prepared with care, we can give no warranty regarding the contents and shall not be liable for any direct, incidental or consequential damage arising out of its use. For complete information on any material the appropriate standard should be consulted.

Copper Development Association
5 Grovelands Business Centre
Boundary Way
Hemel Hempstead
Hertfordshire
HP2 7TE
Tel: +44 (0)1442 275700
Fax: +44 (0)1442 275716

Email: helpline@copperdev.co.uk
Websites: www.cda.org.uk www.brass.org

(Revision of CDA Publication TN10, 1986)

Copper and Copper Alloys

Compositions, Applications and Properties

- The Introduction explains the rationale of the EN series of standards for coppers and copper alloys.
- Section 1 (page 5) shows, where possible, the equivalents to the old British Standard materials.
- Section 2 (page 8) lists the ranges of compositions and properties of coppers and copper alloys included in the EN standards that replaced the old British Standards for these materials. For most materials it is easy to obtain near-equivalents to those included in previous standards. Full details of compositions and other requirements are included in the standards, obtainable from The British Standards Institution.
- Section 3 (page 19) includes a selection of tables giving near-equivalents for the brasses previously included in the British Standards in order to simplify selection from the very wide range of materials now available.
- The CDA Technical Helpline offers free advice on the selection and use of coppers and copper alloys.

Telephone: 01442 275700
Fax: 01442 275716
Email: helpline@copperdev.co.uk
Websites: www.cda.org.uk & www.brass.org

CONTENTS

Introduction

The EN Standards

The EN series of standards for copper and copper alloys offers a selection of materials to suit a very wide variety of end uses. They represent a consensus agreement on those most frequently ordered by consumers.

Commencing in the late 1980s, drafting of European Standards for Copper and Copper Alloys became a major activity for national standards' organisations and their industrial partners.

Because a large number of national preferences have needed to be taken into account against the background of a pan-European agreement to develop tight product standards, the EN standards are more complex than the old BS standards. Furthermore, the EN standards tend to cover narrower fields than BS standards; hence there are more alloys in the EN series than in the old BS standards.

This publication summarises the main compositions and the range of properties. For full details refer to the standards documents obtainable from: The British Standards Institution, 398 Chiswick High Road, London W4 4AL.
Tel: 020 8996 9001 Fax: 020 8996 7001
www: bsi-global.com

Withdrawal of Old Standards

As the new standards have been published they were in conflict with the old British Standards. These were withdrawn, as were those of other European countries, leaving Europe with one harmonised series of standards published in each country but applicable across all.

The majority of the new standards, published or due during the period 1996-2003, caused withdrawal of conflicting national standards such as BS 1400 for castings, the BS 287x series for wrought materials and the BS 143x series covering coppers for electrical purposes.

Materials popularly used from the old BS standards continue to be available but the new designations should be used.

Numbers and Titles of Standards

Table 1 shows EN standards' titles, categorised by product type, and the BS standards that have been replaced. During the standardisation process, at the stage of draft for public comment, an EN number is allocated. At this stage drafts are identified with the prefix 'pr'. After successful formal vote, when the draft is approved for publication throughout Europe, the EN implementation uses the same number.

Table 2 shows old BS standard numbers in numerical order and their replacement EN standards.

Product Forms

As part of the standardisation process, uniform definitions have now been adopted for all product forms. This will result in some products having new terminology. As an example, the term 'wire' now includes all material made in coil form.

Material Designations

Material designations (individual copper and copper alloy identifications) are in two forms, symbol and number. As with many other existing European national standards, symbols are based on the ISO compositional system (e.g. CuZn37 is 63/37 brass). ISO and EN symbols may be identical but the detailed compositional limits are not always identical and cannot be assumed to refer to unique materials.

Numbering System

A new numbering system has therefore been developed to offer a more user- and computer-friendly alternative. The system is a 6-character, alpha-numeric series, beginning C for copper based material; the second letter indicates the product form as follows:-

- B – Materials in ingot form for re-melting to produce cast products
- C – Materials in the form of cast products
- F – Filler materials for brazing and welding
- M – Master alloys
- R – Refined unwrought copper
- S – Materials in the form of scrap
- W – Materials in the form of wrought products
- X – Non-standardised materials

A three-digit number series in the 3rd, 4th and 5th places is used to designate each material and can range from 001 to 999. Numbers are allocated in preferred groups, each series being shown below. The sixth character, a letter, indicates the copper or alloy grouping as follows:-

Number series	Letters	Materials
000-099	A or B	Copper
100-199	C or D	Copper alloys, low alloyed (less than 5% alloying elements)
200-299	E or F	Miscellaneous copper alloys (5% or more alloying elements)
300-349	G	Copper–aluminium alloys
350-399	H	Copper–nickel alloys
400-449	J	Copper–nickel–zinc alloys
450-499	K	Copper–tin alloys
500-599	L or M	Copper–zinc alloys, binary
600-699	N or P	Copper–zinc–lead alloys
700-799	R or S	Copper–zinc alloys, complex

Symbol Designations

- The symbols used are based on the ISO designation system (ISO 1191 Pt1).
- The principal element, copper, is first.
- Other alloying elements are included in decreasing order of percentage content.
- Where contents are similar, alphabetical order may be used.
- The numbers after elements represent nominal compositions.
- No number is normally used if the nominal composition is less than 1%.

Material Condition (Temper) Designations

Material condition (alternative term – temper) designations are defined in EN 1173. In most product standards, materials are available in a choice of material conditions. Depending on the product standard there may be one or more mandatory properties associated with the particular material condition. For designation purposes the principal mandatory property for each material condition is identified by a letter, as follows:-

A – Elongation
B – Spring bending limit
D – As drawn, without specified mechanical properties
G – Grain size
H – Hardness (Brinell or Vickers)
M – As manufactured, without specified mechanical properties
R – Tensile strength
Y – 0.2% proof strength

Products can only be ordered to one material condition and not a combination. However, besides the designating property, other properties may be mandatory; check the standard document for full details.

Normally three digits, but in a few instances four digits, follow the material condition designating letter, where appropriate, to indicate the value of the mandatory property with the possibility of a final character, 'S', for the stress relieved condition. Normally the value refers to a minimum for the property. Sometimes, as with grain size, it refers to a nominal mid-range value.

Tables 6 to 12 show not only the existence of copper or copper alloys in particular standards but also the material conditions available as mandatory properties within those standards.

Castings

For castings, properties are dependent on the casting process used. This is designated according to the system:

GS sand casting

GM permanent mould casting

GZ centrifugal casting

GC continuous casting

GP pressure diecasting

Examples

CW614N – R420	refers to wrought CuZn39Pb3 copper-zinc-lead alloy to be supplied to a minimum tensile strength of 420 N/mm^2
CC750S-GS	refers to sand cast CuZn33Pb2 copper-zinc duplex alloy

Ordering Information

Each product standard gives examples of the full ordering information required including quantity, product form, standard number, designation, condition, tolerances and packaging.

Typical Properties

In Tables 6 to 12, typical properties are usually shown as ranges. For materials available in both 'soft' condition, for example as forging stock, and 'very hard', for example as spring wire, then the ranges are very wide. Tables 14 to 18 show typical properties for ranges of brasses similar to those previously included in British Standards in order to give a closer idea of the range of properties available in each product form.

It is vital that designers and purchasers consult with suppliers to clarify what property values and combinations are available to be best fit for purpose in the desired product form.

Declarations of Conformity

Where the full quality systems standardised in EN ISO 9001 series of standards are not required, a declaration of conformity may still be needed to confirm compliance with order requirements:

In EN 1655 'Copper and Copper Alloys – Declarations of Conformity', four levels of declaration of conformity are available:

Type A for suppliers who do not have a certified quality assurance scheme.

Type B for suppliers who do not have a certified quality assurance scheme but have access to an accredited laboratory.

Type C for suppliers who have a certified quality assurance scheme but do not have access to an accredited laboratory.

Type D for suppliers who have both a certified quality assurance scheme and access to an assessed laboratory.

These declarations are more specific than those based on systems used for steels included in EN 10204 'Metallic Products – Types of Inspection Documents'.

Table 1: EN Standards for Copper and Copper Alloys		
EN Number	**Title**	**Nearest Old BS Equivalent**
Unwrought Products		
1976	Cast unwrought copper products	6017
1977	Copper drawing stock (wire rod)	6926
1978	Copper cathodes	6017
1981	Master alloys	-
1982	Ingots and castings	1400
Rolled Flat Products		
1172	Sheet and strip for building purposes	2870
1652	Plate, sheet, strip and circles for general purposes	2870, 2875
1653	Plate, sheet and circles for boilers, pressure vessels and hot water storage units	2870, 2875
1654	Strip for springs and connectors	2870
1758	Strip for lead frames	-
13148	Hot dip tinned strip	-
14436	Electrolytically tinned strip	-
Tubes		
1057	Seamless, round tubes for water and gas in sanitary and heating applications	2871 Pt 1
12449	Seamless, round tubes for general purposes	2871 Pt 2
12450	Seamless, round capillary tubes	-
12451	Seamless, round tubes for heat exchangers	2871 Pt 3
12452	Rolled, finned, seamless tubes for heat exchangers	-
12735	Seamless round tubes for air conditioning and refrigeration	-
	Part 1: Tubes for piping systems	-
	Part 2: Tubes for equipment	-
13348	Seamless, round copper tubes for medical gases	-
13349	Pre-insulated copper tubes with solid covering	-
Rod/Bar, Wire, Profiles		
12163	Rod for general purposes	2874
12164	Rod for free machining purposes	2874
12165	Wrought and unwrought forging stock	2872
12166	Wire for general purposes	2873
12167	Profiles and rectangular bar for general purposes	2874
12168	Hollow rod for free machining purposes	-
13347	Rod and wire for welding and braze welding	1453, 1845, 2901
Electrical Purposes		
13599	Copper plate, sheet and strip for electrical purposes	4608
13600	Seamless copper tubes for electrical purposes	1977
13601	Copper rod, bar and wire for general electrical purposes	1433, 1432, 4109
13602	Drawn round copper wire for the manufacture of electrical conductors	4109
13604	Products of high conductivity copper for electronic tubes, semiconductor devices and vacuum applications	3839
13605	Copper profiles for electrical purposes	-
60317-0-1	Enamelled copper wire	6811
Forgings and Fittings		
1254 Pt 1-5	Plumbing fittings	864
prEN1254 Pt 6-7	Plumbing fittings	-
12420	Forgings	2872
prEN14905	Recommended practice for the installation of plumbing fittings	-
Test Methods		
723	Combustion method for determination of carbon on the inner surface of copper tubes or fittings	-
1971	Eddy current test for tubes	-
12384	Determination of spring bending limit on strip	-
12893	Determination of spiral elongation number	DD79
13147	Determination of residual stresses in the border area of strip	-
13603	Test methods for assessing protective tin coatings on drawn round copper wire for electrical purposes	-
ISO 196	Detection of residual stress - mercury(I) nitrate test	-
ISO 2624	Estimation of average grain size	-
ISO 2626	Hydrogen embrittlement test	5899
ISO 6509	Determination of dezincification resistance of brass	-
Miscellaneous		
1173	Material condition or temper designation	-
1412	European numbering system	-
1655	Declarations of conformity	-
10204	Metallic products - types of inspection documents	-
12861	Scrap	-
CR13388	Copper and copper alloys - Compendium of compositions and products	-

Table 2: Listing of Old BS Standards replaced by EN Standards		
Old BS Standard	**Title (abbreviated)**	**EN Standards**
1400	Copper and copper alloy ingots and castings	1982
1432	Drawn copper strip for electrical purposes	13601
1433	Copper rod and bar for electrical purposes	13601
1434	Copper sections in bars, blanks and segments for commutators (electrical purposes)	n/a
1453	Filler metals for gas welding	13347
1845	Filler metals for brazing	13347
1977	Copper tubes for electrical purposes	13600
2870	Sheet, strip and foil	1172, 1652, 1653, 1654
2871 Pt 1	Tubes for water, gas and sanitation	1057
2871 Pt 2	Tubes for general purposes	12449
2871 Pt 3	Tubes for heat exchangers	12451
2872	Forgings and forging stock	12165, 12420
2873	Wire	12166
2874	Rods and sections	12163, 12164, 12167
2875 Pt 3	Plate	1652, 1653
2901	Copper and copper alloy filler wires for gas shielded arc welding	13347
3839	Oxygen free high conductivity copper for electronic tubes and semiconductor devices	13604
4109	Copper wire for electrical purposes	13602
4577	Materials for resistance welding electrodes	n/a
4608	Copper sheet, strip and foil for electrical purposes	13599
6017	Copper refinery shapes	1976, 1978
6811	Winding wires (part)	13602
6926	Copper wire rod for electrical purposes	1977

Symbols for chemical elements used as alloying additions or found as impurities

Ag	Silver
Al	Aluminium
As	Arsenic
Au	Gold
B	Boron
Be	Beryllium
Bi	Bismuth
Cd	Cadmium
Co	Cobalt
Cr	Chromium
Fe	Iron
Mn	Manganese
Nb	Niobium
Ni	Nickel
O	Oxygen
P	Phosphorus
Pb	Lead
S	Sulphur
Sb	Antimony
Si	Silicon
Sn	Tin
Te	Tellurium
Zn	Zinc
Zr	Zirconium

Conversion factors

All units quoted are those used in the relevant standards.

The following conversions may be used for other units:

$1 N/mm^2$ = 1 MPa
= 10^{-1} hbar
= 6.4749×10^{-2} tonf/in^2
= 145.038 lbf/in^2
= 0.101972 kgf/mm^2

Table 3: Unwrought and Wrought Coppers - Conversion of Old BS into EN Material Designations

Nearest Old BS Equivalent		EN Material Designation			Main Table Number
		Symbol	Number		
Wrought	Unwrought		Wrought	Unwrought	
Copper Cathode					6a, 6b
-	Cu-CATH-1	Cu-CATH-1	-	CR001A	
-	Cu-CATH-2	Cu-CATH-2	-	CR002A	
Coppers ex Cu-CATH-1					6a, 6b
C100	-	Cu-ETP1	CW003A	CR003A	
-	-	Cu-OF1	CW007A	CR007A	
C110	Cu-OFE	Cu-OFE	CW009A	CR009A	
-	-	Cu-PHCE	CW022A	CR022A	
Other Unalloyed Coppers					6a, 6b
C101	Cu-ETP-2	Cu-ETP	CW004A	CR004A	
C102	Cu-FRHC	Cu-FRHC	CW005A	CR005A	
C103	Cu-OF	Cu-OF	CW008A	CR008A	
C104	Cu-FRTP	Cu-FRTP	CW006A	CR006A	
C105	Cu-AS	-	-	-	
Phosphorus - containing Coppers					6a, 6b
-	-	Cu-PHC	CW020A	CR020A	
-	-	Cu-HCP	CW021A	CR021A	
-	-	Cu-DLP	CW023A	CR023A	
C106	Cu-DHP	Cu-DHP	CW024A	CR024A	
-	-	Cu-DXP	-	CR025A	
C107	Cu-AsP	-	-	-	
Silver-bearing Coppers					6a, 6b
Tough Pitch					
C101	Cu-Ag-2	CuAg0.04	CW011A	CR011A	
C101	Cu-Ag-3	CuAg0.07	CW012A	CR012A	
C101	Cu-Ag-4	CuAg0.10	CW013A	CR013A	
Phosphorus Deoxidised					
-	-	CuAg0.04P	CW014A	CR014A	
-	-	CuAg0.07P	CW015A	CR015A	
-	-	CuAg0.10P	CW016A	CR016A	
Oxygen Free					
C103	Cu-Ag-OF2	CuAg0.04(OF)	CW017A	CR017A	
-	-	CuAg0.07(OF)	CW018A	CR018A	
C103	Cu-Ag-OF4	CuAg0.10(OF)	CW019A	CR019A	

Conversion of Old BS into EN Material Designations

Table 4: Wrought Copper Alloys – Conversion of Old BS into EN Material Designations

(These are arranged broadly in increasing order of alloying content)

Nearest Old BS Equivalent	EN Material Designation		Table No
	Symbol	Number	
Heat-treatable Alloys			8
CB101	CuBe1.7	CW100C	
-	CuBe2	CW101C	
-	CuBe2Pb	CW102C	
-	CuCo1Ni1Be	CW103C	
C112	CuCo2Be	CW104C	
-	CuNi2Be	CW110C	
CC101	CuCr1	CW105C	
CC102	CuCr1Zr	CW106C	
C113	CuNi1P	CW108C	
-	CuNi1Si	CW109C	
-	CuNi2Si	CW111C	
-	CuNi3Si1	CW112C	
-	CuZr	CW120C	
Non Heat-treatable Alloys - Free Machining			8
-	CuPb1P	CW113C	
C109	CuTeP	CW118C	
C111	CuSP	CW114C	
Non Heat-treatable Alloys - Other			8
-	CuFe2P	CW107C	
-	CuSi1	CW115C	
CS101	CuSi3Mn	CW116C	
-	CuSn0.15	CW117C	
-	CuZn0.5	CW119C	
C108	CuCd	-	
-	CuCd0.7	CW130C	
-	CuCd1.0	CW131C	
Copper-tin (Phosphor Bronze)			10
PB101	CuSn4	CW450K	
PB102	CuSn5	CW451K	
PB103	CuSn6	CW452K	
PB104	CuSn8	CW453K	
-	CuSn8P	CW459K	
-	CuSn4Pb2P	CW455K	
-	CuSn4Te1P	CW457K	
-	CuSn5Pb1	CW458K	
-	CuSn8PbP	CW460K	
-	CuSn3Zn9	CW454K	
-	CuSn4Pb4Zn4	CW456K	
Copper-zinc (Brass)			10
CZ125	CuZn5	CW500L	
CZ101	CuZn10	CW501L	
CZ102	CuZn15	CW502L	
CZ103	CuZn20	CW503L	
-	CuZn28	CW504L	
CZ106	CuZn30	CW505L	
-	CuZn33	CW506L	
CZ107	CuZn36	CW507L	
CZ108	CuZn37	CW508L	
CZ109	CuZn40	CW509L	
Copper-zinc-lead Alloys (Leaded Brasses)			11
CZ104	-	-	
CZ124	CuZn36Pb3	CW603N	
CZ121Pb4	CuZn38Pb4	CW609N	
CZ121Pb3	CuZn39Pb3	CW614N	
CZ122	CuZn40Pb2	CW617N	
CZ119	CuZn37Pb2	CW606N	
CZ131	CuZn37Pb2	CW606N	
CZ120	CuZn38Pb2	CW608N	
CZ128	CuZn38Pb2	CW608N	
CZ120	CuZn39Pb2	CW612N	
CZ128	CuZn39Pb2	CW612N	
CZ118	CuZn35Pb1	CW600N	
CZ119	CuZn35Pb2	CW601N	
CZ131	CuZn35Pb2	CW601N	
-	CuZn38Pb1	CW607N	
CZ123	CuZn39Pb0.5	CW610N	
CZ137	CuZn39Pb0.5	CW610N	
CZ129	CuZn39Pb1	CW611N	
CZ132	CuZn36Pb2As	CW602N	
-	CuZn39Pb2Sn	CW613N	
-	CuZn40Pb2Sn	CW619N	
-	CuZn39Pb3Sn	CW615N	
-	CuZn40Pb1Al	CW616N	
-	CuZn40Pb2Al	CW618N	
-	CuZn41Pb1Al	CW620N	

continued top right

Nearest Old BS Equivalent	EN Material Designation		Table No
	Symbol	Number	
Copper-zinc-lead Alloys (Leaded Brasses) - *continued*			11
-	CuZn42PbAl	CW621N	
	CuZn43Pb1Al	CW622N	
CZ130	CuZn43Pb2Al	CW624N	
CZ130	CuZn43Pb2	CW623N	
-	CuZn37Pb0.5	CW604N	
-	CuZn37Pb1	CW605N	
Copper-zinc Alloys (Special Brasses) – (Corrosion Resistant Alloys)			12
CZ127	CuZn13Al1Ni1Si1	CW700R	
CZ110	CuZn20Al2As	CW702R	
CZ111	CuZn28Sn1As	CW706R	
CZ126	CuZn30As	CW707R	
CZ105	CuZn30As	CW707R	
-	CuZn38AlFeNiPbSn	CW715R	
-	CuZn38Sn1As	CW717R	
-	CuZn32Pb2AsFeSi	CW709R	
CZ134	CuZn36Pb2Sn1	CW711R	
CZ112	CuZn36Sn1Pb	CW712R	
CZ113	-	-	
-	CuZn37Pb1Sn1	CW714R	
CZ133	CuZn39Sn1	CW719R	
High Tensile Brasses			12
-	CuZn23Al6Mn4Fe3Pb	CW704R	
CZ116	CuZn25Al5Fe2Mn2Pb	CW705R	
-	CuZn35Ni3Mn2AlPb	CW710R	
CZ114	CuZn40Mn1Pb1AlFeSn	CW721R	
CZ115	CuZn40Mn1Pb1FeSn	CW722R	
-	CuZn31Si1	CW708R	
CZ135	CuZn37Mn3Al2PbSi	CW713R	
-	CuZn39Mn1AlPbSi	CW718R	
Other Brasses			12
-	CuZn19Sn	CW701R	
-	CuZn23Al3Co	CW703R	
-	CuZn38Mn1Al	CW716R	
CZ136	CuZn40Mn1Pb1	CW720R	
-	CuZn40Mn2Fe1	CW723R	
Copper-aluminium (Aluminium Bronze)			9
-	CuAl5As	CW300G	
CA101	-	-	
CA107	CuAl6Si2Fe	CW301G	
-	CuAl7Si2	CW302G	
CA106	CuAl8Fe3	CW303G	
CA102	-	-	
CA105	CuAl9Ni3Fe2	CW304G	
CA103	-	-	
-	CuAl10Fe1	CW305G	
-	CuAl10Fe3Mn2	CW306G	
CA104	CuAl10Ni5Fe4	CW307G	
-	CuAl11Fe6Ni6	CW308G	
Copper-nickel			9
CN105	CuNi25	CW350H	
CN101	-	-	
-	CuNi9Sn2	CW351H	
CN102	CuNi10Fe1Mn	CW352H	
CN103	-	-	
CN104	-	-	
CN106	-	-	
CN108	CuNi30Fe2Mn2	CW353H	
CN107	CuNi30Mn1Fe	CW354H	
Copper-nickel-zinc (Nickel Silver)			9
NS103	CuNi10Zn27	CW401J	
NS104	CuNi12Zn24	CW403J	
NS111	CuNi12Zn25Pb1	CW404J	
-	CuNi12Zn29	CW405J	
-	CuNi12Zn30Pb1	CW406J	
NS105	-	-	
NS112	-	-	
NS113	CuNi18Zn19Pb1	CW408J	
NS106	CuNi18Zn20	CW409J	
NS107	CuNi18Zn27	CW410J	
NS108	-	-	
NS109	-	-	
-	CuNi7Zn39Pb3Mn2	CW400J	
NS101	CuNi10Zn42Pb2	CW402J	
-	CuNi12Zn38Mn5Pb2	CW407J	

Conversion of Old BS into EN Material Designations

Table 5: Copper and Copper Alloy Ingots and Castings - Comparison of BS 1400 and EN 1982

Showing near equivalents where standardised in EN 1982 and original compositional symbols for guidance where no near equivalent is included.
See Table 7 for full details of compositions and properties.

Nearest Equivalent in Old BS 1400 or BS 4577	EN or ISO Symbol for Castings (1)	EN Material Designation Number for Castings (2)	EN Relevant Casting Processes and Designations (3)				
			GM	GS	GZ	GP	GC
			Die Casting	Sand	Centrifugal	Pressure Die	Continuous
Copper and Copper-chromium (High Conductivity Coppers)							
HCC1	Cu-C	CC040A	*	*			
CC1-TF	CuCr1-C	CC140C	*	*			
A4/1	G-CuNiP	–					
A3/2	G-CuNi2Si	–					
A3/1	G-CuCo2Be	–					
A4/2	G-CuBe	–					
Copper-zinc (Brasses)							
DZR1	CuZn35Pb2Al-C	CC752S	*			*	
DZR2	CuZn33Pb2Si-C	CC751S				*	
-	CuZn37Pb2Ni1AlFe-C	CC753S	*				
PCB1	G-CuZn40Pb	–					
DCB1	CuZn38Al-C	CC767S	*				
DCB2	G-CuZn37Sn	–					
DCB3	CuZn39Pb1Al-C	CC754S	*	*	*	*	
-	CuZn39Pb1AlB-C	CC755S	*			*	
SCB1	G-CuZn25Pb3Sn2	–					
SCB2	G-CuZn30Pb3	–					
SCB3	CuZn33Pb2-C	CC750S		*	*		
SCB4	G-CuZn36Sn	–					
SCB5	G-CuZn10Sn	–					
SCB6	CuZn15As-C	CC760S		*			
-	CuZn16Si4-C	CC761S	*	*	*	*	
-	CuZn32Al2Mn2Fe1-C	CC763S		*		*	
-	CuZn34Mn3Al2Fe1-C	CC764S	*	*	*		
HTB1	CuZn35Mn2Al1Fe1-C	CC765S	*	*	*		*
HTB2	G-CuZn36Al4FeMn	–					
HTB3	CuZn25Al5Mn4Fe3-C	CC762S	*	*	*		*
-	CuZn37Al1-C	CC766S	*				
Copper-tin (Gunmetals and Phosphor Bronzes)							
CT1	CuSn10-C	CC480K	*	*	*		*
PB1	CuSn11P-C	CC481K	*	*	*		*
-	CuSn11Pb2-C	CC482K		*	*		*
PB2	CuSn12-C	CC483K	*	*	*		*
CT2	CuSn12Ni2-C	CC484K		*	*		*
PB4	G-CuSn10PbP	–					
LPB1	G-CuSn7PbP	–					
Copper-tin-lead (Gunmetals and Leaded Bronzes)							
LG1	CuSn3Zn8Pb5-C	CC490K		*	*		*
LG2	CuSn5Zn5Pb5-C	CC491K	*	*	*		*
LG3	G-CuSn7Pb4Zn2	–					
LG4	CuSn7Zn2Pb3-C	CC492K	*	*	*		*
-	CuSn7Zn4Pb7-C	CC493K	*	*	*		*
LB1	CuSn7Pb15-C	CC496K		*	*		*
LB2	CuSn10Pb10-C	CC495K	*	*	*		*
LB3	G-CuSn10Pb5	–					
LB4	CuSn5Pb9-C	CC494K	*	*	*		*
LB5	CuSn5Pb20-C	CC497K		*	*		*
G1	G-CuSn10Zn2	–					
G2	G-CuSn8Zn4Pb	–					
G3	G-CuSn7Ni5Zn3	–					
Copper-aluminium (Aluminium Bronzes)							
-	CuAl9-C	CC330G	*		*		
AB1	CuAl10Fe2-C	CC331G	*	*	*		*
-	CuAl10Ni3Fe2-C	CC332G	*	*	*		*
AB2	CuAl10Fe5Ni5-C	CC333G	*	*	*		*
-	CuAl11Fe6Ni6-C	CC334G	*	*	*		
AB3	G-CuAl6Si2Fe	–					
Copper-manganese-aluminium							
CMA1	CuMn11Al8Fe3Ni3-C	CC212E		*			
CMA2	G-CuMn13Al9Fe3Ni3	–					
Copper-nickel (Cupro-nickels)							
-	CuNi10Fe1Mn1-C	CC380H		*	*		*
-	CuNi30Fe1Mn1-C	CC381H		*	*		
CN1	CuNi30Cr2FeMnSi-C	CC382H		*			
CN2	CuNi30Fe1Mn1NbSi-C	CC383H		*			

Notes:
(1) Symbol finishes with B for material in ingot form
(2) Number begins CB for material in ingot form
NB: Ingots are not specified for high conductivity coppers

(3) GM - permanent mould casting
GS - sand casting
GZ - centrifugal
GP - pressure die casting
GC - continuous casting
Method of casting affects properties significantly.

Table 6a: Unwrought (1) and Wrought Coppers – Compositions, Uses and Typical Properties

Material Designation			Composition, %, Range or Max		Nearest Old BS Equivalent		Characteristics and Uses	Electrical Properties at 20°C (Annealed)		Typical Mechanical Properties			
Symbol	Number		Cu (incl. 0.015 max Ag)	Max of 19 listed elements (2), other than Cu	Unwrought (BS 6017)	Wrought		Max. Mass Resistivity (Ω g/m²)	Nominal Min. Conductivity (% IACS)	0.2% Proof Strength (N/mm²)	Tensile Strength (N/mm²)	Elongation (%)	Hardness (HV)
	Unwrought	Wrought											
Copper Cathode													
Cu-CATH-1	CR001A	–	Rem.	0.0065 excl. O 0.04 max O	Cu-CATH-1	–	Flat products for remelting made by electrolytic deposition.	0.15176	101.0	–	–	–	–
Cu-CATH-2	CR002A	–	99.90 min.	0.03 excl. Ag, O	Cu-CATH-2	–		0.15328	100.0	–	–	–	–
Coppers ex Cu-CATH-1													
Cu-ETP1	CR003A	CW003A	Rem.	0.0065 excl. O 0.04 max O	Cu-ETP1	C100	For re-draw to wire; suitable for high speed annealing and enamelling.	0.15176	101.0	Properties similar to those for Cu-ETP			
Cu-OF1	CR007A	CW007A	Rem.	0.0065 excl. O	Cu-OF	C103	Oxygen-free version of ETP1 for use in reducing atmospheres.	0.15176	101.0				
Cu-OFE	CR009A	CW009A	99.99 min.	15 elements listed individually	Cu-OFE	C110	Oxygen-free and low phosphorus coppers, suitable for use in electronic vacuum devices.	0.15176	101.0				
Cu-PHCE	CR022A	CW022A	99.99 min.	P 0.001-0.006 plus 14 elements listed individually	–	–		0.15328	100.0				
Other Unalloyed Coppers													
Cu-ETP	CR004A	CW004A	99.90 min.	0.03 excl. Ag, O	Cu-ETP-2	C101	Suitable for conductors and fabricated electrical components but not in reducing atmospheres.	0.15328	100.0	50-340	200-400	50-5	40-120
Cu-FRHC	CR005A	CW005A	99.90 min.	0.04 excl. Ag, O	Cu-FRHC	C102		0.15328	100.0	Properties similar to those for Cu-ETP			
Cu-OF	CR008A	CW008A	99.95 min.	0.03 excl. Ag	Cu-OF	C103	Oxygen-free version of Cu-ETP for use in reducing atmospheres.	0.15328	100.0	50-340	200-400	50-5	40-120
Cu-FRTP	CR006A	CW006A	99.90 min.	0.05 excl. Ag, Ni, O	Cu-FRTP	C104	General engineering and building applications - not in reducing atmospheres.	–	–	50-340	200-400	50-5	40-120
Phosphorus–containing Coppers													
Cu-PHC	CR020A	CW020A	99.95 min.	0.03 excl. Ag & P (P 0.001-0.006)	–	–	Phosphorus deoxidised coppers for general and chemical engineering applications, particularly when brazing or welding is involved. PHC & HCP are suited to electrical applications. Cu-DXP is used for anodes for electroplating.	0.15328	100.0	Properties similar to those for Cu-DLP			
Cu-HCP	CR021A	CW021A	99.95 min.	0.03 excl. Ag & P (P 0.002-0.007)	–	–		0.15596	98.3	50	200	30	45
Cu-DLP	CR023A	CW023A	99.90 min.	0.03 excl. Ag, Ni & P (P 0.005-0.013)	–	–		–	–	50-340	200-400	50-5	40-120
Cu-DHP	CR024A	CW024A	99.90 min.	P 0.015-0.040	Cu-DHP	C106		–	–	50-340	200-400	50-5	40-120
Cu-DXP	CR025A	–	99.90 min.	0.03 excl. Ag, Ni & P (P 0.04-0.06)	–	–		–	–	Properties similar to those for Cu-DLP			
Silver–bearing Coppers													
Tough Pitch							Increasing additions of silver give increase in creep strength and resistance to softening in elevated service temperatures. Good creep resistance to 250°C (short times at 350°C).			Properties similar to those for Cu-ETP at ambient temperatures			
Cu-Ag 0.04	CR011A	CW011A	Rem.	0.03 excl. Ag & O (Ag 0.03-0.05) 0.04 max	Cu-Ag-2	C101		0.15328	100.0				
Cu-Ag 0.04	CR012A	CW012A	Rem.	0.03 excl. Ag & O (Ag 0.06-0.08) 0.04 max	Cu-Ag-3	C101		0.15328	100.0				
Cu-Ag 0.10	CR013A	CW013A	Rem.	0.03 excl. Ag & O (Ag 0.08-0.012) 0.04 max	Cu-Ag-4	C101		0.15328	100.0				
Phosphorus Deoxidised													
Cu-Ag 0.04P	CR014A	CW014A	Rem.	0.03 excl. Ag & P (Ag 0.03-0.05) P 0.001-0.007	-	-		0.15596	98.3				
Cu-Ag 0.07P	CR015A	CW015A	Rem.	0.03 excl. Ag & P (Ag 0.06-0.08) P 0.001-0.007	-	-		0.15596	98.3				
Cu-Ag 0.10P	CR016A	CW016A	Rem.	0.03 excl. Ag & P (Ag 0.08-0.12) P 0.001-0.007	-	-		0.15596	98.3				
Oxygen Free													
Cu-Ag 0.04(OF)	CR017A	CW017A	Rem.	0.0065 excl. Ag & O (Ag 0.03-0.05)	Cu-Ag-OF2	C103		0.15328	100.0				
Cu-Ag 0.07(OF)	CR018A	CW018A	Rem.	0.0065 excl. Ag & O (Ag 0.06-0.08)	-	-		0.15328	100.0				
Cu-Ag 0.10(OF)	CR019A	CW019A	Rem.	0.0065 excl. Ag & O (Ag 0.08-0.12)	Cu-Ag-OF4	C103		0.15328	100.0				

Notes:

(1) Unwrought coppers in EN 1976 – Cast Unwrought Copper Products and EN 1978 - Copper Cathodes

(2) Ag, As, Bi, Cd, Co, Cr, Fe, Mn, Ni, O, P, Pb, S, Sb, Se, Si, Sn, Te, Zn

Table 6b: Unwrought (1) and Wrought Coppers - Relevant Standards

Material Designation			Inclusion in the following EN Standards with Indicated Material Conditions (2)															
Symbol	Number		1652	1653	1758	12163	12165	12166	12167	12449	12451	12452	1977	13599	13600	13601	13602	13605
	Unwrought	Wrought	Plate, Strip, Sheet, Circles (3)	Plate, Sheet, Circles (4)	Strip for Lead Frames	Rod (3)	Forging Stock	Wire	Profiles, Rectangular Bar	Tubes (3)	Tubes for Heat Exchangers	Finned Tubes for Heat Exchangers	Copper Drawing Stock (Wire Rod)	Copper Plate, Sheet, Strip	Seamless Copper Tubes	Copper Rod, Bar, Wire	Drawn Round Copper Wire	Copper Profiles
Copper Cathode															(For Electrical Purposes)			
Cu-CATH-1	CR001A	–																
Cu-CATH-2	CR002A	–																
Coppers ex Cu-CATH-1																		
Cu-ETP1	CR003A	CW003A											SV				AR	
Cu-OF1	CR007A	CW007A											EV				AR	
Cu-OFE	CR009A	CW009A											EV					
Cu-PHCE	CR022A	CW022A											EV					
Other Unalloyed Coppers																		
Cu-ETP	CR004A	CW004A	RH				MH						V	MRH	DRH	DRH	AR	DRH
Cu-FRHC	CR005A	CW005A											V	MRH	DRH	DRH	AR	DRH
Cu-OF	CR008A	CW008A	RH				MH						EV	MRH	DRH	DRH	AR	DRH
Cu-FRTP	CR006A	CW006A	RH			MRH												
Phosphorus-containing Coppers																		
Cu-PHC	CR020A	CW020A											EV	MRH	DRH	DRH		DRH
Cu-HCP	CR021A	CW021A					MH						EV	MRH	DRH	DRH		DRH
Cu-DLP	CR023A	CW023A	RH	R	RH	MRH			MRH									
Cu-DHP	CR024A	CW024A	RH	R		MRH	MH	MRHG	MRH	MRH	RH	RH						
Cu-DXP	CR025A	–																
Silver-bearing Coppers																		
CuAg0.04	CR011A	CW011A											V			DRH		DRH
CuAg0.07	CR012A	CW012A											V			DRH		DRH
CuAg0.10	CR013A	CW013A											V	MRH	DRH	DRH		DRH
CuAg0.04P	CR014A	CW014A											EV			DRH		DRH
CuAg0.07P	CR015A	CW015A											EV			DRH		DRH
CuAg0.10P	CR016A	CW016A											EV	MRH	DRH	DRH		DRH
CuAg0.04(OF)	CR017A	CW017A											EV			DRH		DRH
CuAg0.07(OF)	CR018A	CW018A											EV			DRH		DRH
CuAg0.10(OF)	CR019A	CW019A											EV	MRH	DRH	DRH		DRH

Notes:

(1) Unwrought coppers in EN 1976 – Cast Unwrought Copper Products and EN 1978 – Copper Cathodes

(2) A – mandatory elongation
D – cold worked
E – mandatory hydrogen embrittlement test
G – mandatory grain size
H – mandatory hardness
M – as manufactured
R – mandatory tensile strength
S – spiral elongation test
V – volume resistivity test

(3) For general purposes

(4) For boilers, pressure vessels and hot water storage units

Table 7: EN 1982 Copper and Copper Alloy Ingots and Castings – Compositions, Uses and Typical Properties

Material Designation		Composition, %, Range or Max											Nearest Equivalent in Old BS 1400	Characteristics and Uses	Typical Minimum Mechanical Properties (Properties vary significantly with method of casting)				Relevant Casting Processes and Designations (4)				
Symbol for Castings (1)	Number for Castings (2)	Cu	Al	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	Others			0.2% Proof Strength (N/mm²)	Tensile Strength (N/mm²)	Elongation (%)	Hardness (HB)	GM Die Casting	GS Sand	GZ Centri-fugal	GP Pressure Die	GC Continuous
Copper and Copper-chromium (High Conductivity Coppers)																							
Cu-C	CC040A	Castings shall be made from the copper grades Cu-CATH-2, Cu-ETP-2 and Cu-FRHC											HCC1	Electrical and thermal applications. Additionally specified by minimum conductivity requirements. eg. 93-99% IACS	40	150	25	40	*	*			
CuCr1-C	CC140C	Rem.										0.4 - 1.2 Cr	CC1 - TF		250	350	10	95	*	*			
Copper-zinc (Brasses)																							
CuZn33Pb2-C	CC750S	63.0 - 66.0				1.0		1.0 - 3.0		1.5	Rem.		SCB3	General purpose applications	70	180	12	45		*	*		
CuZn33Pb2Si-C	CC751S	63.5 - 66.0		0.25 - 0.5		0.8		1.3 - 2.2	0.065 - 1.1		Rem.		DZR2	Dezincification resistant alloys for water fittings in areas with aggressive waters.	280	400	5	110				*	
CuZn35Pb2Al-C	CC752S	61.5 - 64.5	0.3 - 0.70					1.5 - 2.5			Rem.	0.15 As	DZR1		120	280	10	70	*		*		
CuZn37Pb2Ni1AlFe-C	CC753S	58.0 - 61.0	0.4 - 0.8	0.5 - 0.8		0.5 - 1.2		1.8 - 2.5		0.8	Rem.		-	Fine grained, freely machinable.	150	300	15	90	*				
CuZn39Pb1Al-C	CC754S	58.0 - 63.0	0.8			1.0		0.5 - 2.5		1.0	Rem.		DCB3	General purposes, extensively for plumbing fittings. Boron in CC755S gives superior strength for thin sections.	120	280	10	70	*	*	*	*	
CuZn39Pb1AlB-C	CC755S	59.5 - 61.0		0.05 - 0.2				1.2 - 1.7			Rem.	(3)	-		180	350	10	90	*			*	
CuZn15As-C	CC760S	83.0 - 88.0									Rem.	0.05 - 0.15 As	SCB6	Brazable. Good corrosion resistance.	70	160	20	45		*			
CuZn16Si4-C	CC761S	78.0 - 83.0	0.1			1.0		0.8	3.0 - 5.0		Rem.		-	Silicon brass for valves and water fittings.	300	500	8	130	*	*		*	
CuZn25Al5Mn4Fe3-C	CC762S	60.0 - 67.0	3.0 - 7.0	1.5 - 4.0	2.5 - 5.0	3.0					Rem.		HTB3	High tensile brasses for engineering castings when good wear resistance is required and high loads encountered.	480	750	5	190	*	*	*		*
CuZn32Al2Mn2Fe1-C	CC763S	59.0 - 67.0	1.0 - 2.5	0.5 - 2.0	1.0 - 3.5	2.5		1.5	1.0	1.0	Rem.		-		200	430	8	110		*		*	
CuZn34Mn3Al2Fe1-C	CC764S	55.0 - 66.0	1.0 - 3.0	0.5 - 2.5	1.0 - 4.0	3.0					Rem.		-		260	600	12	140	*	*	*		
CuZn35Mn2Al1Fe1-C	CC765S	57.0 - 65.0	0.5 - 2.5	0.5 - 2.0	0.5 - 3.0	6.0				1.0	Rem.		HTB1		200	480	18	110	*	*	*		*
CuZn37Al1-C	CC766S	60.0 - 64.0	0.3 - 1.8			2.0					Rem.		-	General purpose, high quality engineering castings.	170	450	25	105	*				
CuZn38Al-C	CC767S	59.0 - 64.0	0.1 - 0.8			1.0					Rem.		DCB1		130	380	30	75	*				
Copper-tin (Gunmetals and Phosphor-Bronzes)																							
CuSn10-C	CC480K	88.0 - 90.0				2.0	0.2	1.0		9.0 - 11.0			CT1	For gears and general bearing applications offering higher corrosion/erosion resistance than gunmetals. The lead in CC482K gives improved machinability and the nickel in CC484K increases strength and hardness.	160	270	10	80	*	*	*		*
CuSn11P-C	CC481K	87.0 - 89.5					0.5 - 1.0			10.0 - 11.5			PB1		170	310	4	85	*	*	*		*
CuSn11Pb2-C	CC482K	83.5 - 87.0				2.0	0.40	1.0 - 2.5		10.5 - 12.5	2.0		-		150	280	5	90		*	*		*
CuSn12-C	CC483K	85.0 - 88.5				2.0	0.60	0.7		11.0 - 13.0			PB2		150	270	5	85	*	*	*		*
CuSn12Ni2-C	CC484K	84.5 - 87.5				1.5 - 2.5	0.05 - 0.40			11.0 - 13.0			CT2		180	300	10	95		*	*		*

Notes:
(1) Symbol finishes 'B' for material in ingot form
(2) Number begins 'CB' for material in ingot form
NB. Ingots are not specified for high conductivity coppers
(3) Boron for grain refining
(4) GM – permanent mould casting
GS – sand casting
GZ – centrifugal casting
GP – pressure die casting
GC – continuous casting

Table 7 (continued): EN 1982 Copper and Copper Alloy Ingots and Castings – Compositions, Uses and Typical Properties

Material Designation		Composition, %, Range or Max											Nearest Equivalent in Old BS 1400	Characteristics and Uses	Typical Minimum Mechanical Properties (Properties vary significantly with method of casting)				Relevant Casting Processes and Designations (4)				
Symbol for Castings (1)	Number for Castings (2)	Cu	Al	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	Others			0.2% Proof Strength (N/mm²)	Tensile Strength (N/mm²)	Elongation (%)	Hardness (HB)	GM Die Casting	GS Sand	GZ Centri-fugal	GP Pressure Die	GC Continuous
Copper-tin-lead (Gunmetals and Leaded Bronzes)																							
CuSn3Zn8Pb5-C	CC490K	81.0 - 86.0				2.0	0.05	3.0 - 6.0		2.0 - 3.5	7.0 - 9.5		LG1	Leaded gunmetals giving good corrosion resistance with moderate strength and good castability. Applications include pumps, valves and bearings.	100	220	12	70		*	*		*
CuSn5Zn5Pb5-C	CC491K	83.0 - 87.0				2.0	0.10	4.0 - 6.0		4.0 - 6.0	4.0 - 6.0		LG2		110	230	10	65	*	*	*		*
CuSn7Zn2Pb3-C	CC492K	85.0 - 89.0				2.0	0.10	2.5 - 3.5		6.0 - 8.0	1.5 - 3.5		LG4		130	240	12	70	*	*	*		*
CuSn7Zn4Pb7-C	CC493K	81.0 - 85.0				2.0	0.10	5.0 - 8.0		6.0 - 8.0	2.0 - 5.0		-		120	240	12	70	*	*	*		*
CuSn5Pb9-C	CC494K	80.0 - 87.0				2.0	0.10	8.0 - 10.0		4.0 - 6.0	2.0		LB4	Leaded tin bronzes whose plasticity increases with lead content for bearings when some measure of plasticity is required and for when there is a risk of scoring mating materials.	80	200	6	60	*	*	*		*
CuSn10Pb10-C	CC495K	78.0 - 82.0				2.0	0.10	8.0 - 11.0		9.0 - 11.0	2.0		LB2		110	220	5	65	*	*	*		*
CuSn7Pb15-C	CC496K	74.0 - 80.0				0.5 - 2.0	0.10	13.0 - 17.0		6.0 - 8.0	2.0		LB1		90	200	8	65		*	*		*
CuSn5Pb20-C	CC497K	70.0 - 78.0				0.5 - 2.0	0.10	18.0 - 23.0		4.0 - 6.0	2.0		LB5		75	175	6	50		*	*		*
Copper-aluminium (Aluminium Bronzes)																							
CuAl9-C	CC330G	88.0 - 92.0	8.0 - 10.5	1.2	0.50	1.0							-	Resists tarnishing. Building and decorative components.	170	470	15	100	*		*		
CuAl10Fe2-C	CC331G	83.0 - 89.5	8.5 - 10.5	1.5 - 3.5	1.0	1.5							AB1	For highly stressed components in corrosive environments where high wear and shock loads may be encountered. Pumps, bearings, tools, bushings, housings.	200	550	18	130	*	*	*		*
CuAl10Ni3Fe2-C	CC332G	80.0 - 86.0	8.5 - 10.5	1.0 - 3.0	2.0	1.5 - 4.0							-		220	550	20	120	*	*	*		*
CuAl10Fe5Ni5-C	CC333G	76.0 - 83.0	8.5 - 10.5	4.0 - 5.5	3.0	4.0 - 6.0							AB2		280	650	12	150	*	*	*		*
CuAl11Fe6Ni6-C	CC334G	72.0 - 78.0	10.0 - 12.0	4.0 - 7.0	2.5	4.0 - 7.5							-		380	750	5	185	*	*	*		
Copper-manganese-aluminium																							
CuMn11Al8Fe3Ni3-C	CC212E	68.0 - 77.0	7.0 - 9.0	2.0 - 4.0	8.0 - 15.0	1.5 - 4.5							CMA1	Seawater handling components, propellers.	275	630	18	150		*			
Copper-nickel																							
CuNi10Fe1Mn1-C	CC380H	84.5		1.0 - 1.8	1.0 - 1.5	9.0 - 11.0						1.0 Nb	-	High strength and corrosion resistance for the most arduous marine applications. Pipe fittings and flanges in chemical engineering.	100	280	25	70		*	*		*
CuNi30Fe1Mn1-C	CC381H	64.5		0.5 - 1.5	0.6 - 1.2	29.0 - 31.0							-		120	340	18	80		*	*		
CuNi30Cr2FeMnSi-C	CC382H	Rem.		0.5 - 1.0	0.5 - 1.0	29.0 - 32.0			0.15 - 0.50			0.15 Zr 1.5 - 2.0 Cr 0.25 Ti	CN1		250	440	18	115		*			
CuNi30Fe1Mn1NbSi-C	CC383H	Rem.		0.5 - 1.5	0.6 - 1.2	29.0 - 31.0			0.3 - 0.7			0.5 - 1.0 Nb	CN2		230	440	18	115		*			

Notes:
(1) Symbol finishes 'B' for material in ingot form
(2) Number begins 'CB' for material in ingot form
NB: Ingots are not specified for high conductivity coppers
(3) Boron for grain refining
(4) GM – permanent mould casting
GS – sand casting
GZ – centrifugal casting
GP – pressure die casting
GC – continuous casting

Table 8: Wrought Low-Alloyed Copper Alloys – Compositions, Uses, Typical Mechanical Properties, Relevant Standards and Approximate Electrical Conductivity

Material Designation		Composition, %, Range or max							Nearest Old BS Equivalent	Characteristics and Uses	Typical Mechanical Properties				Inclusion in the following EN Standards with Indicated Material Conditions (1)								Approx. Conductivity
															1652	1654	12163	12164	12165	12166	12167	12168	12449	
Symbol	Number	Cu	Be	Cr	Ni	P	Si	Others & Total Impurities			0.2% Proof Strength (N/mm²)	Tensile Strength (N/mm²)	Elong-ation (%)	Hardness HV	Plate, Strip, Sheet, Circles (2)	Strip for Springs, Connectors	Rod (2)	Rod for Free Machining	Forging Stock	Wire	Profiles, Rectangular Bar	Free Machining Hollow Rod	Tubes (2)	% IACS
Heat-treatable Alloys																								
CuBe1.7	CW100C	Rem.	1.6-1.8					0.5	CB101	High strength beryllium coppers for springs and pressure sensitive devices. CW102C is the free machining version.	200-1100	410-1300	35-3	100-400		RHYB								30
CuBe2	CW101C	Rem.	1.8-2.1					0.5	-		200-1300	410-1400	20-2	100-420	RH	RHYB	MRH		MH	MRH	MRH			30
CuBe2Pb	CW102C	Rem.	1.8-2.0					0.2-0.6 Pb 0.5	-		200-1300	410-1400	20-4	100-210				MR		MRH				45
CuCo1Ni1Be	CW103C	Rem.	0.4-0.7		0.8-1.3			0.8-1.3 Co 0.5	-	Beryllium containing alloys with lower strength and better conductivity and ductility than beryllium copper, also suitable for higher temperature service.	135-760	250-800	25-3	100-230	RH		MRH		MH	MRH	MRH			
CuCo2Be	CW104C	Rem.	0.4-0.7					2.0-2.8 Co 0.5	C112		135-900	240-800	25-3	90-230	RH	RHY	MRH		MH	MRH	MRH			45
CuNi2Be	CW110C	Rem.	0.2-0.6		1.4-2.4			0.5	-		135-900	240-800	25-3	90-230	RH	RHY	MRH		MH	MRH	MRH			
CuCr1	CW105C	Rem.		0.5-1.2				0.2	CC101	Resistance welding electrode materials. Good conductivity and strength at elevated temperatures. Zr in CW106C raises softening temperature.	100-440	220-500	30-8	70-185			MRH		MH		MRH			80
CuCr1Zr	CW106C	Rem.		0.5-1.2				0.03-0.3 Zr 0.2	CC102		100-440	220-540	35-5	55-175			MRH		MH	MRH	MRH			75
CuNiP	CW108C	Rem.			0.8-1.2	0.15-0.25		0.1	C113	As silicon is added and increased, strength and wear resistance increase and conductivity decreases. Electrode holders, seam welding wheel shafts, welding dies and bearing cages.	140-730	250-800	30-5	80-240			MRH							50
CuNi1Si	CW109C	Rem.			1.0-1.6		0.4-0.7	0.3	-		100-570	300-590	30-5	80-220			MRH		MH	MRH	MRH			
CuNi2Si	CW111C	Rem.			1.6-2.5		0.4-0.8	0.3	-		100-620	300-700	35-5	80-220	RH	RH	MRH		MH	MRH	MRH		MRH	40
CuNi3Si1	CW112C	Rem.			2.6-4.5		0.8-1.3	0.5	-		120-780	320-800	30-5	80-230			MRH		MH					
CuZr	CW120C	Rem.						0.1-0.2 Zr 0.1	-	Special applications at elevated temperatures.	40-350	180-350	30-14	40-135			MRH		MH	MRH	MRH			85-90
Non Heat-treatable Alloys - Free Machining																								
CuPb1P	CW113C	Rem.				0.003-0.012		0.7-1.5 Pb 0.1	-	Free machining high conductivity coppers with machinability index of about 80%.	200-320	250-360	7-2	90-110				MR						75
CuSP	CW114C	Rem.				0.003-0.012		0.2-0.7 S 0.1	C111		200-320	250-360	7-2	90-110				MR				MH		93
CuTeP	CW118C	Rem.				0.003-0.012		0.4-0.7 Te 0.1	C109		200-320	250-360	7-2	90-110				MR		MRH		MH		90
Non Heat-treatable Alloys - Other																								
CuFe2P	CW107C	Rem.				0.005-0.015		2.1-2.6 Fe 0.05-0.20 Zn 0.2	-	Special tube products and strip for lead frames (see EN 1758)	240-550	350-600	13-5	100-180		RH							MRH	
CuSi1	CW115C	Rem.					0.8-2.0	0.5	-	Special wire products.	300-400	510-760	15-6	145-200						MRHG				
CuSi3Mn	CW116C	Rem.					2.7-3.2	0.7-1.3 Mn 0.5	CS101	Good corrosion resistance and strength. Nails, marine fixings, welding wire.	200-890	380-900	50-3	90-220			MRH			MRHG				
CuSn0.15	CW117C	Rem.						0.10-0.15 Sn 0.1	-	Strip for leadframes (see EN 1758)		250-490	9-2	60-140										88
CuZn0.5	CW119C	Rem.						0.1-1.0 Zn 0.1	-	Strip for radiator fins.	140-320	220-480	42-6	40-115	RH									80

Notes:

(1) M - as manufactured
R - mandatory tensile strength
H - mandatory hardness
G - mandatory grain size
B - mandatory spring bending limit
Y - mandatory 0.2% proof strength

(2) For general purposes

Table 9: Wrought Copper-aluminium, Copper-nickel and Copper-nickel-zinc Alloys – Compositions, Uses, Typical Properties, Relevant Standards and Machinability

Material Designation		Composition, %, Range or Max								Nearest Old BS Equivalent	Characteristics and Uses	Typical Mechanical Properties				Shows Inclusion In the following EN Standards with Indicated Material Conditions (1)										Machinability Index (%)
																1652	1653	1654	12163	12165	12166	12167	12449	12451	12452	
Symbol	Number	Cu	Al	Fe	Mn	Ni	Pb	Si	Others and Total Impurities			0.2% Proof Strength (N/mm²)	Tensile Strength (N/mm²)	Elongation (%)	Hardness (HV)	Plate, Strip, Sheet, Circles (2)	Plate, Sheet, Circles (3)	Strip for Springs, Connectors	Rod (2)	Forging Stock	Wire	Profiles, Rectangular Bar	Tubes (2)	Tubes for Heat Exchangers	Finned Tubes for Heat Exchangers	
Copper-aluminium (Aluminium Bronze)																										
CuAl5As	CW300G	Rem.	4.0 - 6.5						0.1 - 0.4 As 0.3	-	An alpha phase alloy for tube manufacture. May be heavily cold worked.	130	380	55	85									RH		20
CuAl6Si2Fe	CW301G	Rem.	6.0 - 6.4	0.5 - 0.7				2.0 - 2.4	0.2	CA107	Medium strength alloys, readily hot worked and moderately cold workable. With machinability of 40-50%, the alloys are suitable for manufacture of items of chemical plant, machine parts, tools and instruments when good corrosion resistance is required.	250-350	500-650	25-10	125-160				MRH	MH		MRH				50
CuAl7Si2	CW302G	Rem.	7.3 - 7.6					1.5 - 2.2	0.2	-		250-350	500-650	25-10	125-160				MRH	MH		MRH				50
CuAl8Fe3	CW303G	Rem.	6.5 - 8.5	1.5 - 3.5					0.2	CA106		180-210	460-500	30	125-135	RH	R			MH						20
CuAl9Ni3Fe2	CW304G	Rem.	8.0 - 9.5	1.0 - 3.0		2.0 - 4.0			0.2	CA105		180	500	30	125		R			MH						20
CuAl10Fe1	CW305G	Rem.	9.0 - 10.0	0.5 - 1.5					0.3	-		210-480	420-670	22-5	110-205				MRH	MH		MRH				20
CuAl10Fe3Mn2	CW306G	Rem.	9.0 - 11.0	2.0 - 4.0	1.5 - 3.5				0.2	-	High strength alloys for use in aggressive media when wear resistance and good impact strength are required.	330-510	600-720	15-5	130-210				MRH	MH		MRH				30
CuAl10Ni5Fe4	CW307G	Rem.	8.5 - 11.0	3.0 - 5.0		4.0 - 6.0			0.2	CA104		400-530	600-760	15-5	170-220		R		MRH	MH		MRH				30
CuAl11Fe6Ni6	CW308G	Rem.	10.5 - 12.5	5.0 - 7.0		5.0 - 7.0			0.2	-		500-680	750-850	10-5	200-260				MRH	MH		MRH				30
Copper-nickel																										
CuNi25	CW350H	Rem.				24.0 - 26.0			0.1	CN105	UK "silver" coinage alloy.	120	300	-	85	RH										20
CuNi9Sn2	CW351H	Rem.				8.5 - 10.5			1.8 - 2.8 Sn 0.1	-	Good elastic properties for electrical contacts.	200-550	350-620	45-2	80-220	RH		RHB								20
CuNi10Fe1Mn	CW352H	Rem.		1.0 - 2.0	0.5 - 1.0	9.0 - 11.0			0.2	CN102	Excellent sea-water corrosion resistance. The alloys with 30% nickel have good resistance to erosion.	100-420	290-520	35-8	80-160	RH	R		MRH	MH			RH	RH	RH	20
CuNi30Fe2Mn2	CW353H	Rem.		1.5 - 2.5	1.5 - 2.5	29.0 - 32.0			0.2	CN108		175	450	35	110									RH		20
CuNi30Mn1Fe	CW354H	Rem.		0.4 - 1.0	0.5 - 1.5	30.0 - 32.0			0.2	CN107		130-330	350-520	35-12	90-130	RH	R		MRH	MH			RH	RH	RH	20
Copper-nickel-zinc (Nickel Silver)																										
CuNi10Zn27	CW401J	61.0 - 64.0				9.0 - 11.0			Zn Rem. 0.2	NS103	Alpha phase alloys with good corrosion resistance. Colour becomes whiter as nickel content increases. Lead, when present, improves machinability. Applications include tableware, telecommunication components, decorative building features and general mechanical and food manufacturing equipment.	180-880	360-880	50-2	80-210	RHG					MRHG						30
CuNi12Zn24	CW403J	63.0 - 66.0				11.0 - 13.0			Zn Rem. 0.2	NS104		180-800	360-880	50-2	80-210	RHG		RH	MRH		MRHG	MRH	RH			30
CuNi12Zn25Pb1	CW404J	60.0 - 63.0				11.0 - 13.0	0.5 - 1.5		Zn Rem. 0.2	NS111		260-650	380-730	20-2	110-210	RH										75
CuNi12Zn29	CW405J	57.0 - 60.0				11.0 - 13.5			Zn Rem. 0.2	-		450-720	520-820	4-2	170-240			RH								30
CuNi12Zn30Pb1	CW406J	56.0 - 58.0				11.0 - 13.0	0.5 - 1.5		Zn Rem. 0.2	-		300-440	410-550	15-2	110-190						MRH	MRH				80
CuNi18Zn19Pb1	CW408J	59.5 - 62.5				17.0 - 19.0	0.5 - 1.5		Zn Rem. 0.2	NS113		320-460	450-600	15-2	120-200						MRH	MRH				75
CuNi18Zn20	CW409J	60.0 - 63.0				17.0 - 19.0			Zn Rem. 0.2	NS106		200-800	380-900	40-2	85-230	RHG		RHB	MRH		MRHG	MRH	RH			30
CuNi18Zn27	CW410J	53.0 - 56.0				17.0 - 19.0			Zn Rem. 0.2	NS107		280-680	400-820	45-2	90-230	RH		RH								30
CuNi7Zn39Pb3Mn2	CW400J	47.0 - 50.0			1.5 - 3.0	6.0 - 8.0	2.3 - 3.3		Zn Rem. 0.2	-	Two-phase, alpha-beta alloys for similar applications to those above but for use when hot formability is required for production of forgings or hot extruded architectural profiles.	250-620	460-720	20-2	120-220					MH	MRH	MRH				90
CuNi10Zn42Pb2	CW402J	45.0 - 48.0				9.0 - 11.0	1.0 - 2.5		Zn Rem. 0.2	NS101		250-500	460-660	15-2	120-220					MH	MRH	MRH				90
CuNi12Zn38Mn5Pb2	CW407J	42.0 - 45.0			4.5 - 6.0	11.0 - 13.0	1.0 - 2.5		Zn Rem. 0.2	-		400-450	600-660	8	165-190							MRH				80

Notes:

(1) M - as manufactured
R - mandatory tensile strength
H - mandatory hardness
G - mandatory grain size
B - mandatory spring bending limit

(2) For general purposes

(3) For boilers, pressure vessels and hot water storage units

Table 10: Wrought Copper–zinc and Copper–tin Binary Alloys – Compositions, Uses and Typical Properties

Material Designation		Composition, %, Range or Max						Nearest Old BS Equivalent	Characteristics and Uses	Typical Mechanical Properties				Inclusion in the following EN Standards with Indicated Material Conditions (1)							
														1652	1654	12163	12164	12165	12166	12167	12449
Symbol	Number	Cu	P	Pb	Sn	Zn	Others			0.2% Proof Strength (N/mm²)	Tensile Strength (N/mm²)	Elongation (%)	Hardness (HV)	Plate, Strip, Sheet, Circles (2)	Strip for Springs, Connectors	Rod (2)	Rod for Free Machining	Forging Stock	Wire	Profiles, Rectangular Bar	Tubes (2)
Copper–zinc (Brass)																					
CuZn5	CW500L	94.0 - 96.0				Rem.	0.1	CZ125	Very good cold working properties for electrical engineering components. Flexible tubes and sleeves. Attractive range of colours for costume jewellery. Can easily be enamelled.	60-420	240-420	45-4	50-125	RH		MRH					MRH
CuZn10	CW501L	89.0 - 91.0				Rem.	0.1	CZ101		120-560	240-600	45-2	60-165	RH		MRH			MRHG		MRH
CuZn15	CW502L	84.0 - 86.0				Rem.	0.1	CZ102		120-590	260-630	50-2	65-170	RHG	RHY	MRH			MRHG		MRH
CuZn20	CW503L	79.0 - 81.0				Rem.	0.1	CZ103		120-590	260-630	50-2	65-170	RHG		MRH			MRHG		MRH
CuZn28	CW504L	71.0 - 73.0				Rem.	0.1	-	Very good cold working properties for extreme deep drawing and cold forging applications.	120-420	310-500	30-2	90-160			MRH					
CuZn30	CW505L	69.0 - 71.0				Rem.	0.1	CZ106		130-810	300-830	55-1	65-200	RHG	RHY	MRH			MRHG		MRH
CuZn33	CW506L	66.0 - 68.0				Rem.	0.1	-		120-420	300-500	30-2	65-160	RHG		MRH					
CuZn36	CW507L	63.5 - 65.5				Rem.	0.1	CZ107	The standard alloys for deep drawing, spinning, upsetting, thread rolling and bending. Good soldering properties.	130-800	280-820	50-1	65-190	RHG	RH	MRH			MRHG	MRH	MRH
CuZn37	CW508L	62.0 - 64.0				Rem.	0.1	CZ108		130-800	280-820	50-1	65-190	RHG		MRH		MH	MRHG	MRH	MRH
CuZn40	CW509L	59.5 - 61.5				Rem.	0.2	CZ109	Muntz metal - good hot and cold working properties.	200-420	340-500	45-2	90-150	RH		MRH		MH		MRH	MRH
Copper–tin (Phosphor Bronze)																					
CuSn4	CW450K	Rem.	0.01 - 0.4		3.5 - 4.5		0.2	PB101	Strength increases as tin content increases. Good corrosion and corrosion fatigue properties lead to uses such as springs, instrument components, wire cloth, condenser tube-plates and vessels, and electronic components. Controlled resistivity wire for power applications.	140-850	320-950	60-1	75-230	RH	RHY				MRHG		
CuSn5	CW451K	Rem.	0.01 - 0.4		4.5 - 5.5		0.2	PB102		140-850	320-950	60-1	75-230	RH	RHY	MRH			MRHG		
CuSn6	CW452K	Rem.	0.01 - 0.4		5.5 - 7.0		0.2	PB103		140-950	340-1000	60-1	80-250	RH	RHYB	MRH			MRHG	MRH	MRH
CuSn8	CW453K	Rem.	0.01 - 0.4		7.5 - 8.5		0.2	PB104		170-1000	390-1100	60-1	85-270	RH	RHYB	MRH			MRHG	MRH	MRH
CuSn8P	CW459K	Rem.	0.2 - 0.4		7.5 - 8.5		0.2	-		260-550	390-650	50-2	95-200			MRH					MRH
CuSn4Pb2P	CW455K	Rem.	0.2 - 0.4	1.5 - 2.5	3.5 - 4.5		0.2	-	Free-machining versions of the above alloys.	400-500	480-550	10-5	150-210				MR				MRH
CuSn4Te1P	CW457K	Rem.	0.1 - 0.4		4.0 - 5.0		(0.5 - 1.0 Te) 0.2	-		300-400	380-480	15-2	140-160				MR				
CuSn5Pb1	CW458K	Rem.	0.01 - 0.4	0.5 - 1.5	3.5 - 4.5		0.2	-		350-680	450-750	15-2	150-210				MR				
CuSn8PbP	CW460K	Rem.	0.2 - 0.4	0.1 - 0.5	7.5 - 9.0		0.2	-		280-550	460-650	40-5	125-180								MRH
CuSn3Zn9	CW454K	Rem.			1.5 - 3.5	7.5 - 10.0	0.2	-	A dilute alloy with properties approaching those of the true bronzes.	200-620	320-700	40-2	80-210	RH	RH						
CuSn4Pb4Zn4	CW456K	Rem.	0.01 - 0.4	3.5 - 4.5	3.5 - 4.5	3.5 - 4.5	0.2	-	Wrought version of a casting-type, bearing material composition.	350-680	450-750	15-2	150-210				MR				

Notes:

(1) M – as manufactured
R – mandatory tensile strength
H – mandatory hardness
G – mandatory grain size
B – mandatory spring bending limit
Y – mandatory 0.2% proof strength

(2) For general purposes

Table 11: Wrought Copper-zinc-lead Alloys (Leaded Brasses) – Compositions, Uses, Typical Properties, Relevant Standards and Machinability

Material Designation		Composition, %, Range or Max.							Nearest Old BS Equivalent	Characteristics and Uses	Typical Mechanical Properties				Inclusion in the following EN Standards with Indicated Material Conditions (1)							Machinability Index (%)
															1652	12164	12165	12166	12167	12168	12449	
Symbol	Number	Cu	Al	As	Pb	Sn	Zn	Others Total			0.2% Proof Strength (N/mm^2)	Tensile Strength (N/mm^2)	Elongation (%)	Hardness (HV)	Plate, Strip, Sheet, Circles(2)	Free Machining Rod	Forging Stock	Wire	Profiles, Rectangular Bar	Free Machining Hollow Rod	Tubes (2)	
CuZn36Pb3	CW603N	60.0 - 62.0			2.5 - 3.5		Rem.	0.2	CZ124	These alloys have excellent machinability but very limited cold workability. Alloy CW614N is rated as a standard against which other materials are compared. Alloy CW617N is the standard hot forging brass.	160-450	340-580	35-5	90-150		MR		MRH	MRH	MH	MRH	95
CuZn39Pb3	CW614N	57.0 - 59.0			2.5 - 3.5		Rem.	0.2	CZ121Pb3		150-420	360-580	25-5	100-160		MR	MH	MRH	MRH	MH	MRH	100
CuZn40Pb2	CW617N	57.0 - 59.0			1.6 - 2.5		Rem.	0.2	CZ122		150-420	360-580	25-5	100-160		MR	MH	MRH	MRH	MH	MRH	90
CuZn37Pb2	CW606N	61.0 - 62.0			1.6 - 2.5		Rem.	0.2	CZ119, CZ131	These alloys have good machinability and some cold workability for limited bending and riveting.	160-450	300-580	45-5	90-150	RH	MR		MRH	MRH	MH		70
CuZn38Pb2	CW608N	60.0 - 61.0			1.6 - 2.5		Rem.	0.2	CZ120, CZ128		150-450	360-580	40-5	90-150	RH	MR	MH	MRH	MRH	MH	MRH	75
CuZn39Pb2	CW612N	59.0 - 60.0			1.6 - 2.5		Rem.	0.2	CZ120, CZ128		150-450	360-580	40-5	90-160	RH	MR	MH	MRH	MRH	MH		80
CuZn35Pb1	CW600N	62.5 - 64.0			0.8 - 1.6		Rem.	0.1	CZ118	These alloys are machinable and have good to very good cold workability. This group contains the standard alloys for bending, CW610N, and extreme riveting, CW601N.	150-450	300-580	45-10	90-150	RH	MR		MRH	MRH		MRH	50
CuZn35Pb2	CW601N	62.0 - 63.5			1.6 - 2.5		Rem.	0.1	CZ119, CZ131		150-350	330-470	30-10	90-130		MR		MRH	MRH	MH	MRH	65
CuZn38Pb1	CW607N	60.0 - 61.0			0.8 - 1.6		Rem.	0.2	–		150-420	360-580	30-5	90-150		MR			MRH	MH	MRH	55
CuZn39Pb0.5	CW610N	59.0 - 60.5			0.2 - 0.8		Rem.	0.2	CZ123, CZ137		150-450	360-580	40-5	90-150	RH	MR	MH	MRH	MRH			50
CuZn39Pb1	CW611N	59.0 - 60.0			0.8 - 1.6		Rem.	0.2	CZ129		150-420	360-580	30-5	90-150		MR	MH		MRH	MH		60
CuZn36Pb2As	CW602N	61.0 - 63.0		0.02 - 0.15	1.7 - 2.8		Rem.	0.2	CZ132	Dezincification resistant brass with good machinability and moderate hot and cold workability.	120-200	280-450	40-20	80-140		MR	MH		MRH	MH	MRH	70
CuZn39Pb2Sn	CW613N	59.0 - 60.0			1.6 - 2.5	0.2 - 0.5	Rem.	0.2	–	These alloys have good machinability and limited cold workability.	150-420	360-580	30-5	90-150			MH		MRH			75
CuZn40Pb2Sn	CW619N	57.0 - 59.0			1.6 - 2.5	0.2 - 0.5	Rem.	0.2	–		150-420	360-580	25-5	100-160			MH		MRH			85
CuZn39Pb3Sn	CW615N	57.0 - 59.0			2.5 - 3.5	0.2 - 0.5	Rem.	0.2	–	These alloys are designed for hot forging.	130-160	340-380	20-12	85-95			MH					95
CuZn40Pb1Al	CW616N	57.0 - 59.0	0.05 - 0.30		1.0 - 2.0		Rem.	0.2	–		130-160	340-380	20-12	85-95			MH					60
CuZn40Pb2Al	CW618N	57.0 - 59.0	0.05 - 0.5		1.6 - 3.0		Rem.	0.2	–	This group of alloys is used for production of profiles by hot extrusion. Aluminium imparts a golden lustre, avoiding need for further polishing. The alloys with more than 1.6% Pb have very good machinability.	–	–	–	–					M			90
CuZn41Pb1Al	CW620N	57.0 - 59.0	0.05 - 0.5		0.8 - 1.6		Rem.	0.2	–		–	–	–	–					M			85
CuZn42PbAl	CW621N	57.0 - 59.0	0.05 - 0.5		0.2 - 0.8		Rem.	0.2	–		–	–	–	–					M			55
CuZn43Pb1Al	CW622N	55.0 - 57.0	0.05 - 0.5		0.8 - 1.6		Rem.	0.2	–		–	–	–	–					M			60
CuZn43Pb2Al	CW624N	55.0 - 57.0	0.05 - 0.5		1.6 - 3.0		Rem.	0.2	CZ130		–	–	–	–					M			95
CuZn43Pb2	CW623N	55.0 - 57.0			1.6 - 3.0		Rem.	0.2	CZ130		150-220	350-420	30-20	100-130					MRH			95
CuZn37Pb0.5	CW604N	62.0 - 64.0			0.1 - 0.8		Rem.	0.2	–	For manufacture of plate and tube.	160-450	300-580	45-10	80-150	RH						MRH	45
CuZn37Pb1	CW605N	61.0 - 62.0			0.8 - 1.6		Rem.	0.2	–	For manufacture of tube and hollow rod.	160-340	340-440	35-10	80-130						MH	MRH	50

Notes:

(1) M – as manufactured
R – mandatory tensile strength
H – mandatory hardness

(2) For general purposes

Table 12a: Wrought, Complex, Copper–zinc Alloys (Special Brasses) – Composition, Uses and Typical Properties

Material Designation		Composition, %, Range or Max									Nearest Old BS Equivalent	Characteristics and Uses	Typical Mechanical Properties			
Symbol	Number	Cu	Al	Fe	Mn	Pb	Si	Sn	Others	Zn			0.2% Proof Strength (N/mm²)	Tensile Strength (N/mm²)	Elongation (%)	Hardness (HV)
Corrosion Resistant Alloys																
CuZn13Al1Ni1Si1	CW700R	81.0 - 86.0	0.7 - 1.2				0.8 - 1.3		0.8 - 1.4 Ni	Rem.	CZ127	Special purpose tubes	120-350	400-580	50-10	70-180
CuZn20Al2As	CW702R	76.0 - 79.0	1.8 - 2.3						0.02 - 0.06 As	Rem.	CZ110	Sea-water resistant alloys for condenser plates and tubes; heat exchangers.	140-380	340-540	60-20	80-160
CuZn28Sn1As	CW706R	70.0 - 72.5						0.9 - 1.3	0.02 - 0.06 As	Rem.	CZ111		110-410	320-460	60-20	80-160
CuZn30As	CW707R	69.0 - 71.0							0.02 - 0.06 As	Rem.	CZ126		110-410	320-460	60-20	80-160
CuZn38AlFeNiPbSn	CW715R	59.0 - 60.7	0.1 - 0.5	0.1 - 0.4		0.3 - 0.7		0.3 - 0.6	0.2 - 0.5 Ni	Rem.	–		160-220	400-460	25	115-130
CuZn38Sn1As	CW717R	59.0 - 62.0						0.5 - 1.0	0.02 - 0.06 As	Rem.	–		130-230	320-430	35-20	80-120
CuZn32Pb2AsFeSi	CW709R	64.0 - 66.5		0.1 - 0.2		1.5 - 2.2	0.45 - 0.8		0.03 - 0.08 As	Rem.	–	Complex DZR Brass	200-300	380-450	25-12	115-145
CuZn36Pb2Sn1	CW711R	59.5 - 61.5				1.3 - 2.2		0.5 - 1.0		Rem.	CZ134	Naval brasses for sea-water environments; 60-70% machinability when lead is included.	200-400	360-540	30-5	110-160
CuZn36Sn1Pb	CW712R	61.0 - 63.0				0.2 - 0.6		1.0 - 1.5		Rem.	CZ112		160-360	340-480	30-10	90-150
CuZn37Pb1Sn1	CW714R	59.0 - 61.0				0.4 - 1.0		0.5 - 1.0		Rem.	–		200-400	360-540	30-5	110-160
CuZn39Sn1	CW719R	59.0 - 61.0						0.5 - 1.0		Rem.	CZ133		160-360	340-480	30-10	190-210
High Tensile Brasses																
CuZn23Al6Mn4Fe3Pb	CW704R	63.0 - 65.0	5.0 - 6.0	2.0 - 3.5	3.5 - 5.0	0.2 - 0.8				Rem.	–	High strength structural materials. CW722R is aluminium-free and suitable for brazing and soldering. Machinability 50-80%.	500-540	700-800	10	190-210
CuZn25Al5Fe2Mn2Pb	CW705R	65.0 - 68.0	4.0 - 5.0	0.5 - 3.0	0.5 - 3.0	0.2 - 0.8				Rem.	CZ116		300-400	550-650	12	150-200
CuZn35Ni3Mn2AlPb	CW710R	58.0 - 60.0	0.3 - 1.3		1.5 - 2.5	0.2 - 0.8			2.0 - 3.0 Ni	Rem.	–		250-350	450-550	15	120-150
CuZn40Mn1Pb1AlFeSn	CW721R	57.0 - 59.0	0.3 - 1.3	0.2 - 1.2	0.8 - 1.8	0.8 - 1.6		0.2 - 1.0		Rem.	CZ114		200-380	450-580	30-15	130-170
CuZn40Mn1Pb1FeSn	CW722R	56.5 - 58.5		0.2 - 1.2	0.8 - 1.8	0.8 - 1.6		0.2 - 1.0		Rem.	CZ115		200-380	450-580	30-15	130-170
CuZn31Si1	CW708R	66.0 - 70.0					0.7 - 1.3			Rem.	–	Bearings and sliding stress requirements, synchro rings. Machinability 40-50%.	250-350	460-560	25-10	120-160
CuZn37Mn3Al2PbSi	CW713R	57.0 - 59.0	1.3 - 2.3		1.5 - 3.0	0.2 - 0.8	0.3 - 1.3			Rem.	CZ135		300-450	550-650	25-8	170-210
CuZn39Mn1AlPbSi	CW718R	57.0 - 59.0	0.3 - 1.3		0.8 - 1.8	0.2 - 0.8	0.2 - 0.8			Rem.	–		250-350	440-540	20-10	120-170
Other Brasses																
CuZn19Sn	CW701R	80.0 - 82.0						0.2 - 0.5		Rem.	–	Scouring pads.	–	350-900	55-35	70-180
CuZn23Al3Co	CW703R	72.0 - 75.0	3.0 - 3.8						0.25 - 0.55 Co	Rem.	–	Springs, connectors.	600-800	660-880	12-4	200-250
CuZn38Mn1Al	CW716R	59.0 - 61.5	0.3 - 1.3		0.6 - 1.8					Rem.	–	Medium strength structural materials.	200-350	450-570	20-8	130-160
CuZn40Mn1Pb1	CW720R	57.0 - 59.0			0.5 - 1.5	1.0 - 2.0				Rem.	CZ136		160-350	350-550	20-10	100-170
CuZn40Mn2Fe1	CW723R	56.5 - 58.5		0.5 - 1.5	1.0 - 2.0					Rem.	–		160-320	350-550	20-8	100-160

Table 12b: Wrought, Complex, Copper-zinc Alloys (Special Brasses) – Relevant Standards

Material Designation		Inclusion in the following EN Standards with Indicated Material Conditions (1)											
Symbol	Number	1652	1653	1654	12163	12164	12165	12166	12167	12168	12449	12451	12452
		Plate, Sheet, Strip, Circles (2)	Plate, Sheet, Circles (3)	Strip for Springs, Connectors	Rod (2)	Rod for Free-machining	Forging Stock	Wire	Profiles, Rectangular Bar (2)	Hollow Rod for Free-machining	Tubes (2)	Tubes for Heat Exchangers	Finned Tubes for Heat Exchangers
Corrosion Resistant Alloys													
CuZn13Al1Ni1Si1	CW700R										MRH		
CuZn20Al2As	CW702R	RH	R								MRH	RH	RH
CuZn28Sn1As	CW706R											RH	RH
CuZn30As	CW707R											RH	
CuZn38AlFeNiPbSn	CW715R		R										
CuZn38Sn1As	CW717R		R										
CuZn32Pb2AsFeSi	CW709R				MRH								
CuZn36Pb2Sn1	CW711R					MR				MH			
CuZn36Sn1Pb	CW712R				MRH		MH	MRH	MRH				
CuZn37Pb1Sn1	CW714R					MR	MH	MRH	MRH	MH			
CuZn39Sn1	CW719R		R		MRH		MH		MRH				
High Tensile Brasses													
CuZn23Al6Mn4Fe3Pb	CW704R				MRH		MH						
CuZn25Al5Fe2Mn2Pb	CW705R				MRH		MH						
CuZn35Ni3Mn2AlPb	CW710R				MRH		MH		MRH		MRH		
CuZn40Mn1Pb1AlFeSn	CW721R					MR	MH		MRH	MH			
CuZn40Mn1Pb1FeSn	CW722R					MR	MH		MRH	MH			
CuZn31Si1	CW708R				MRH						MRH		
CuZn37Mn3Al2PbSi	CW713R					MR	MH		MRH	MH	MRH		
CuZn39Mn1AlPbSi	CW718R				MRH		MH		MRH		MRH		
Other Brasses													
CuZn19Sn	CW701R							MRH					
CuZn23Al3Co	CW703R			RH									
CuZn38Mn1Al	CW716R				MRH						MRH		
CuZn40Mn1Pb1	CW720R					MR	MH	MRH	MRH	MH			
CuZn40Mn2Fe1	CW723R				MRH		MH		MRH		MRH		

Notes:

(1) M – as manufactured
R – mandatory tensile strength
H – mandatory hardness (HB)

(2) For general purposes

(3) For boilers, pressure vessels and hot water storage units

Table 13: Copper and Copper Alloys for Welding and Braze Welding - Composition and Melting Ranges (EN 13347)

Material Designation		Composition, %, Range or Max											Nearest Old BS Equivalent			Equivalent in EN 1044 (2)	Melting Range °C
Symbol	Number	Cu	Al	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	Others Total	1453	1845	2910		
Coppers																	
Cu-ETP	CF004A	99.90 min	0.0005 Bi, 0.005 Pb, Total 0.03 max excl. Ag, O(1)													Cu101	1085
Cu-OF	CF008A	99.90 min	0.0005 Bi, 0.005 Pb, Total 0.03 max excl. Ag, (1)											Cu3		Cu102	1085
Cu-DHP	CF024A	99.90 min					0.015-0.040							Cu6		Cu104	1085
Miscellaneous Copper Alloys																	
CuMnSi	CF132C	Rem.	0.03	0.03	0.1-0.4	0.1	0.015	0.01	0.1-0.4	0.1		0.2			C7		
CuSn1MnSi	CF133C	Rem.	0.03	0.03	0.1-0.4	0.1	0.015	0.01	0.1-0.4	0.5-1.0		0.2			C7		
CuSi3Mn1	CF116C	Rem.	0.05	0.2	0.7-1.3		0.05	0.05	2.7-3.2		0.4	0.5			C9		
CuMn13Al6Fe2Ni2	CF239E	72.0-78.0	5.5-6.5	1.5-2.5	9.0-14.0	1.5-2.5		0.02	0.2		0.2	0.5					
Copper-phosphorus																	
CuP8	CF222E	Rem.	0.01				7.5-8.1	0.025			0.05	0.03 Bi 0.025 Cd 0.25				CP201	710-770
Copper-zinc																	
CuZn40Si	CF724R	58.5-61.5	0.01	0.25				0.02	0.2-0.4	0.2	Rem.	0.2	C2	CZ6		Cu301	875-895
CuZn40SiSn	CF725R	58.5-61.5	0.01	0.25				0.02	0.2-0.4	0.2-0.5	Rem.	0.2	C2	CZ6A		Cu302	875-895
CuZn40MnSi	CF726R	58.5-61.5	0.01	0.25	0.05-0.25			0.02	0.15-0.4	0.2	Rem.	0.2		CZ7		Cu303	870-900
CuZn40MnSiSn	CF727R	58.5-61.5	0.01	0.25	0.05-0.25			0.02	0.15-0.4	0.2-0.5	Rem.	0.2		CZ7A		Cu304	870-900
CuZn39Mn1SiSn	CF728R	59.0-61.0	0.05	0.05	0.05-1.0			0.02	0.15-0.40	0.2-0.5	Rem.	0.2					
CuZn37Si	CF729R	62.6-63.5	0.02	0.05	0.02	0.3		0.05	0.1-0.2	0.05	Rem.	0.2					
CuZn40Sn1	CF730R	57.0-61.0	0.02	0.2	0.01			0.05	0.2	0.25-1.0	Rem.	0.2					
CuZn40Sn1MnNiSi	CF731R	56.0-62.0	0.01	0.25	0.2-1.0	0.5-1.5		0.02	0.1-0.5	0.5-1.5	Rem.	0.2				Cu306	870-890
CuZn40Fe1Sn1MnSi	CF732R	56.0-60.0	0.01	0.25-1.2	0.01-0.5			0.05	0.04-0.15	0.8-1.1	Rem.	0.2	C2C				
CuZn39Fe1Sn1MnNiSi	CF733R	56.0-60.0	0.01	0.25-1.2	0.01-0.5	0.2-0.8		0.05	0.04-0.15	0.8-1.1	Rem.	0.2	C2B				
CuZn40FeSiSn	CF734R	58.5-61.5	0.02	0.1-0.5	0.05-0.25			0.03	0.15-0.3	0.2-0.5	Rem.	0.2	C4				
Copper-tin																	
CuSn5	CF451K	Rem.		0.1		0.2	0.01-0.4	0.02		4.5-5.5	0.2	0.2			C10		
CuSn6	CF452K	Rem.		0.1		0.2	0.01-0.4	0.02		5.5-7.0	0.2	0.2			C11	Cu201	910-1040
CuSn8	CF453K	Rem.		0.1		0.2	0.01-0.4	0.02		7.5-8.5	0.2	0.2					
CuSn12	CF461K	Rem.	0.005				0.01-0.4	0.02		11.0-13.0	0.05	0.025 Cd 0.4				Cu202	825-990
Copper-aluminium																	
CuAl8	CF309G	Rem.	7.0-9.0	0.5	0.5	0.5		0.02	0.2	0.1	0.2	0.2					
CuAl10Fe1	CF305G	Rem.	9.0-10.0	0.5-1.5	0.5	1.0		0.02	0.2		0.5	0.2			C13		
CuAl6Si2Fe	CF301G	Rem.	6.0-6.4	0.5-0.7	0.1	0.1		0.02	2.0-4.0	0.1	0.4	0.2			C23		
CuAl9Ni4Fe3Mn2	CF310G	Rem.	8.5-9.5	2.5-4.0	1.0-2.0	3.5-5.5		0.02	0.1		0.2	0.2			C20		
Copper-nickel-zinc																	
CuNi10Zn42	CF411J	46.0-50.0	0.01	0.25	0.2	8.0-11.0		0.02	0.15-0.4	0.2	Rem.	0.2				Cu305	890-920

Notes:

(1) Ag, As, Bi, Cd, Co, Cr, Fe, Mn, Ni, O, P, Pb, S, Sb, Se, Si, Sn, Te, Zn

(2) EN 1044 Brazing - filler metals

Table 14: Brass Rods and Sections - Compositions, Uses and Typical Properties

This table shows only the old BS alloys with their equivalent EN specifications. For alloys not included, see earlier tables.

Designation			Description	Composition, %, Range (Excluding Impurities)								Typical Mechanical Properties (1)				Remarks
Old BS Near Equivalent	EN			Cu	Al	Fe	Mn	Pb	Si	Others	Zn	0.2% Proof Strength (N/mm²)	Tensile Strength (N/mm²)	Elongation %	Hardness (HV)	
	Symbol	Number														
CZ121-Pb3	CuZn39Pb3	CW614N	High-speed machining brass	57.0-59.0				2.5-3.5			Rem.	110-260	370-460	35-15	90-160	The most suitable materials for high speed machining, but have limited ability to be cold worked. The hardness of sections is typically 115 HV.
CZ122	CuZn40Pb2	CW617N	Free cutting brasses	57.0-59.0				1.6-2.5			Rem.	140-310	350-540	40-15	90-160	Excellent machinability combined with sufficient ductility for some cold work. CW617N is the standard hot forging brass.
CZ124	CuZn36Pb3	CW603N		60.0-62.0				2.5-3.5			Rem.	140-320	340-520	40-5	70-160	
CZ128	CuZn38Pb2 and CuZn39Pb2	CW608N and CW612N		60.0-61.0 59.0-60.0				1.6-2.5 1.6-2.5			Rem. Rem	140-320 140-320	340-520 340-520	40-15 40-15	90-160 90-160	
CZ131 (superseded CZ119)	CuZn35Pb2 and CuZn37Pb2	CW601N CW606N	Free cutting brasses with improved ductility	62.0-63.5 61.0-62.0				1.6-2.5 1.6-2.5			Rem. Rem.	140-450 140-450	330-570 330-570	45-5 45-5	70-160 70-160	The higher copper and lower lead contents of these alloys improves ductility, while retaining free machining characteristics. Can be used for cold heading, riveting, etc. CW601N is the standard material for extreme riveting.
CZ129	CuZn39Pb1	CW611N		59.0-60.0				0.8-1.6			Rem.	120-280	340-460	45-20	90-140	
CZ120	CuZn38Pb2	CW608N		60.0-61.0				1.6-2.5			Rem.	140-320	340-520	40-15	90-160	
	CuZn39Pb2	CW612N		59.0-60.0				1.6-2.5			Rem.	140-320	340-520	40-15	90-160	
CZ104	(CuZn20Pb)	None		79.0-81.0				0.1-1.0			Rem.	90-460	340-650	50-5	70-170	
CZ130	CuZn43Pb2 and CuZn43Pb2Al	CW623N CW624N	Brasses for architectural sections	55.0-57.0 55.0-57.0	0.05-0.5			1.6-3.0 1.6-3.0			Rem. Rem.	160-200 160-200	370-430 370-430	35-25 35-25	90-120 90-120	The aluminium containing alloy has a bright yellow colour on the surface of extruded sections, while the manganese containing alloy may be toned to a chocolate brown colour. This gives an accentuated uniform improvement to natural oxidation effects.
CZ136	CuZn40Mn1Pb1	CW720R		57.0-59.0			0.5-1.5	1.0-2.0			Rem.	125-200	340-500	40-30	80-115	
CZ114	CuZn40Mn1Pb1AlFeSn	CW721R	High tensile brasses	57.0-59.0	0.3-1.3	0.2-1.2	0.8-1.8	0.8-1.6		0.2-1.0 Sn	Rem.	230-340	430-590	30-20	110-175	The alloying additions produce improved mechanical properties. The lead in CW721R improves machinability. Used for fasteners, valve parts, etc. Silicon addition gives added wear resistance.
CZ116	CuZn25Al5Fe2Mn2Pb	CW705R		65.0-68.0	4.0-5.0	0.5-3.0	0.5-3.0	0.2-0.8			Rem.	420-490	690-770	20-15	170-220	
CZ115	CuZn40Mn1Pb1FeSn	CW722R		56.5-58.5		0.2-1.2	0.8-1.8	0.8-1.6		0.2-1.0 Sn	Rem.	230-340	430-590	30-20	110-175	
CZ135	CuZn37Mn3Al2PbSi	CW713R	High tensile brass/ wear-resistant	57.0-59.0	1.3-2.3		1.5-3.0	0.2-0.8	0.3-1.3		Rem.	230-340	500-700	20-12	150-200	
CZ132	CuZn36Pb2As	CW602N	Dezincification-resistant brass	61.0-63.0				1.7-2.8		0.02-0.15 As	Rem.	110-140	310-370	45-35	70-80	Brass with good hot ductility which is then heat treated to give excellent resistance to dezincification (see CDA Information Sheet No. IS 36). The addition of arsenic to 70/30 brass improves resistance to corrosion.
CZ105 and CZ126	CuZn30As	CW707R	Arsenical brass	69.0-71.0						0.02-0.06 As	Rem.	110-170	200-350	55-20	70-90	
CZ112	CuZn36Sn1Pb	CW712R	Naval brass	61.0-63.0				0.2-0.6		1.0-1.5 Sn	Rem.	125-185	340-430	40-20	100-160	The tin addition improves corrosion resistance, especially in sea water. The leaded version has improved machinability.
CZ134	CuZn36Pb2Sn1	CW711R	Leaded naval brass	59.5-61.5				1.3-2.2		0.5-1.0 Sn	Rem.	125-170	340-400	40-20	100-150	
CZ133	CuZn39Sn1	CW719R	Naval brass (uninhibited)	59.0-61.0						0.5-1.0 Sn	Rem.	155-280	400-460	30-20	100-145	
CZ137 (superseded CZ123)	CuZn39Pb0.5	CW610N	60/40 brasses	59.0-60.5				0.2-0.8			Rem.	120-280	340-460	45-25	90-150	Will withstand limited amount of cold working and bending.
CZ109	CuZn40	CW509L		59.5-61.5							Rem.	120-280	340-460	45-25	90-150	
CZ106	CuZn30	CW505L	Ductile brasses	69.0-71.0							Rem.	90-480	370-770	55-3	70-190	Can be deformed extensively by cold working.
CZ107	CuZn36	CW507L		63.5-65.5							Rem.	90-480	370-770	55-3	70-190	
CZ103	CuZn20	CW503L		79.0-81.0							Rem.	90-460	340-650	50-5	70-170	

Notes:

(1) Properties:

The typical mechanical properties shown apply to rod for free machining and general purposes which can have significant cold drawing after extrusion. The values represent those typically required rather than the limits that are possible. Products such as hollows and profiles which are not normally significantly cold drawn will have the lower end of the range for proof stress, tensile strength and hardness and will have good elongation values.

Compositions:

Compositions given are the EN materials appropriate to designation number. Composition ranges may be outside those of previous BS specifications, therefore compliance should be checked before assuming suitability for applications.

Standards:

This table includes materials previously included in BS 2874 'Specification for copper and copper alloy rods and sections (other than forging stock)'. These materials are now included in the following EN standards for individual product forms:

EN 12163 'Copper and copper alloys - Rod for general purposes'
EN 12164 'Copper and copper alloys - Rod for free machining purposes'
EN 12167 'Copper and copper alloys - Profiles and rectangular bar for general purposes'
EN 12168 'Copper and copper alloys - Hollow rod for free machining purposes'

Table 15: Brass Forgings, Stampings and Hot Pressings - Compositions, Uses and Typical Properties

This table shows only the old BS alloys with their equivalent EN specifications. For alloys not included, see earlier tables.

Designation			Description	Composition, %, Range (Excluding Impurities)							Typical Mechanical Properties (Except where Minimum Quoted)				Remarks
Old BS Near Equivalent	EN			Cu	Al	Fe	Mn	Pb	Others	Zn	0.2% Proof Strength (N/mm²)	Tensile Strength (N/mm²)	Elongation %	Hardness (HV)	
	Symbol	Number													
CZ122	CuZn40Pb2	CW617N	Leaded brasses	57.0-59.0				1.6-2.5		Rem.	170	400	35	100	The most popular alloy for hot stamping. The lead content ensures free-machining characteristics. Commonly used hot stamping brasses with a useful range of ductility and machinability.
CZ121-Pb3	CuZn39Pb3	CW614N		57.0-59.0				2.5-3.5		Rem	200	420	32	100	
CZ121-Pb4	CuZn38Pb4	CW609N		57.0-59.0				3.5-4.2		Rem.	180	380	40	100	
CZ128	CuZn38Pb2 and CuZn39Pb2	CW608N and CW612N		60.0-61.0 59.0-60.0				1.6-2.5 1.6-2.5		Rem. Rem.	180 180	380 380	40 40	100 100	
CZ129	CuZn39Pb1	CW611N		59.0-60.0				0.8-1.6		Rem.	180	380	40	100	
CZ137 (superseded CZ123)	CuZn39Pb0.5	CW610N	60/40 brasses	59.0-60.5				0.2-0.8		Rem.	140	370	40	100	These alloys are very plastic at the hot working temperature, therefore very intricate shapes, showing fine surface detail, can be produced. Components made from these alloys have limited cold working ability.
CZ109	CuZn40	CW509L	Lead free 60/40 brass	59.5-61.5						Rem.	140	370	40	100	
CZ114	CuZn40Mn1Pb1AlFeSn	CW721R	High tensile brasses	57.0-59.0	0.3-1.3	0.2-1.2	0.8-1.8	0.8-1.6	0.2-1.0 Sn	Rem.	195 min	460 min	15 min	110	Used in applications where high strength is required, such as high pressure gas valves etc. The lead addition in CW721R improves machinability.
CZ116	CuZn25Al5Fe2Mn2Pb	CW705R		65.0-68.0	4.0-5.0	0.5-3.0	0.5-3.0	0.2-0.8		Rem.	295 min	540 min	12 min	160	
CZ115	CuZn40Mn1Pb1FeSn	CW722R	High tensile brass (soldering quality)	56.5-58.5		0.2-1.2	0.8-1.8	0.8-1.6	0.2-1.0 Sn	Rem.	195 min	460 min	15 min	110	Similar to CW721R, but the restriction in aluminium content avoids non-wetting problems during soft soldering operations.
CZ135	CuZn37Mn3Al2PbSi	CW713R	High tensile brass with silicon	57.0-59.0	1.3-2.3		1.5-3.0	0.2-0.8	0.3-1.3 Si	Rem.	230 min	500 min	12 min	150	Readily hot stamped. Possesses excellent wear resistance.
CZ132	CuZn36Pb2As	CW602N	Dezincification-resistant brass	61.0-63.0				1.7-2.8	0.02-0.15 As	Rem.	130	350	40	75	Brass with good hot ductility which is then heat treated to give excellent resistance to dezincification.
CZ136	CuZn40Mn1Pb1	CW720R	Manganese brass	57.0-59.0			0.5-1.5	1.0-2.0		Rem.	125	340	40	90	Used for architectural purposes. Generally it is chemically toned to a decorative chocolate colour. Also used for valve spindles and nuts in contact with cast iron, having an excellent resistance to seizure.
CZ112	CuZn36Sn1Pb	CW712R	Naval brass	61.0-63.0				0.2-0.6	1.0-1.5 Sn	Rem.	150	390	35	110	The tin addition improves corrosion resistance, especially in sea water. The higher melting temperature facilitates brazing with standard filler materials.
CZ104	(CuZn20Pb)	None													

Notes:

Compositions:
Compositions given are the EN materials appropriate to designation number. Composition ranges may be outside those of previous BS specifications, therefore compliance should be checked before assuming suitability for applications.

Standards:
This table includes materials previously included in BS 2872 'Specification for copper and copper alloy forging stock and forgings'. These materials are now included in the following EN standards for individual product forms:
EN 12420 'Copper and copper alloys - Forgings'
EN 12165 'Copper and copper alloys - Wrought and unwrought forging stock'

Table 16: Brass Sheet, Strip and Plate - Compositions, Uses and Typical Properties

This table shows only the old BS alloys with their equivalent EN specifications. For alloys not included, see earlier tables.

Designation			Description	Composition, %, Range (Excluding Impurities)					Typical Mechanical Properties (1)								Remarks
Old BS Near Equivalent	EN			Cu	Al	Pb	Others	Zinc	0.2% Proof Strength (N/mm²)		Tensile Strength (N/mm²)		Elongation %		Hardness (HV)		
	Symbol	Number							(a)	(h)	(a)	(h)	(a)	(h)	(a)	(h)	
Cold Rolled Sheet and Strip																	
CZ125	CuZn5	CW500L	Cap Copper	94.0-96.0				Rem.	100	370	250	420	50	4	60	130	Industrial use practically confined to caps for ammunition.
CZ101	CuZn10	CW501L	Gilding Metals	89.0-91.0				Rem.	100	385	265	450	55	8	60	140	Used for architectural metalwork, imitation jewellery etc. on account of golden colours and ability to be brazed and enamelled.
CZ102	CuZn15	CW502L		84.0-86.0				Rem.	100	400	290	465	60	10	65	150	
CZ103	CuZn20	CW503L		79.0-81.0				Rem.	110	450	310	540	65	12	70	160	
CZ106	CuZn30	CW505L	70/30 brass (Cartridge brass)	69.0-71.0				Rem.	125	450	325	540	70	15	70	170	Deep drawing brass having maximum ductility of the Cu-Zn alloys.
CZ107	CuZn36	CW507L	2/1 brass	63.5-65.5				Rem.	124	450	325	540	65	10	70	170	A good cold working alloy.
CZ108	CuZn37	CW508L	Common brass (Basis brass)	62.0-64.0				Rem.	125	550	355	585	55	7	80	180	General purpose alloy suitable for simple forming etc.
CZ137 (superseded CZ123)	CuZn39Pb0.5	CW610N	60/40 brass	59.0-60.5		0.2-0.8		Rem.	180	350	355	465	45	25	90	140	Good hot working alloys which can also be cold worked to a limited extent.
CZ109	CuZn40	CW509L	Lead free 60/40 brass	59.5-61.5				Rem.			355	465	45	25	90	140	
CZ110	CuZn20Al2As	CW702R	Aluminium brass	76.0-79.0	1.8-2.3		0.02-0.06 As	Rem.			340	390	60	50	75	100	The addition of aluminium and tin produces enhanced corrosion resistance when compared with the unalloyed brass.
CZ112	CuZn36Sn1Pb	CW712R	Naval brass	61.0-63.0		0.2-0.6	1.0-1.5 Sn	Rem.			370	525	45	20	95	160	
CZ120	CuZn38Pb2 and CuZn39Pb2	CW608N and CW612N	Leaded clock brasses	60.0-61.0 59.0-60.0		1.6-2.5 1.6-2.5		Rem. Rem.	170 170	495 495	420 420	590 590	30 30	5 5	110 110	185 185	In the hard condition these alloys can be accurately punched to shape with a minimum of 'burr', hence their major use as pinions for clocks, watches and instruments. Also suitable for engraving.
CZ131 (superseded CZ119)	CuZn35Pb2	CW601N		62.0-63.5		1.6-2.5		Rem.	125	465	340	540	50	7	75	175	
CZ118	CuZn35Pb1	CW600N		62.5-64.0		0.8-1.6		Rem.	108	325	325	525	50	7	70	170	
Hot Rolled Plate																	
CZ137 (superseded CZ123)	CuZn39Pb0.5	CW610N	60/40 brass	59.0-60.5		0.2-0.8		Rem.	170		385		40		110		Used for tube plates of condensers and similar purposes.
CZ109	CuZn40	CW509L	Lead free 60/40 brass	59.5-61.5				Rem.	170		385		40		110		
CZ110	CuZn20Al2As	CW702R	Aluminium brass	76.0-79.0	1.8-2.3		0.02-0.06 As	Rem.	170		400		35		110		These alloys are more resistant to corrosion (especially by sea water) than 60/40 brass. They are also used for the purposes outlined above.
CZ112	CuZn36Sn1Pb	CW712R	Naval brass	61.0-63.0		0.2-0.6	1.0-1.5 Sn	Rem.	120		340		55		85		
CZ105	CuZn30As	CW707R	70/30 arsenical brass	69.0-71.0			0.02-0.06 As	Rem.	110		325		55		85		
CZ106	CuZn30	CW505L	70/30 brass (Cartridge brass)	69.0-71.0				Rem.	110		325		55		85		

Notes:

(1) Ranges of tempers are available between annealed and hard and, for some materials, up to extra hard and extra spring hard.
(a) - annealed (h) - hard

Compositions:
Compositions given are the EN materials appropriate to designation number. Composition ranges may be outside those of previous BS specifications, therefore compliance should be checked before assuming suitability for applications.

Standards:
This table includes materials previously included in BS 2870 'Specification for rolled copper and copper alloys: sheet, strip and foil' and BS 2875 'Specification of copper and copper alloys: plate'. These materials are now included in the following EN standards for individual product forms:
EN 1652 'Copper and copper alloys - Plate, sheet, strip and circles for general purposes'
EN 1653 'Copper and copper alloys - Plate, sheet and circles for boilers, pressure vessels and hot water storage units'
EN 1654 'Copper and copper alloys - Strip for springs and connectors'
EN 1172 'Copper and copper alloys - Sheet and strip for building purposes'

Table 17: Brass Tubes - Compositions, Uses and Typical Properties

This table shows only the old BS alloys with their equivalent EN specifications. For alloys not included, see earlier tables.

Old BS Near Equivalent	EN		Description	Composition, %, Range (Excluding Impurities)						Typical Mechanical Properties (1)								Remarks
				Cu	Al	Pb	Si	Others	Zinc	0.2% Proof Strength (N/mm²)		Tensile Strength (N/mm²)		Elongation %		Hardness (HV)		
	Symbol	Number								(a)	(h)	(a)	(h)	(a)	(h)	(a)	(h)	
CZ101	CuZn10	CW501L	90/10 brass	89.0-91.0					Rem.	90	340	260	420	60	20	60	125	Used for driving bands for projectiles. Architectural - hand rails. Communication systems - wave guides. Bellows for fluid and steam systems.
CZ102	CuZn15	CW502L	85/15 brass	84.0-86.0					Rem.	85	360	280	430	50	20	65	140	Used for condenser and cooling units, gauges and instrument tubes. Decorative uses. Musical instruments.
CZ103	CuZn20	CW503L	80/20 brass	79.0-81.0					Rem.	115	450	315	380	55	15	75	135	Architectural applications.
CZ108	CuZn37	CW508L	Common brass	62.0-64.0					Rem.	120	480	360	540	60	10	75	170	Sanitary and decorative applications. Aerials.
CZ109	CuZn40	CW509L	60/40 brass	59.5-61.5					Rem.	110		370		40		75		
CZ126	CuZn30As	CW707R	70/30 arsenical brass	69.0-71.0				0.02-0.06 As	Rem.	110	420	310	465	60	20	70	165	Standard compositions for condenser tubes. The arsenic is added to inhibit dezincification.
CZ111	CuZn28Sn1As	CW706R	Admiralty brass	70.0-72.5				0.02-0.06 As 0.9-1.3 Sn	Rem.	110	410	320	460	60	20	75	165	Good corrosion resistance in brackish water.
CZ110	CuZn20Al2As	CW702R	Aluminium brass	76.0-79.0	1.8-2.3			0.02-0.06 As	Rem.	115	460	360	560	60	20	75	165	Possesses excellent corrosion resistance in clean seawater and is a favoured alloy for condenser tubes.
CZ131 (superseded CZ119)	CuZn35Pb2	CW601N	Free cutting brass	62.0-63.5		1.6-2.5			Rem.	90	350	340	465	40	10	80	150	The lead content gives good machinability but ductility is reduced.
CZ127	CuZn13Al1Ni1Si1	CW700R	Aluminium-nickel-silicon brass	81.0-86.0	0.7-1.2		0.8-1.3	0.8-1.4 Ni	Rem.	n/a	360	n/a	495	n/a	44	n/a	n/a	Trade name 'Tungum'. Used for hydraulic and pneumatic control and instrumentation circuits in aviation, offshore and marine applications. Used to transmit high pressure oxygen (non-sparking).

Notes:
(1) Ranges of tempers are available between annealed and hard.
(a) - annealed (h) - hard.

Compositions:
Compositions given are the EN materials appropriate to designation number. Composition ranges may be outside those of previous BS specifications, therefore compliance should be checked before assuming suitability for applications.

Standards:
This table includes materials previously included in BS 2871 'Specification for copper and copper alloys. Tubes':
Part 1 'Copper tubes for water, gas and sanitation'
Part 2 'Tubes for general purposes'
Part 3 'Tubes for heat exchangers'
These materials are now included in the following EN standards for individual product forms:
EN 12449 'Copper and copper alloys - Seamless, round tubes for general purposes'
EN 12451 'Copper and copper alloys - Seamless, round tubes for heat exchangers'
EN 12452 'Copper and copper alloys - Rolled, finned seamless tubes for heat exchangers'.

Table 18: Brass Wire - Compositions, Uses and Typical Properties

This table shows only the old BS alloys with their equivalent EN specifications. For alloys not included, see earlier tables.

Old BS Near Equivalent	EN		Description	Composition, %, Range				Typical Mechanical Properties (1)				Remarks
				Cu	Pb	Others	Zn	Tensile Strength (N/mm²)		Elongation %		
	Symbol	Number						(a)	(hh)	(a)	(hh)	
CZ101	CuZn10	CW501L	90/10 brass	89.0-91.0			Rem.	280	420	50	10	Alloys within this range have better corrosion resistance properties than the lower copper content alloys and are used for paper machine plant. They are also used for ornamental purposes because of their colour and ability to be brazed. The addition of arsenic improves corrosion resistance still further.
CZ102	CuZn15	CW502L	85/15 brass	84.0-86.0			Rem.	310	510	55	10	
CZ103	CuZn20	CW503L	80/20 brass	79.0-81.0			Rem.	310	510	65	15	
CZ105 and CZ126	CuZn30As	CW707R	70/30 arsenical brass	69.0-71.0		0.02-0.06 As	Rem.	325	525	70	12	
CZ106	CuZn30	CW505L	70/30 brass	69.0-71.0			Rem.	325	525	70	12	Alloys of the higher copper contents, within the range quoted, are the most ductile and suitable for severe cold forming such as heading.
CZ107	CuZn36	CW507L	2/1 brass	63.5-65.5			Rem.	340	570	65	10	
CZ108	CuZn37	CW508L	Common brass	62.0-64.0			Rem.	340	550	60	10	
CZ109	CuZn40	CW509L	Lead-free 60/40 brass	59.5-61.5			Rem.	340	480	55	15	
CZ119	CuZn37Pb2	CW606N	Leaded brass	61.0-62.0	1.6-2.5		Rem.	340	400	50	25	The lead content is added to impart good machining properties but should be low if the brass is to be cold headed.
CZ121-Pb3	CuZn39Pb3	CW614N	Leaded brass 58% copper, 3% lead	57.0-59.0	2.5-3.5		Rem.	390	480	35	15	Wire supplied as continuous feedstock for high speed machining operations.
CZ122	CuZn40Pb2	CW617N	Free cutting brasses	57.0-59.0	1.6-2.5		Rem.	440	530	25	8	A variety of copper and lead contents to give a choice of optimum combinations of ductility, formability and machinability to suit a very wide range of end-uses.
CZ123	CuZn39Pb0.5	CW610N		59.0-60.5	0.2-0.8		Rem.	340	420	40	18	
CZ124	CuZn36Pb3	CW603N		60.0-62.0	2.5-3.5		Rem.	340	400	40	25	
CZ128	CuZn39Pb2	CW612N		59.0-60.0	1.6-2.5		Rem.	400	500	25	12	
CZ131 (superseded CZ119)	CuZn35Pb2	CW601N		62.0-63.5	1.6-2.5		Rem.	400	500	25	12	
NS103	CuNi10Zn27	CW401J	Nickel Silver	61.0-64.0		9.0-11.0 Ni	Rem.	360	850	40	6	White colour. Good corrosion resistance. Jewellery, model making.

Notes:
(1) Ranges of tempers are available between annealed and half hard. Hard and spring hard tempers are also available for most alloys.
(a) - annealed (hh) - half hard

Compositions:
Compositions given are the EN materials appropriate to designation number. Composition ranges may be outside those of previous BS specifications, therefore compliance should be checked before assuming suitability for applications.

Standards:
This table includes materials previously included in BS 2873 'Copper and copper alloys. Wire' which are now included in EN 12166 'Wire for General Purposes'.

Copper Development Association
5 Grovelands Business Centre
Boundary Way
Hemel Hempstead
Hertfordshire
HP2 7TE
Tel: +44 (0)1442 275700
Fax: +44 (0)1442 275716

Email: helpline@copperdev.co.uk
Websites: www.cda.org.uk www.brass.org