- The Basic application of the contact wire is carrying current for railway traction.
- Electric trains that collect current from overhead lines use a device such as a pantograph, Low collector or trolley pole. It presses against the underside of the lowest overhead wire that is called CONTACT WIRE.
- Mainly contact wire made from copper or copper alloy with different cross section area from 80 mm^2 to 193 mm^2 in different alloy form.

Different Type of Copper alloy is mentioned below:

1) Normal and High Strength Copper:-

Mainly used in INDIA RAILWAY-RDSO.
Copper ETP is still the most universal metal, but is increasingly being replaced by alloys with better characteristics. Non-alloyed Cu offer the best possible conductivity, and is typically used in contact wires for tramways and conventional railway lines but is most appropriate for auxiliary conductor and feeder cables.

2) Copper-Silver Alloy:-

This alloy offer electrical and mechanical characteristics similar to copper, but has better thermal stability. This allows higher over current on DC lines, without increasing the wear on the contact wire.

3) Copper-Cadmium Alloy:-

Copper cadmium combines high strength with good conductivity. With unsurpassed flex, CuCd is highly resistance to the frequent vibrations that ideal choice for high energy efficiency, reduced voltage drop and operational cost saving.

4) Copper-Magnesium Alloy:-

Copper Magnesium has the highest tensile strength when compared to other alloy, making it the perfect alloy for contact wire in high speed line with speed well above 300 km/h. Together it is the perfect alloy for the messenger/catenary cable, having the appropriate strength to carry the entire catenary system.

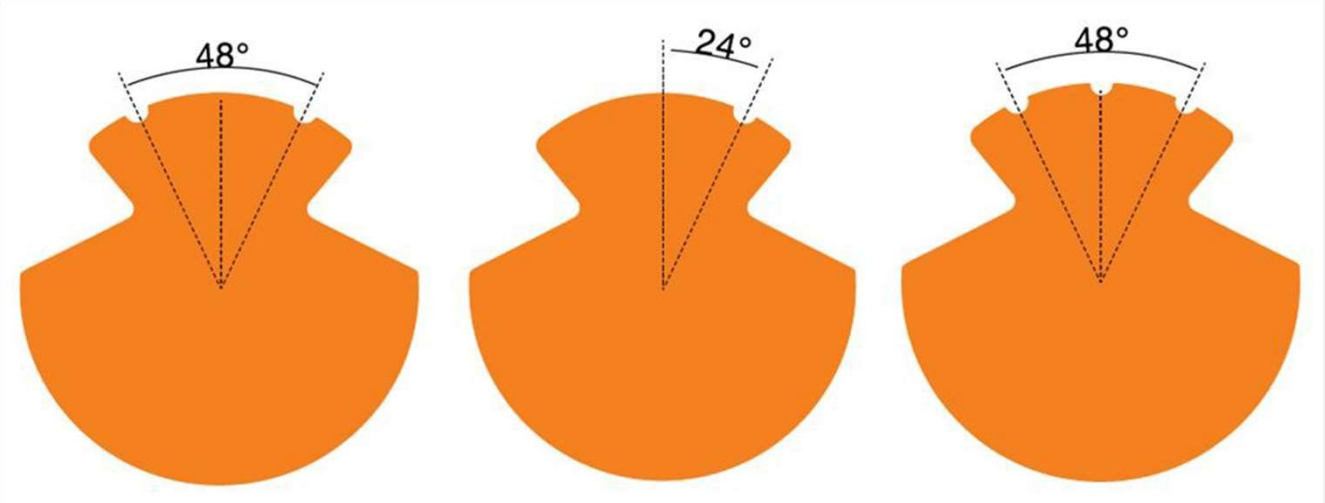
5) Copper-Tin Alloy:-

The development of a high performance Copper-Tin alloy was an imperative, displaying the right balance of electrical and mechanical properties. CuSn has applications for use in the contact wires for both high-speed and conventional railway lines.

Identification of Different Type of Contact wire :

***As per EN 50149:2012**

All wire manufactured from alloys shall be clearly identified. For normal and high strength copper and copper-silver, copper-cadmium. Copper-magnesium and copper- tin alloy the method of identification shall be by identification grooves as shown in below figure.



Contact wires made of copper-silver alloy have two identical identification grooves on the upper lobe of the wire.

Contact wires made of copper-tin alloy have one identification groove on the upper lobe of the wire at an angle of 24° from the vertical.

Contact wires made of copper-magnesium alloy have three identification grooves on the upper lobe of the wire.

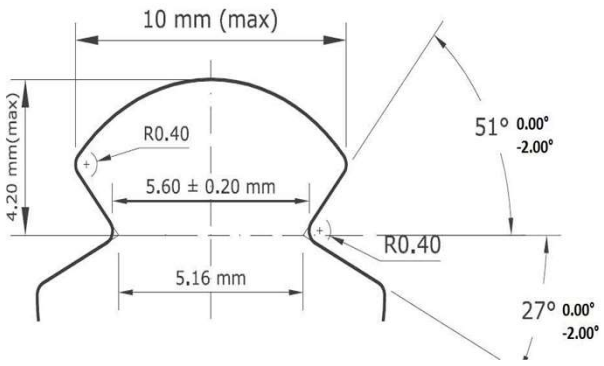
Contact wires made of copper-cadmium alloy have one identification groove on the upper lobe of wire.

Contact wires made of pure copper (Cu-ETP) do not have identification grooves.

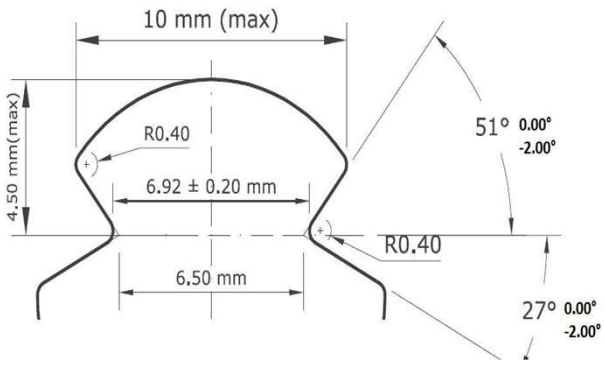
Identification of Different Sections of Contact wire :

***As per EN 50149:2012**

Whatever cross section of the contact wire id used, the dimensions of clamping grooves are accordance with either TYPE A or TYPE B as given in below figure.

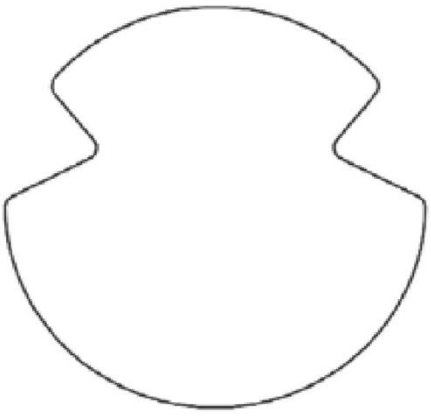


TYPE A CLAMPING GROOVE

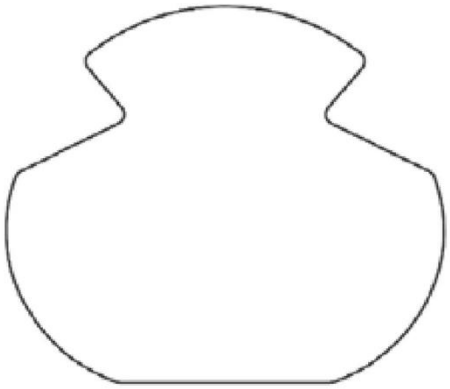


TYPE B CLAMPING GROOVE

Also, whatever clamping grooves is used; the main two types of profile are in accordance with either CIRCULAR TYPE or FLATTENED TYPE as given in below figure



CIRCULAR TYPE WIRE



FLATTENED TYPE WIRE

Nomenclature based on clamping grooves and shape of the contact wire
Example,AC-107

1) We can manufacture AC-107 with Type A Clamping groove having Circular bottom.
2) We can manufacture AC-107 with Type B Clamping groove having Circular bottom.
3) We can manufacture AC-107 with Type A Clamping groove having Flat bottom.
4) We can manufacture AC-107 with Type B Clamping groove having Flat bottom.

Identification of Contact wire based on Composition

***As per EN 50149:2012**

Common alloy compositions and designations									
Some possible material compositions and designations									
Material designation		Composition in %							
		Element							
Material group	Symbol		Cu	Bi	O	P	Pb	Other elements	
								Total	Excluding
Normal and high strength copper	Cu-ETP	Min.	99.90a	-	-	-	-	-	Ag, O
		max.	-	0.0005	0.040 b	-	0.005	0.03	
	Cu-FRHC	Min.	99.90a	-	-	-	-	-	Ag, O
		max.	-	-	0.040 b	-	-	0.04	
	Cu-OF	Min.	99.95	-	-	-	-	-	Ag
		max.	-	0.0005	c	-	0.005	0.03	
	Cu-HCP	Min.	99.95	-	-	0.002	-	-	Ag, P
		max.	-	0.0005	c	0.007	0.005	0.03	
			Cu	Bi	O		Ag	Other elements	
								Total	Excluding
Normal and high strength copper-silver-alloy	CuAg, 0.1	Min.	Rest	-	-	-	0.08	-	Ag, O
		max.	-	0.0005	0.04	-	0.012	0.03	
			Cu	Mg	Sn	Cd	p	Other elements	
								Total	Excluding
Copper-magnesium alloy	CuMg, 0.2	Min.	Rest	0.1	-	-	-	-	Mg, P
		max.		0.3	-	-	0.01	0.01	
	CuMg, 0.5	Min.	Rest	0.4	-	-	-	-	Mg, P
		max.		0.7	-	-	0.01	0.01	
Copper-tin alloy	CuSn, 0.2	Min.	Rest	-	1.15	-	-	-	Sn
		max.		-	0.55		-	0.01	
Copper- cadmium-alloy	CuCd, 0.7	Min.	Rest	-	-	0.5	-	-	Cd
		max.		-	-	0.8	-	0.01	
	CuCd, 1.0	Min.	Rest	-	-	0.8	-	-	Cd
		max.		-	-	1.2	-	0.01	

a Including silver, up to a maximum of 0,015 %.

b Oxygen content up to 0,060 % is permitted, subject to agreement between the purchaser and the supplier.

c The oxygen content shall be controlled by the manufacturer so that the material conforms to the hydrogen embritlement requirements.

NOTE 1 Composition of all copper types are in accordance with EN 1977:1998.

NOTE 2 The total of other elements (than copper) is defined in EN 1977: 1998 as the sum of Ag, As, Bi, Cd, Co, Cr, Fe, Mn, Ni, 0, P, Pb, S, Sb, Se, Si, Sn, Te and Zn, subject to the exclusion of any individual elements indicated.

Physical Constant :

***As per EN 50149:2012**

Material Group	Cu-ETP & Hard Darwn	CuAg	CuMg	CuSn	CuCd
Nominal Density at 20°C (g/cm^3)	8.89	8.89	8.89	8.92	8.945
Final Modulus of Elasticity (Gpa)	120	120	120	120	120
CLE (per °C)	17×10^{-6}	17×10^{-6}	17×10^{-6}	17×10^{-6}	17×10^{-6}
Maximum Resistivity at 20°C ohm.mm²/Km	17.77	17.77 for CuAg 0.1	22.4 for CuMg 0.2 Normal Conductivity	20.05 for CuSn 0.2 Normal Conductivity	20.05 for CuCd 0.7
			21.55 for CuMg 0.2 High Conductivity	21.55 for CuSn 0.2 High Conductivity *	21.55 for CuCd 1.0
			27.78 for CuMg 0.5		
Temperature Coefficient (per °C)	0.0038	0.0038	0.0031 0.0027 for CuMg 0.5	0.0032	Agreed between purchaser and manufacturer
* CuSn 0.2 (High Conductivity) was previous denoted CuSn 0.4					
1) In a temperature range from -50°C up to 100°C the coefficient of temperature for the resistance is constant					

Contact Wire as per EN 50149 : 2012

Maximum Resistance/Kilometer

Nominal cross section mm²	Material designation a						
	Cu-ETP Cu-OF Cu-FRHC Cu-HCP	CuAg 0.1	CuMg 0.2	CuMg 0.5	CuSn 0.2	CuCd 0.7	CuCd 1.0 CuSn0.2 (high conductivity) b CuMg 0.2 (high conductivity)
80	0.229	0.229	0.289	0.385	0.309	0.258	0.278
100	0.183	0.183	0.231	0.286	0.247	0.207	0.222
107	0.171	0.171	0.216	0.268	0.231	0.193	0.208
120	0.153	0.153	0.192	0.239	0.206	0.172	0.185
150	0.122	0.122	0.154	0.191	0.165	0.138	0.148
a value in Ω/Km at 20°C - Calculated on minimum cross section area							
b CuSn 0.2 (Gigh Conductivity) was previous denoted CuSn 0.4							

Tensile Strength, Breaking load and after Elongation Fraction

Material	Designation	Nominal cross section mm²	Percentage elongation after fracture A200		Minimum tensile strength Mpa a	Minimum breaking load kN
			min %	Max. %		
Normal strength Copper	Cu-ETP Cu-FRHC Cu-HCP CuOF	80	3	10	355	27.5
		100	3	10	355	34.5
		107	3	10	350	36.3
		120	3	10	330	38.4
		150	3	10	310	45.1
High strength copper and high strength copper-silver alloy	CuETP CuFRHC CuHCP CuOF CuAg 0.1	80	3	8	375	29.1
		100	3	8	375	36.4
		107	3	8	360	37.4
		120	3	8	360	41.9
		150	3	8	360	52.4
Normal strength copper-silver alloy	CuAg 0.1	80	3	10	365	28.3
		100	3	10	360	34.9
		107	3	10	350	36.3
		120	3	10	350	40.7
		150	3	10	350	50.9
Copper-magnesium alloy	CuMg 0.2	80	3	10	460	35.7
		100	3	10	450	43.7
	CuMg 0.2 (high conductivity)	107	3	10	440	45.7
		120	3	10	430	50.1
		150	3	10	420	61.1
Copper-magnesium alloy	CuMg 0.5	80	3	10	520	40.4
		100	3	10	510	49.5
		107	3	10	500	51.9
		120	3	10	490	57.0
		150	3	10	470	68.4
Copper-Tin Alloy	CuSn 0.2	80	2	8	460	40.4
		100	2	8	450	49.5
	CuSn 0.2 (high conductivity)	107	2	8	430	51.9
		120	2	8	420	57
		150	2	8	420	68.4
Copper-cadmium Alloy	CuCd0.7	80	2	7	430	33.4
		100	2	7	430	41.7
		107	2	7	430	44.6
		120	2	7	430	50.1
		150	2	7	430	62.6
Copper-Tin Alloy	CuCd1.0	80	2	7	455	35.3
		100	2	7	445	43.2
		107	2	7	445	46.2
		120	2	7	445	51.8
		150	2	7	445	64.7

Contact Wire as per IS 3476:1986

HARD DRAW COPPER TROLLY AND CONTACT WIRE

Cross Sectional Area	Standard weight a	Maximum Resistance at 20°C b	Minimum Tensile Strength	Conventional limit of elasticity c	Minimum Elongation in 200 mm	Minimum Number of bending
mm²	kg/km	ohm/km	Kg/mm²	Kg/mm²	%	Nos
80	711.2	0.2275	38	32.5	3	8
100	889	0.1818	36.5	31	3	7
107	951.2	0.1699	36.5	31	3	7
150	1333.5	0.1212	35.6	31	3	6
161	1431	0.1125	33	-	3	6
193	1715.8	0.0936	31	-	4	5

a value correspond to the standard cross sectional area

b value correspond to the minimum cross sectional area and minimum tensile strength of wire

c For information only

HARD DRAW CADMIUM-COPPER TROLLY AND CONTACT WIRE

Cross Sectional Area	Standard weight	Maximum Resistance at 20°C	Minimum Tensile Strength	Conventional limit of elasticity	Minimum Elongation in 200 mm	Minimum Number of bending
	a	b		c		
mm²	kg/km	ohm/km	Kg/mm²	Kg/mm²	%	Nos
100	894.5	0.2116	44	37.5	2.5	7
107	957.1	0.1977	44	37.5	2.5	7
150	1342	0.1411	44	37.5	2.5	6

a = value correspond to the standard cross sectional area

b = value correspond to the minimum cross sectional area and minimum tensile strength of wire

c = For information only

Contact Wire as per RDSO AIL-ETI-OHE-76-6-97

Cross Section	Diameter of CCC wire rod		Standard Weight per Km a	Resistance per Km at 20°C b	Tensile Strength	Conventional Limit of Elasticity	Elongation in 200 mm	No. of Bending	Hardness
Nominal	Min	Max	Nominal	Nominal	Min	Min	Min	Min	Min
mm²	mm	mm	Kg	Ohms	Kgf/mm²	Kgf/mm²	%	Nos	BHN
107	19	22	951.2	0.166	36.5	31	3	7	107
150	23	27	1333.5	0.1184	36.5	31	3	6	107
161	23	27	1431.3	0.1103	36.5	31	3	6	107
193	23	27	1715.8	0.0921	36.5	31	3	5	107

a & b = Value correspond to nominal cross section area of HDGC Contact wire