Annealed Copper Conductors—Nickel Plated (NPC), Silver Plated (SPC), and Tin Plated (TPC)

AWG Size	Conductor area (Circular Mils)		K-Value	Stranding (# of Strands x Strand AWG)	Nominal Dia. of Individual Strands	Diameter of Stranded Conductor					Max. Resistance @ 20° C (Ω / 1000 feet)		
							Maximum						
							Small Diameter		General Purpose				
	Nominal	Minimum				Minimum	SPC	NPC & TPC	SPC	NPC & TPC	SPC	NPC	TPC
30	112	102	.770	7x38	.0040	.0105	.0124	.0134	.0124	.0134	100.7	110.7	108.4
28	175	161	1.05	7x36	.0050	.0135	.0154	.0164	.0154	.0164	63.8	67.9	68.6
26	304	275	1.34	19x38	.0040	.0175	.0194	.0204	.0204	.0214	38.4	42.2	41.3
24	475	434	1.18	19x36	.0050	.0225	.0244	.0244	.0254	.0264	24.3	25.9	26.2
22	754	694	1.87	19x34	.0063	.0285	.0304	.0314	.0324	.0334	15.1	16.0	16.2
20	1,216	1,127	1.34	19x32	.0080	.0365	.0384	.0394	.0404	.0414	9.19	9.77	9.88
18	1,900	1,770	1.34	19x30	.0100	.0455	.0484	.0494	.0504	.0514	5.79	6.10	6.23
16	2,426	2,261	1.19	19x29	.0113	.0515	.0544	.0554	.0574	.0584	4.52	4.76	4.81
14	3,831	3,570	1.38	19x27	.0142	.0645	.0684	.0694	.0724	.0734	2.88	3.00	3.06
12	6,038	5,672	1.67	19x25	.0179	.0815	.0854	.0864	.0904	.0924	1.81	1.89	1.92
12	5,874	5,473	1.26	37x28	.0126	.0835	.0874	.0894	.0894	.0904	1.90	1.98	2.02
10	9,354	8,716	1.35	37x26	.0159	.1060	.1100	.1120	.1120	.1140	1.19	1.24	1.26
8	16,983	16,645	2.29	133x29	.0113	.1580	.1660	.1690	.1690	.1730	.658	.694	.701
6	26,818	26,284	2.31	133x27	.0142	.1980	.2080	.2120	.2130	.2170	.418	.436	.445
4	42,615	41,767	2.55	133x25	.0179	.2500	.2630	.2680	.2680	.2740	.264	.275	.280
2	66,500	64,981	3.21	665x30	.0100	.3200			.3400	.3400	.170	.177	.183
1	81,700	79,878	2.89	817x30	.0100	.3660			.3800	.3800	.139	.144	.149
1/0	104,500	102,126	3.24	1,045x30	.0100	.3950			.4250	.4250	.108	.113	.116
2/0	133,000	130,059	3.15	1,330x30	.0100	.4400			.4750	.4750	.085	.089	.091
3/0	166,500	162,795	3.09	1,665x30	.0100	.5000			.5400	.5400	.068	.071	.071
4/0	210,900	206,213	3.32	2,109x30	.0100	.5650			.6050	.6050	.054	.056	.056

Allowable number of missing strands: AWG 30–4: 0; AWG 2–1: 2; AWG 1/0–2/0: 3; AWG 3/0: 4; AWG 4/0: 5. • **Elongation, % min:** AWG 30–24: 6; AWG 22–4/0: 10.
Nominal values are for information only, and are not requirements. Dimensions in inches.

High-Strength Copper Alloy Conductors—Nickel Plated (NPA) and Silver Plated (SPA)

AWG Size	Conductor area (Circular Mils)		K-Value	Stranding (# of Strands x Strand AWG)	Nominal Dia. of Individual Strands	Diameter of Stranded Conductor					Minimum Break Strength (pounds)	Max. Resistance @ 20° C (Ω / 1000 feet)	
							Maximum						
							Small Diameter		General Purpose				
	Nominal	Minimum				Minimum	SPA	NPA	SPA	NPA		SPA	NPA
30	112	102	.770	7x38	.0040	.0105	.0124	.0134	.0124	.0134	5.20	129.6	117.4
28	175	161	1.05	7x36	.0050	.0135	.0154	.0164	.0154	.0164	8.20	79.0	74.4
26	304	275	1.34	19x38	.0040	.0175	.0204	.0204	.0204	.0214	14.2	49.4	44.8
24	475	434	1.18	19x36	.0050	.0225	.0244	.0254	.0254	.0264	22.4	30.1	28.4
22	754	694	1.87	19x34	.0063	.0285	.0314	.0314	.0324	.0334	35.8	18.6	17.5
20	1,216	1,127	1.34	19x32	.0080	.0365	.0395	.0404	.0404	.0414	58.1	11.4	10.7
18	1,900	1,770	1.34	19x30	.0100	.0465	.0467	.0467	.0504	.0514	90.3	6.79	6.43
16	2,426	2,261	1.19	19x29	.0113	.0515	.0530	.0530	.0574	.0584	115	5.16	4.90

Allowable number of missing strands: All sizes: 0 • **Elongation, % min:** All sizes: 6.
Nominal values are for information only, and are not requirements. Dimensions in inches.

27 Percent Nickel-Coated Conductors—Copper (NHC) and High-Strength Copper Alloy (NHA)

AWG Size	Conductor area (Circular Mils)		K-Value	Stranding (# of Strands x Strand AWG)	Nominal Dia. of Individual Strands	Diameter of Stranded Conductor		Max. Resistance @ 20˚ C (Ω / 1000 feet)	
	Nominal	Minimum				Minimum	Maximum	NHC	NHA
22	754	694	1.87	19x34	.0063	.0290	.0330	23.7	25.6
20	1,216	1,127	1.34	19x32	.0080	.0365	.0415	14.6	15.3
18	1,900	1,770	1.34	19x30	.0100	.0455	.0520	9.14	9.59
16	2,426	2,261	1.19	19x29	.0113	.052	.061	6.85	7.30
14	3,831	3,570	1.38	19x27	.0142	.065	.074	4.32	
12	6,038	5,672	1.67	19x25	.0179	.082	.094	2.78	
10	9,880	8,716	1.35	49x27	.0142	.123	.129	1.68	
8	16,983	16,645	2.29	133x29	.0113	.158	.179	.936	
6	26,818	26,284	2.31	133x27	.0142	.198	.218	.591	
4	42,615	41,767	2.55	133x25	.0179	.250	.272	.375	
2	66,500	64,981	3.21	665x30	.0100	.320	.345	.241	
1	81,700	79,878	2.89	817x30	.0100	.355	.384	.196	
1/0	104,500	102,126	3.24	1,045x30	.0100	.395	.432	.153	
2/0	133,000	130,059	3.15	1,330x30	.0100	.440	.490	.120	
3/0	166,500	162,795	3.09	1,665x30	.0100	.500	.548	.096	
4/0	210,900	206,213	3.32	2,109x30	.0100	.565	.615	.077	

Allowable number of missing strands: AWG 22–4: 0; AWG 2–1: 2; AWG 1/0–2/0: 3; AWG 3/0: 4; AWG 4/0: 5.
Elongation, % min: NHA, AWG 22–16: 6; NHC, all sizes: 10.
Nominal values are for information only, and are not requirements. Dimensions in inches.

Type KPH, KPS, KNH, and KNS Thermocouple Conductors

AWG Size	Conductor area (Circular Mils)		Stranding (# of Strands x Strand AWG)	Nominal Dia. of Individual Strands	Diameter of Stranded Conductor		Max. Resistance @ 20˚ C (Ω / 1000 feet)			
							KPH and KPS		KNH and KNS	
	Nominal	Minimum			Minimum	Maximum	Min.	Max.	Min.	Max.
22	754	694	19x34	.0063	.029	.033	546.7	604.3	228.2	252.3
20	1.216	1,127	19x32	.0080	.037	.041	339.2	375.0	141.5	156.5
18	1,900	1,770	19x30	.0100	.046	.051	217.0	240.0	90.5	100.2
16	2,426	2,261	19x29	.0113	.052	.058	169.7	187.7	70.6	78.2
14	3.831	3,570	19x27	.0142	.065	.073	107.6	119.0	44.9	49.7

Allowable number of missing strands: All sizes: 0.
Nominal values are for information only, and are not requirements. Dimensions in inches.

Coaxial Cable Formulae

The following formulae can be used to calculate performance characteristics of coaxial cables with various dielectric and conductor materials.

Characteristic Impedance: Coaxial cables are typically 50Ω, 75Ω, or 95Ω impedance. Cables with 50Ω impedance are the most common, because they offer the best balance between maximum power transmission and minimum loss. Where minimum attenuation is the most important consideration, such as in CATV systems, 75Ω cable is more widely used.

Attenuation: Losses occur in coaxial cables both from conductor loss and dielectric inefficiency. PTFE has become the most commonly-used dielectric in MIL-C-17 and other coaxial cables because it combines a low dielectric constant with good mechanical stability through a wide temperature and frequency range.

VSWR (Voltage–Standing Wave Ratio): VSWR is one of the most important characteristics of a coaxial cable, because it is the measure of the cable's overall efficiency in transmitting a signal at a given frequency. It is expressed as the ratio of the cable's mismatch to a perfect match, i.e. 1.25:1. Advanced, consistent cable manufacturing techniques minimize not only the overall VSWR, but can also minimize or eliminate VSWR spikes at specific frequencies.

Cutoff Frequency: The cutoff frequency of a coaxial cable is the frequency at which it no longer transmits its TEM (Transverse Electromagnetic Mode) signal.

Coaxial Cable Formulae

Capacitance (C) = $\dfrac{7.354 \times E}{\text{Log}_{10}\left(\frac{D+a}{d \times f}\right)}$ Picofarads per foot

Impedance (Z_o) = $\sqrt{\dfrac{L}{C}} = \dfrac{138}{\sqrt{E}} \text{Log}_{10}\left(\dfrac{D+a}{d \times f}\right)$ Ohms

Time Delay = $1.0167 \times \sqrt{E}$ Nanoseconds per foot

Reflection Coefficient = I = $\dfrac{Z_r - Z_o}{Z_r + Z_o} = \dfrac{VSWR - 1}{VSWR + 1}$

Inductance (L) = $.140 \text{Log}_{10} (D / d)$ Microhenries per foot

Velocity of Propagation = $\dfrac{100}{\sqrt{E}}$ % of speed of light

Cutoff Frequency = $\dfrac{7.50}{(D + d)\sqrt{E}}$ GHz

VSWR = $\dfrac{1 + \tilde{A}}{1 - \tilde{A}}$

d = Outside diameter of inner conductor, in inches.

D = Inside diameter of outer conductor, in inches.

E = Dielectric constant of insulation (see below).

a = Nominal shield correction factor ($^1/_2$ of the diameter of an individual shield wire).

f = Correction factor for stranded conductors:
Solid conductor: 1.00
7 strands: .93
19 strands: .97
37 strands: .98

$\tilde{A}$ = Reflection coefficient.

Log = Logarithm to base 10.

Dielectric Constants

Air 1.0	Foamed FEP 1.5–2.0	Polyimide 3.0–3.5	PVC 4.5–5.8
E Glass 6.0	Mica Glass 1.2–3.0	Polyimide/FEP film .. 2.2–2.3	PVF 3.0–8.4
ETFE 2.6	Nylon 4.5	Polypropylene 2.3	Silicone Rubber 2.1–3.5
Expanded PTFE 1.4–2.0	PFA 2.0	Polysulfone 3.1	Urethanes 6.7–7.5
FEP 2.0	Polyethylene 2.3	PTFE 2.0	

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