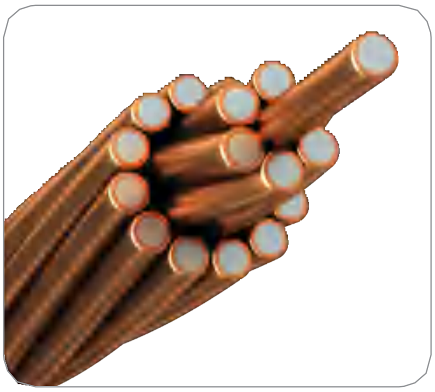
ASTM B452

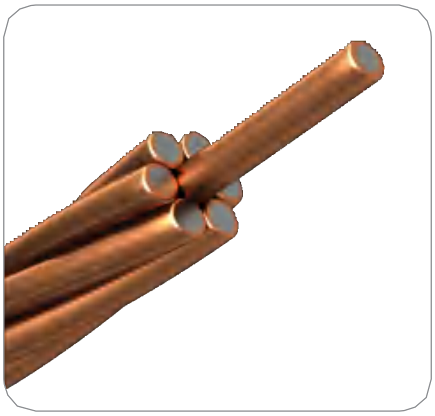
Copper Clad Steel Strand(CCS)



19-strand Copperclad Steel Wire

Copperclad Steel Wire

Copperclad Steel Wire is the ideal solution for grounding wire for power type applications. Composed of a steel core with coppercladding, the steel wire gives the wire its strength and the consistent layer of copper provides electrical conductivity and resistance to corrosion.
To manufacture Copperclad Steel Wire, carbon steel (low, high strength and extra high strength) is bonded with a uniform layer of oxygen-free coppercladding to achieve 30% and 40% IACS (International Annealed Copper Standard) conductivities. The material is available in a single wire, 3, 7 and 19 cable strands with some sizes jacketed to give the wire a different appearance to copper.



7-strand Copperclad Steel Wire

Copperclad Steel Wire

Copperclad Steel Wire is the ideal solution for grounding wire for power type applications. Composed of a steel core with coppercladding, the steel wire gives the wire its strength and the consistent layer of copper provides electrical conductivity and resistance to corrosion.
To manufacture Copperclad Steel Wire, carbon steel (low, high strength and extra high strength) is bonded with a uniform layer of oxygen-free coppercladding to achieve 30% and 40% IACS (International Annealed Copper Standard) conductivities. The material is available in a single wire, 3, 7 and 19 cable strands with some sizes jacketed to give the wire a different appearance to copper.

Single strand Copperclad Steel Wire in large and small diameters

Dead Soft Annealed Copperclad Steel Wire

Copperclad Steel Wire is a strong, non-rusting, efficient grounding conductor. It is composed of Coppercladding that is permanently bonded to the central steel core of each wire. Copperclad provides the same conductivity and corrosion resistance as copper while maintaining the high strength of steel. Dead Soft Annealed (DSA) Copperclad Steel Wire is very flexible for easy preparation and installation.

When compared to solid copper, Copperclad Steel Wire has faster impedance to ground for better protection of lines and equipment plus a higher resistance to thermal expansion failures. It also reduces the fatigue damage caused by more than 10 times that of annealed solid copper.

Copperclad Steel Wire is an excellent solution for areas with high rates of copper theft as the amount of copper used in the bonding process is minimal—6% to 10% depending on the conductivity. When Copperclad Steel Wire is used in place of copper, the grounding conductor is far less likely to be stolen. This feature is important not only from an economic standpoint, but also from the standpoint of safety and reliability. Often, the fact that a copper downlead has been removed is not evident until a surge current causes a failure in the system.

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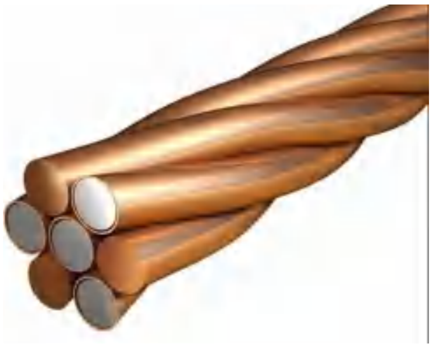

Swage Grounding Coupler compressed onto 19-strand Copperclad Steel Wire

Selecting the Right Size for the Application

When selecting a conductor for a ground grid, it must meet the maximum fault current for the identified duration and meet a minimum breaking load as required by the substation design (typically 5,000 pounds). The key to properly sizing copperclad steel wire is the actual fault current requirement. Often copper is physically oversized to gain the physical strength needed in the application. With Copperclad, the physical strength is inherent to the product so the primary consideration is electrical. Table 2 below compares the ampacity ratings of copper and Copperclad Steel Wire which allows the user to visually select the Copperclad equivalent. For example:
Requirements: The equivalent to 4/0 copper per the IEEE Fusing Chart is 19#9 40%. A typical maximum fault current for a distribution substation is ~18 kA at 30 cycles. Most engineers upsize to 4/0 copper in order to meet the mechanical strength requirement.
AFL solution: A 2/0 copper or 7#6 Copperclad SteelWire conductor will meet this requirement instead of the larger size 4/0 copper commonly used for ground grids. The conductor safety margin for 7#6 Copperclad Steel Wire is 30% and meets the fault current and mechanical strength requirements.

40% CCS Overview

CONDUCTOR SIZE	STRANDS	STRAND DIAMETER		OVERALL DIAMETER		AREA		FAULT CURRENT	WEIGHT/LENGTH		WIRE RESISTANCE		MIN. BREAK LOAD	
AWG		IN.	MM	IN.	MM	CMIL	(MM^2)	AMPS AT 0.5 SEC	LBS/KFT	KG/KM	Ω/KFT	Ω/KM	LBF	KGF
19#4	19	0.2043	5.19	1.022	25.95	793,000	401.8	107.28	2251.7	3350.9	0.0338	0.1110	21755	9868
19#5	19	0.1819	4.62	0.910	23.10	628,700	318.6	85.05	1785.0	2656.3	0.0427	0.1400	17246	7823
19#6	19	0.1620	4.11	0.810	20.57	498,600	252.6	67.46	1415.8	2106.9	0.0538	0.1765	13679	6205
19#7	19	0.1443	3.67	0.722	18.33	395,600	200.5	53.52	1123.3	1671.7	0.0678	0.2224	10853	4923
19#8	19	0.1285	3.26	0.643	16.32	313,700	159.0	42.44	890.8	1325.6	0.0855	0.2805	8606	3904
19#9	19	0.1144	2.91	0.572	14.53	248,700	126.0	33.64	706.0	1050.7	0.1079	0.3539	6821	3094
4/0	19	0.1055	2.68	0.528	13.40	211,500	107.2	28.61	600.4	893.6	0.1268	0.4161	5801	2631
19#10	19	0.1019	2.59	0.510	12.94	197,300	100.0	26.69	560.2	833.6	0.1359	0.4460	5412	2455
7#4	7	0.2043	5.19	0.613	15.57	292,200	148.1	39.53	826.3	1229.7	0.0914	0.3000	8015	3635
7#5	7	0.1819	4.62	0.546	13.86	231,600	117.4	31.33	655.0	974.8	0.1153	0.3784	6354	2882
7#6	7	0.1620	4.11	0.486	12.34	183,700	93.1	24.85	519.6	773.2	0.1454	0.4771	5040	2286
7#7	7	0.1443	3.67	0.433	11.00	145,800	73.9	19.72	412.2	613.5	0.1833	0.6013	3998	1814
2/0	7	0.1379	3.50	0.414	10.51	133,100	67.4	18.01	376.5	560.2	0.2007	0.6584	3652	1656
7#8	7	0.1285	3.26	0.386	9.79	115,600	58.6	15.64	326.9	486.5	0.2311	0.7583	3171	1438
1/0	7	0.1228	3.12	0.368	9.35	105,600	53.5	14.28	298.5	444.3	0.2531	0.8303	2896	1313
7#9	7	0.1144	2.91	0.343	8.72	91,610	46.4	12.39	259.1	385.6	0.2916	0.9567	2513	1140
7#10	7	0.1019	2.59	0.306	7.76	72,690	36.8	9.83	205.6	305.9	0.3675	1.2058	1994	904
3#4	3	0.2043	5.19	0.440	11.18	125,200	63.4	16.94	353.4	526.0	0.2129	0.6986	3626	1645
3#5	3	0.1819	4.62	0.392	9.96	99,260	50.3	13.43	280.2	416.9	0.2686	0.8812	2874	1304
3#6	3	0.1620	4.11	0.349	8.86	78,730	39.9	10.65	222.2	330.7	0.3386	1.1110	2280	1034
3#7	3	0.1443	3.67	0.311	7.90	62,470	31.7	8.45	176.3	262.4	0.4268	1.4003	1809	820
3#8	3	0.1285	3.26	0.277	7.04	49,540	25.1	6.70	139.8	208.1	0.5382	1.7658	1434	651
3#9	3	0.1144	2.91	0.247	6.27	39,260	19.9	5.31	110.8	164.9	0.6791	2.2279	1137	516
3#10	3	0.1019	2.59	0.220	5.59	31,150	15.8	4.21	87.9	130.8	0.8559	2.8080	902	409
#2AWG	7	0.0860	2.18	0.258	6.55	51,770	26.2	7.00	146.4	217.9	0.5160	1.6929	1435	651
#4AWG	7	0.0680	1.73	0.204	5.18	32,370	16.4	4.38	91.5	136.2	0.8253	2.7078	897	407
#2AWG	1	0.2576	6.54	0.258	6.54	66,370	33.6	8.98	185.8	276.6	0.3985	1.3075	2023	918
#4AWG	1	0.2043	5.19	0.204	5.19	41,740	21.2	5.65	116.9	173.9	0.6337	2.0791	1272	577
#6AWG	1	0.1620	4.12	0.162	4.12	26,250	13.3	3.55	73.5	109.4	1.0076	3.3058	800	363
#8AWG	1	0.1285	3.26	0.129	3.26	16,510	8.4	2.23	46.2	68.8	1.6018	5.2554	503	228
#9AWG	1	0.1144	2.91	0.114	2.91	13,090	6.6	1.77	36.6	54.5	2.0210	6.6307	399	181
#10AWG	1	0.1019	2.59	0.102	2.59	10,380	5.3	1.40	29.1	43.3	2.5473	8.3572	316	144

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30% CCS Overview

CONDUCTOR SIZE	STRANDS	STRAND DIAMETER		OVERALL DIAMETER		AREA		FAULT CURRENT	WEIGHT/LENGTH		WIRE RESISTANCE		MIN.BREAK LOAD	
AWG		IN.	MM	IN.	MM	CMIL	(MM^2)	AMPS AT 0.5 SEC	LBS/KFT	KG/KM	Ω/KFT	Ω/KM	LBF	KGF
19#4	19	0.2043	5.19	1.022	25.95	793,000	401.8	92.96	2346.4	3491.8	0.0451	0.1479	24474	11101
19#5	19	0.1819	4.62	0.910	23.10	628,700	318.6	73.70	1860.1	2768.1	0.0569	0.1866	19402	8800
19#6	19	0.1620	4.11	0.810	20.57	498,600	252.6	58.45	1475.3	2195.5	0.0717	0.2352	15389	6980
19#7	19	0.1443	3.67	0.722	18.33	395,600	200.5	46.38	1170.6	1742.0	0.0904	0.2965	12210	5538
19#8	19	0.1285	3.26	0.643	16.32	313,700	159.0	36.78	928.3	1381.4	0.1140	0.3739	9682	4392
19#9	19	0.1144	2.91	0.572	14.53	248,700	126.0	29.15	735.7	1094.9	0.1438	0.4717	7674	3481
4/0	19	0.1055	2.68	0.528	13.40	211,500	107.2	24.79	625.7	931.1	0.1691	0.5547	6526	2960
19#10	19	0.1019	2.59	0.510	12.94	197,300	100.0	23.13	583.7	868.7	0.1812	0.5946	6089	2762
7#4	7	0.2043	5.19	0.613	15.57	292,200	148.1	34.25	861.0	1281.4	0.1219	0.3999	9017	4090
7#5	7	0.1819	4.62	0.546	13.86	231,600	117.4	27.15	682.6	1015.8	0.1538	0.5045	7148	3242
7#6	7	0.1620	4.11	0.486	12.34	183,700	93.1	21.54	541.4	805.7	0.1939	0.6360	5670	2572
7#7	7	0.1443	3.67	0.433	11.00	145,800	73.9	17.09	429.6	639.3	0.2443	0.8016	4498	2040
2/0	7	0.1379	3.50	0.414	10.51	133,100	67.4	15.60	392.3	583.8	0.2675	0.8777	4108	1863
7#8	7	0.1285	3.26	0.386	9.79	115,600	58.6	13.55	340.6	506.9	0.3081	1.0108	3567	1618
1/0	7	0.1228	3.12	0.368	9.35	105,600	53.5	12.37	311.1	463.0	0.3374	1.1069	3258	1478
7#9	7	0.1144	2.91	0.343	8.72	91,610	46.4	10.74	270.0	401.8	0.3887	1.2754	2827	1282
7#10	7	0.1019	2.59	0.306	7.76	72,690	36.8	8.52	214.2	318.8	0.4900	1.6075	2243	1017
3#4	3	0.2043	5.19	0.440	11.18	125,200	63.4	14.68	368.3	548.1	0.2838	0.9313	4079	1850
3#5	3	0.1819	4.62	0.392	9.96	99,260	50.3	11.64	292.0	434.5	0.3581	1.1747	3234	1467
3#6	3	0.1620	4.11	0.349	8.86	78,730	39.9	9.23	231.6	344.6	0.4514	1.4811	2565	1163
3#7	3	0.1443	3.67	0.311	7.90	62,470	31.7	7.32	183.7	273.4	0.5690	1.8667	2035	923
3#8	3	0.1285	3.26	0.277	7.04	49,540	25.1	5.81	145.7	216.8	0.7175	2.3540	1614	732
3#9	3	0.1144	2.91	0.247	6.27	39,260	19.9	4.60	115.5	171.9	0.9053	2.9700	1279	580
3#10	3	0.1019	2.59	0.220	5.59	31,150	15.8	3.65	91.6	136.3	1.1410	3.7433	1015	460
#2AWG	7	0.0860	2.18	0.258	6.55	51,770	26.2	6.07	152.6	227.1	0.6879	2.2568	1614	732
#4AWG	7	0.0680	1.73	0.204	5.18	32,370	16.4	3.79	95.4	142.0	1.1002	3.6097	1009	458
#2AWG	1	0.2576	6.54	0.258	6.54	66,370	33.6	7.78	193.7	288.2	0.5313	1.7430	2276	1032
#4AWG	1	0.2043	5.19	0.204	5.19	41,740	21.2	4.89	121.8	181.2	0.8448	2.7716	1431	649
#6AWG	1	0.1620	4.12	0.162	4.12	26,250	13.3	3.08	76.6	114.0	1.3432	4.4069	900	408
#8AWG	1	0.1285	3.26	0.129	3.26	16,510	8.4	1.94	48.2	71.7	2.1354	7.0059	566	257
#9AWG	1	0.1144	2.91	0.114	2.91	13,090	6.6	1.53	38.2	56.8	2.6942	8.8393	449	204
#10AWG	1	0.1019	2.59	0.102	2.59	10,380	5.3	1.22	30.3	45.1	3.3957	11.1409	356	162