7. ELECTRICAL CHARACTERISTICS

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ANIXTER

7. ELECTRICAL CHARACTERISTICS (CONTINUED)

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ANIXTER

For a wire or cable to perform its intended function reliably, safely and efficiently, the wire or cable must be selected so that its many electrical, physical, chemical and thermal properties match those of the application.

The following sections provide information on some of the most frequently requested electrical parameters.

7.1 DC Resistance of Plated Copper Conductors

Table 7.1–DC resistance of plated copper conductors

Wire Size	Number of Wires/Size	Strand Class	Nominal Area	Nominal DC Resistance Ohms/1000 ft @ 20°C (68°F)		
				Silver Plated	Nickel Plated	Tin Plated
AWG/kcmil	AWG or inches		cmils			
777	1952/24	AAR	788,728	–	–	0.0139
750	703/.0327	H	751,711	–	–	0.0146
750	1862/24	I	752,267	–	–	0.0146
750	7448/30	K	744,800	–	–	0.0148
700	703/.0316	H	701,988	–	–	0.0157
700	1729/24	I	698,533	–	–	0.0158
700	6916/30	K	691,600	–	–	0.0165
650	703/.0304	H	649,684	–	–	0.0169
650	1596/24	I	644,800	–	–	0.0171
650	6517/30	K	651,700	–	–	0.0169
646	1647/24	AAR	665,404	–	–	0.0165
600	703/.0292	H	599,406	–	–	0.0183
600	1470/24	I	593,895	–	–	0.0185
600	5985/30	K	598,500	–	–	0.0184
550	703/.028	H	551,152	–	–	0.0200
550	1372/24	I	554,302	–	–	0.0200
550	5453/30	K	545,300	–	–	0.0200
535	1332/24	AAR	538,141	–	–	0.0204
500	427/.0342	H	449,436	–	–	0.0220
500	1125/24	I	494,912	–	–	0.0222
500	5054/30	K	505,400	–	–	0.0218
450	427/.0325	H	451,019	–	–	0.0244
450	1127/24	I	455,319	–	–	0.0241
450	4522/30	K	452,200	–	–	0.0243

Continued

7. ELECTRICAL CHARACTERISTICS

Table 7.1–DC resistance of plated copper conductors

Continued

Wire Size AWG/kcmil	Number of Wires/Size AWG or inches	Strand Class	Nominal Area cmils	Nominal DC Resistance Ohms/1000 ft @ 20°C (68°F)		
				Silver Plated	Nickel Plated	Tin Plated
444	1110/24	AAR	448,451	–	–	0.025
400	427/.0306	H	399,826	–	–	0.028
400	980/24	I	395,930	–	–	0.028
400	3990/30	K	399,000	–	–	0.028
373	925/24	AAR	373,709	–	–	0.029
350	427/.0286	H	349,269	–	–	0.031
350	882/24	I	356,337	–	–	0.031
350	3458/30	K	345,800	–	–	0.032
313	777/24	AAR	313,916	–	–	0.035
300	427/.0265	H	299,861	–	–	0.037
300	735/24	I	296,947	–	–	0.037
300	2989/30	K	298,900	–	–	0.037
262	646/24	AAR	260,990	–	–	0.042
250	427/.0242	H	250,068	–	–	0.043
250	637/24	I	257,354	–	–	0.043
250	2499/30	K	249,900	–	–	0.044
4/0	2109/30	K	210,900	0.052	0.053	0.052
4/0	427/.0223	H	212,343	0.052	0.053	0.052
3/0	1665/30	K	166,500	0.066	0.067	0.069
3/0	427/.0198	H	167,401	0.066	0.067	0.066
2/0	1330/30	K	133,000	0.083	0.084	0.088
2/0	427/.0177	H	133,775	0.083	0.084	0.082
1/0	1045/30	K	104,500	0.105	0.107	0.116
1/0	259/.0202	H	105,682	0.105	0.107	0.103
1	817/30	K	81,700	0.134	0.137	0.144
1	259/.018	H	83,916	0.134	0.137	0.129
2	665/30	K	66,500	0.165	0.168	0.177
2	259/.016	H	66,304	0.165	0.168	0.164
2	133/.0223	H	66,140	0.165	0.168	0.164
3	133/.0199	H	52,669	0.165	0.168	0.205
4	133/25	H	42,615	0.249	0.259	0.264
5	133/.0158	H	33,202	0.249	0.259	0.325
6	133/27	H	26,818	0.393	0.409	0.417
8	19/.0295	C	16,535	0.628	0.689	0.640
8	37/.0211	D	16,473	0.630	0.692	0.655
8	133/29	H	16,983	0.616	0.642	0.654

Continued

Table 7.1–DC resistance of plated copper conductors

Continued

Wire Size	Number of Wires/Size	Strand Class	Nominal Area	Nominal DC Resistance Ohms/1000 ft @ 20°C (68°F)		
				Silver Plated	Nickel Plated	Tin Plated
AWG/kcmil	AWG or inches		cmils			
10	7/.0385	B	10,376	1.00	1.10	1.02
10	19/.0234	C	10,404	1.00	1.10	1.03
10	37/26	D	9,354	1.13	1.18	1.20
12	7/.0305	B	6,512	1.59	1.75	1.65
12	19/25	C	6,088	1.71	1.78	1.81
12	19/.0185	C	6,503	1.60	1.75	1.70
12	37/28	D	5,874	1.80	1.87	1.91
12	65/30	K	6,500	1.80	1.87	1.61
14	7/.0242	B	4,099	2.53	2.69	2.63
14	19/27	C	3,831	2.70	2.81	2.86
14	19/.0147	C	4,105	2.62	2.65	2.78
14	37/.0105	D	4,079	2.62	2.65	2.59
14	41/30	K	4,100	2.62	2.65	2.58
16	7/.0192	B	2,580	4.02	4.28	4.27
16	19/29	C	2,426	4.23	4.41	4.49
16	19/.0117	C	2,600	4.14	4.20	4.39
16	26/30	K	2,600	4.14	4.20	4.07
18	7/.0152	B	1,617	6.58	6.67	6.99
18	7/26	B	1,769	5.86	6.10	6.22
18	16/30	K	1,600	5.86	6.10	6.61
18	19/30	C	1,900	5.38	5.60	5.77
18	19/.0092	C	1,608	6.69	6.82	7.18
20	7/.28	B	1,111	9.27	9.65	9.84
20	10/30	K	1,000	–	–	10.58
20	19/32	C	1,216	8.53	9.07	9.15
22	7/30	B	700	14.60	15.20	15.60
22	19/34	C	754	13.70	14.60	14.70
24	7/34	B	448	23.10	24.60	24.80
24	19/36	C	475	21.50	22.90	23.10
25	7/.0067	B	314	33.00	34.80	36.40
26	7/34	B	277	37.10	39.50	39.80
26	19/38	C	304	33.30	36.60	35.70
28	7/36	B	175	58.40	62.10	66.50
28	19/40	C	182	54.60	60.00	58.60
30	7/38	B	112	90.30	99.20	96.20
30	19/42	C	118	82.70	94.00	88.80

Continued

7. ELECTRICAL CHARACTERISTICS

Table 7.1–DC resistance of plated copper conductors

Continued

Wire Size	Number of Wires/Size	Strand Class	Nominal Area	Nominal DC Resistance Ohms/1000 ft @ 20°C (68°F)		
				Silver Plated	Nickel Plated	Tin Plated
AWG/kcmil	AWG or inches		cmils			
32	7/40	B	67	148.0	163.0	159.0
34	7/42	B	43	225.0	256.0	241.5
36	7/44	B	28	244.0	391.0	369.2

Note: AAR—American Association of Railroads
Strand classes B, C, D, H, I and K per ASTM

7.2 DC and AC Resistance of Class B Copper Conductors

Table 7.2–DC and AC resistance of class B copper conductors, ohms per 1,000 feet

Size	60°C Conductor Temp.			75°C Conductor Temp.			90°C Conductor Temp.		
		60 Hz			60 Hz			60 Hz	
AWG/ kcmil	DC	*Single Cond.	†Multi- Cond.	DC	*Single Cond.	†Multi- Cond.	DC	*Single Cond.	†Multi- Cond.
14	2.98	2.98	2.98	3.14	3.14	3.14	3.29	3.29	3.29
12	1.88	1.88	1.88	1.97	1.97	1.97	2.07	2.07	2.07
10	1.18	1.18	1.18	1.24	1.24	1.24	1.31	1.31	1.31
8	0.744	0.744	0.744	0.783	0.783	0.783	0.822	0.822	0.822
6	0.466	0.466	0.466	0.491	0.491	0.491	0.515	0.515	0.515
4	0.295	0.295	0.295	0.310	0.310	0.310	0.325	0.325	0.325
2	0.184	0.184	0.185	0.195	0.194	0.196	0.203	0.203	0.205
1	0.147	0.147	0.148	0.154	0.154	0.155	0.162	0.162	0.163
1/0	0.116	0.116	0.118	0.122	0.122	0.124	0.128	0.128	0.130

Continued

Table 7.2 – DC and AC resistance of class B copper conductors, ohms per 1,000 feet

Continued

Size	60°C Conductor Temp.			75°C Conductor Temp.			90°C Conductor Temp.		
		60 Hz			60 Hz			60 Hz	
AWG/ kcmil	DC	*Single Cond.	†Multi- Cond.	DC	*Single Cond.	†Multi- Cond.	DC	*Single Cond.	†Multi- Cond.
2/0	0.0923	0.0923	0.0950	0.0971	0.0971	0.100	0.102	0.102	0.105
3/0	0.0730	0.0730	0.0759	0.0769	0.0769	0.0799	0.0807	0.0807	0.0839
4/0	0.0579	0.0579	0.0608	0.0610	0.0610	0.0640	0.0639	0.0639	0.0671
250	0.0490	0.0492	0.0519	0.0516	0.0518	0.0547	0.0541	0.0543	0.0573
300	0.0409	0.0411	0.0437	0.0431	0.0433	0.0461	0.0452	0.0454	0.0483
350	0.0350	0.0353	0.0378	0.0369	0.0372	0.0398	0.0387	0.0390	0.0418
400	0.0307	0.0310	0.0338	0.0323	0.0326	0.0355	0.0339	0.0342	0.0373
500	0.0246	0.0250	0.0278	0.0258	0.0262	0.0291	0.0271	0.0275	0.0306
600	0.0205	0.0210	0.0238	0.0215	0.0220	0.0249	0.0226	0.0231	0.0262
700	0.0175	0.0181	0.0208	0.0184	0.0190	0.0219	0.0193	0.0199	0.0229
750	0.0164	0.0170	0.0198	0.0172	0.0178	0.0208	0.0181	0.0188	0.0219
1,000	0.0123	0.0131	0.0160	0.0129	0.0137	0.0167	0.0135	0.0144	0.0175
1,250	0.00982	0.0108	0.0138	0.0103	0.0113	0.0145	0.0108	0.0119	0.0152
1,500	0.00818	0.00934	0.0125	0.00861	0.00983	0.0132	0.00904	0.01030	0.0138
1,750	0.00701	0.00830	0.0117	0.00738	0.00874	0.0123	0.00774	0.00917	0.0129
2,000	0.00613	0.00755	0.0111	0.00645	0.00795	0.0117	0.00677	0.00835	0.0123

*One single conductor in air, buried, or in nonmetallic conduit.
†Multiconductor cable or 2 or 3 single conductors in one metallic conduit.

Table 7.3 – Temperature correction factors for Table 7.2

Temperature Degrees C	Multiplying Factors for Correction to	
	20°C	25°C
60	0.864	0.881
75	0.822	0.838
90	0.784	0.800

7.3 DC and AC Resistance of Class B Aluminum Conductors

Table 7.4 –DC and AC resistance of class B aluminum conductors, ohms per 1000 feet

Size	60°C Conductor Temp.			75°C Conductor Temp.			90°C Conductor Temp.		
		60 Hz			60 Hz			60 Hz	
AWG/ kcmil	DC	*Single Cond.	†Multi- Cond.	DC	*Single Cond.	†Multi- Cond.	DC	*Single Cond.	†Multi- Cond.
12	3.08	3.08	3.08	3.24	3.24	3.24	3.40	3.40	3.40
10	1.93	1.93	1.93	2.03	2.03	2.03	2.13	2.13	2.13
8	1.21	1.21	1.21	1.28	1.28	1.28	1.34	1.34	1.34
6	0.765	0.765	0.765	0.080	0.808	0.808	0.848	0.848	0.848
4	0.483	0.483	0.483	0.507	0.507	0.507	0.533	0.533	0.533
3	0.382	0.382	0.382	0.402	0.402	0.402	0.422	0.422	0.422
2	0.303	0.303	0.303	0.319	0.319	0.319	0.335	0.335	0.335
1	0.240	0.240	0.240	0.253	0.253	0.253	0.266	0.266	0.266
1/0	0.191	0.191	0.191	0.201	0.201	0.201	0.211	0.211	0.211
2/0	0.151	0.151	0.151	0.159	0.159	0.159	0.167	0.167	0.167
3/0	0.119	0.119	0.120	0.126	0.126	0.127	0.132	0.132	0.133
4/0	0.0953	0.0954	0.0963	0.101	0.101	0.102	0.106	0.106	0.107
250	0.0806	0.0808	0.0822	0.0848	0.0850	0.0865	0.0890	0.0892	0.0908
300	0.0672	0.0674	0.0686	0.0706	0.0708	0.0720	0.0741	0.0744	0.0756
350	0.0575	0.0578	0.0593	0.0605	0.0608	0.0623	0.0635	0.0638	0.0654
400	0.0504	0.0507	0.0525	0.0500	0.0533	0.0552	0.0557	0.0560	0.0580
500	0.0403	0.0406	0.0428	0.0424	0.0427	0.0450	0.0445	0.0448	0.0472
600	0.0336	0.0340	0.0370	0.0353	0.0357	0.0381	0.0370	0.0374	0.0400
700	0.0288	0.0292	0.0320	0.0303	0.0307	0.0337	0.0318	0.0322	0.0353
750	0.0269	0.0273	0.0302	0.0283	0.0288	0.0317	0.0297	0.0302	0.0333
1,000	0.0201	0.0207	0.0239	0.0212	0.0218	0.0253	0.0222	0.0228	0.0265
1,250	0.0162	0.0176	0.0215	0.0170	0.0177	0.0216	0.0179	0.0186	0.0228
1,500	0.0135	0.0143	0.0184	0.0142	0.0150	0.0193	0.0149	0.0158	0.0203
1,750	0.0115	0.0124	0.0168	0.0121	0.0131	0.0177	0.0127	0.0137	0.0186
2,000	0.0101	0.0111	0.0158	0.0106	0.0117	0.0186	0.0111	0.0122	0.0173

*One single conductor in air, buried, or in nonmetallic conduit.
†Multiconductor cable or 2 or 3 single conductors in one metallic conduit.

Table 7.5 –Temperature correction factors for Table 7.4

Temperature Degrees C	Multiplying Factors for Correction to 20°C	25°C
60	0.861	0.878
75	0.818	0.835
90	0.780	0.796

7.4 Reactance and Impedance at 60 Hertz

Table 7.6 –Reactance and impedance at 60 Hz for single copper conductor cables installed in air, buried or in separate nonmetallic conduits

Conductor Size	Distance Between Centers of Conductors—Inches							
	2		4		6		8	
	Approximate Ohms per 1000 Feet per Conductor at 25°C (77°F)							
AWG/ kcmil	Reac- tance	Imped- ance	Reac- tance	Imped- ance	Reac- tance	Imped- ance	Reac- tance	Imped- ance
8	0.0816	0.659	0.0976	0.661	0.1070	0.662	0.1135	0.664
6	0.0764	0.417	0.0922	0.420	0.1016	0.422	0.1082	0.424
4	0.0710	0.255	0.0868	0.261	0.0962	0.264	0.1025	0.267
3	0.0682	0.216	0.0842	0.221	0.0934	0.225	0.1000	0.228
2	0.0656	0.175	0.0815	0.181	0.0908	0.186	0.0974	0.189
1	0.0627	0.143	0.0787	0.151	0.0880	0.156	0.0945	0.160
1/0	0.0600	0.118	0.0760	0.127	0.0853	0.133	0.0918	0.137
2/0	0.0598	0.0993	0.0732	0.109	0.0826	0.116	0.0892	0.121
3/0	0.0573	0.0884	0.0706	0.0954	0.0799	0.103	0.0866	0.108
4/0	0.0520	0.0728	0.0680	0.0850	0.0773	0.0926	0.0840	0.0982
250	0.0500	0.0661	0.0660	0.0789	0.0753	0.0869	0.0819	0.0926
300	0.0481	0.0602	0.0640	0.0734	0.0732	0.0816	0.0798	0.0876

Continued

Table 7.6 – Reactance and impedance at 60 Hz for single copper conductor cables installed in air, buried or in separate nonmetallic conduits

Continued

Conductor Size	Distance Between Centers of Conductors—Inches							
	2		4		6		8	
	Approximate Ohms per 1000 Feet per Conductor at 25°C (77°F)							
AWG/ kcmil	Reac- tance	Imped- ance	Reac- tance	Imped- ance	Reac- tance	Imped- ance	Reac- tance	Imped- ance
350	0.0462	0.0557	0.0622	0.0695	0.0715	0.0779	0.0780	0.0840
400	0.0445	0.0522	0.0606	0.0664	0.0700	0.0750	0.0766	0.0814
500	0.0422	0.0476	0.0581	0.0621	0.0674	0.0709	0.0740	0.0772
600	0.0400	0.0441	0.0559	0.0588	0.0652	0.0678	0.0718	0.0741
700	0.0380	0.0412	0.0539	0.0561	0.0633	0.0652	0.0700	0.0718
750	0.0376	0.0404	0.0534	0.0554	0.0628	0.0645	0.0694	0.0710
800	0.0370	0.0396	0.0527	0.0546	0.0621	0.0636	0.0687	0.0701
900	0.0354	0.0376	0.0512	0.0527	0.0606	0.0619	0.0673	0.0685
1,000	0.0342	0.0360	0.0500	0.0512	0.0594	0.0605	0.0660	0.0670
1,250	0.0314	0.0328	0.0472	0.0481	0.0566	0.0574	0.0632	0.0639
1,500	0.0296	0.0307	0.0453	0.0460	0.0548	0.0554	0.0614	0.0619
1,750	0.0276	0.0285	0.0434	0.0440	0.0527	0.0532	0.0593	0.0597
2,000	0.0264	0.0272	0.0422	0.0427	0.0514	0.0518	0.0582	0.0585

7.5 AC/DC Resistance Ratio at 60 Hertz

Table 7.7–AC/DC resistance ratio at 60 hertz

To determine effective 60 Hertz AC resistance, multiply DC resistance values corrected for proper temperature, by the AC/DC resistance ratio given below.

Conductor Size AWG/kcmils	Single Copper Conductors in Air, or in Individual Nonmetallic Conduits	Multiple Copper Conductor Cable or 2 or 3 Single Conductor Cables in Same Metallic Conduit
Up to 3	1.00	1.00
2 & 1	1.00	1.01
1/0	1.00	1.02
2/0	1.00	1.03
3/0	1.00	1.04
4/0	1.00	1.05
250	1.005	1.06
300	1.006	1.07
350	1.009	1.08
400	1.011	1.10
500	1.018	1.13
600	1.025	1.16
700	1.034	1.19
750	1.039	1.21
800	1.044	–
1,000	1.067	–
1,250	1.102	–
1,500	1.142	–
1,750	1.185	–
2,000	1.233	–

The single conductor column in the table above covers single conductor nonshielded cable including all conditions of use except when two or more cables are pulled into the same metallic or nonmetallic conduit.

The multiple conductor column in the table above covers the following conditions:

(a) Single conductor cable; two or three cables in the same metallic conduit.

(b) Single conductor shielded cable; two or three cables in the same metallic or nonmetallic duct or conduit, but only with conductor sizes up to 250 kcmils. For larger conductor sizes the short-circuited sheath losses increase rapidly and the table above does not apply.
(Continued)

(c) Three conductor nonshielded cable; one cable in metal conduit.

(d) Three conductor shielded cable; all conditions of use in air, in ducts and in conduit.

The table represents maximum AC losses for the conditions outlined.

7.6 Temperature Correction Factors for Resistance

Table 7.8 – Temperature correction factors for the resistance of copper conductors

Temp °C	Multiplying Factor
25	1.000
40	1.058
50	1.096
55	1.116
60	1.135
65	1.154
70	1.173
75	1.193
80	1.212
85	1.231
90	1.250
100	1.289
105	1.308
125	1.385
130	1.404
150	1.482
200	1.674

The DC resistance of copper wire increases with increasing temperature in accordance with the formula:

$$R_t = R_o [1 + a(T - T_o)]$$

where R_t = Resistance at temperature T

R_o = Resistance at temperature T_o

a = Temperature Coefficient of Resistance at T_o [At 20°C (68°F) the temperature coefficient of copper is 0.00393 per degree Centigrade]

7.7 Voltage Drop

The values in Tables 7.9 and 7.10 are calculated at 60°C, the estimated average temperature which may be anticipated in service. They may be used without significant error for conductor temperatures up to and including 75°C. For 90°C multiply by 1.102 for copper, by 1.105 for aluminum. To obtain values for other circuits, multiply by 1.155 for single-phase line-to-line and by 0.577 for single- or three-phase line-to-neutral.

$$\text{Voltage Drop in volts} = \frac{\text{Table Value} \times \text{Current in amps} \times \text{Length of Circuit in feet}}{100}$$

$$\text{Voltage Drop in \%} = \frac{\text{Voltage Drop in volts} \times 100}{\text{Circuit Voltage in volts}}$$

Table 7.9 –Phase-to-phase voltage drop per amp per 100 ft of circuit for a 3-phase, 60 Hz system operating at 60° C with copper conductors

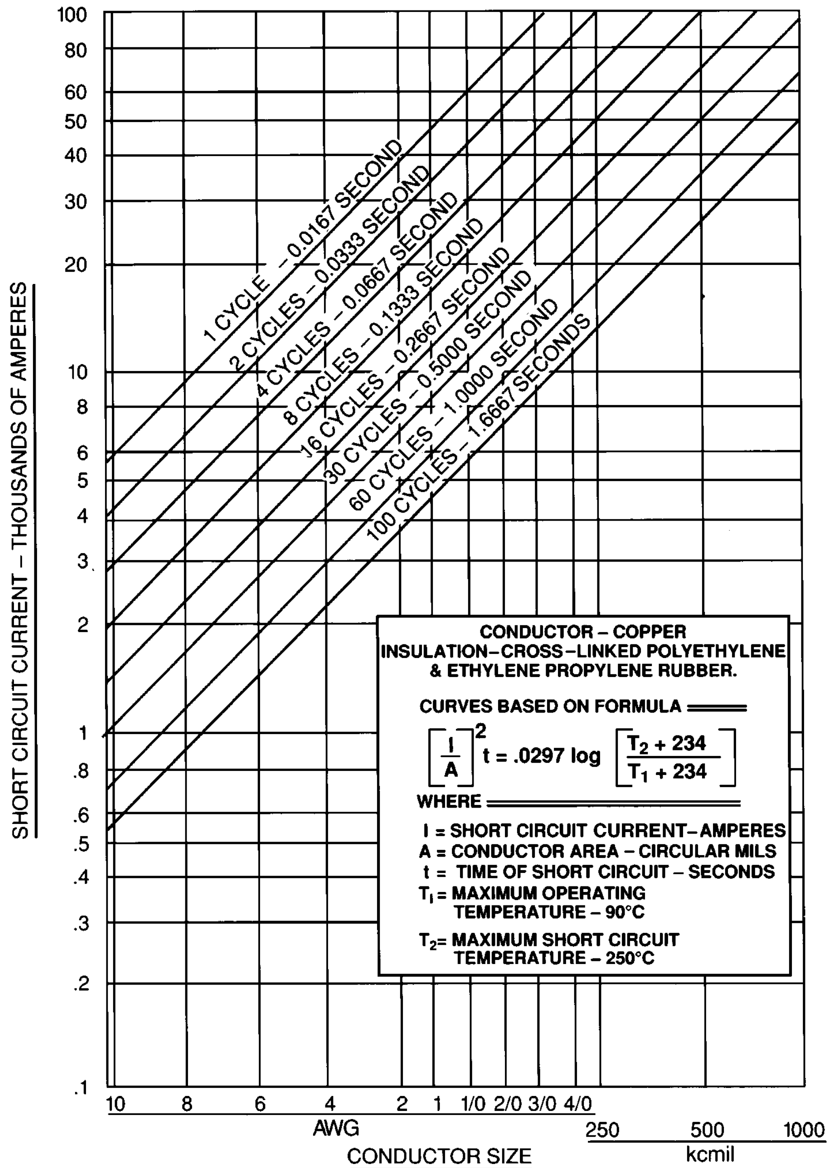
Size	In Non-Magnetic Conduit			In Magnetic Conduit		
	% Power Factor			% Power Factor		
AWG/ kcmil	80	90	100	80	90	100
12	0.2710	0.3030	0.3330	0.2720	0.3030	0.3320
10	0.1710	0.1910	0.2080	0.1720	0.1910	0.2080
8	0.1090	0.1200	0.1300	0.1100	0.1210	0.1300
6	0.0720	0.0790	0.0840	0.0730	0.0800	0.0840
4	0.0470	0.0510	0.0530	0.0480	0.0520	0.0530
2	0.0310	0.0330	0.0330	0.0320	0.0340	0.0340
1	0.0260	0.0270	0.0260	0.0260	0.0280	0.0260
1/0	0.0210	0.0220	0.0210	0.0220	0.0230	0.0210
2/0	0.0170	0.0180	0.0160	0.0190	0.0190	0.0170
3/0	0.0140	0.0150	0.0130	0.0160	0.0160	0.0140
4/0	0.0120	0.0120	0.0100	0.0140	0.0130	0.0110
250	0.0110	0.0110	0.0088	0.0120	0.0120	0.0093
300	0.0097	0.0095	0.0073	0.0110	0.0110	0.0078
350	0.0088	0.0085	0.0062	0.0100	0.0095	0.0067
400	0.0081	0.0076	0.0055	0.0095	0.0088	0.0061
500	0.0073	0.0067	0.0045	0.0085	0.0078	0.0050
600	0.0066	0.0059	0.0038	0.0080	0.0071	0.0042
700	0.0062	0.0055	0.0033	0.0074	0.0066	0.0037
750	0.0059	0.0054	0.0029	0.0073	0.0064	0.0035
1,000	0.0050	0.0043	0.0023	0.0066	0.0055	0.0023

Table 7.10 – Phase-to-phase voltage drop per amp per 100 ft of circuit for a 3-phase, 60 Hz system operating at 60° C with aluminum conductors

Size	In Nonmagnetic Conduit			In Magnetic Conduit		
	% Power Factor			% Power Factor		
AWG or kcmil	80	90	100	80	90	100
12	0.4240	0.4750	0.5230	0.4260	0.4760	0.5230
10	0.2680	0.2990	0.3290	0.2690	0.2140	0.3290
8	0.1700	0.1890	0.2070	0.1720	0.1910	0.2070
6	0.1110	0.1230	0.1330	0.1120	0.1230	0.1320
4	0.0710	0.0780	0.0830	0.0730	0.0790	0.0840
2	0.0460	0.0500	0.0520	0.0470	0.0510	0.0520
1	0.0380	0.0400	0.0420	0.0390	0.0410	0.0420
1/0	0.0310	0.0330	0.0330	0.0320	0.0340	0.0330
2/0	0.0250	0.0260	0.0260	0.0260	0.0270	0.0260
3/0	0.0210	0.0220	0.0210	0.0220	0.0230	0.0210
4/0	0.0170	0.0180	0.0170	0.0180	0.0180	0.0170
250	0.0150	0.0150	0.0140	0.0160	0.0160	0.0140
300	0.0130	0.0130	0.0120	0.0140	0.0140	0.0120
350	0.0120	0.0120	0.0099	0.0130	0.0130	0.0100
400	0.0110	0.0110	0.0087	0.0120	0.0120	0.0091
500	0.0092	0.0089	0.0070	0.0100	0.0099	0.0074
600	0.0083	0.0079	0.0059	0.0095	0.0088	0.0062
700	0.0076	0.0071	0.0050	0.0088	0.0082	0.0055
750	0.0073	0.0068	0.0048	0.0085	0.0079	0.0052
1,000	0.0068	0.0063	0.0042	0.0077	0.0069	0.0042

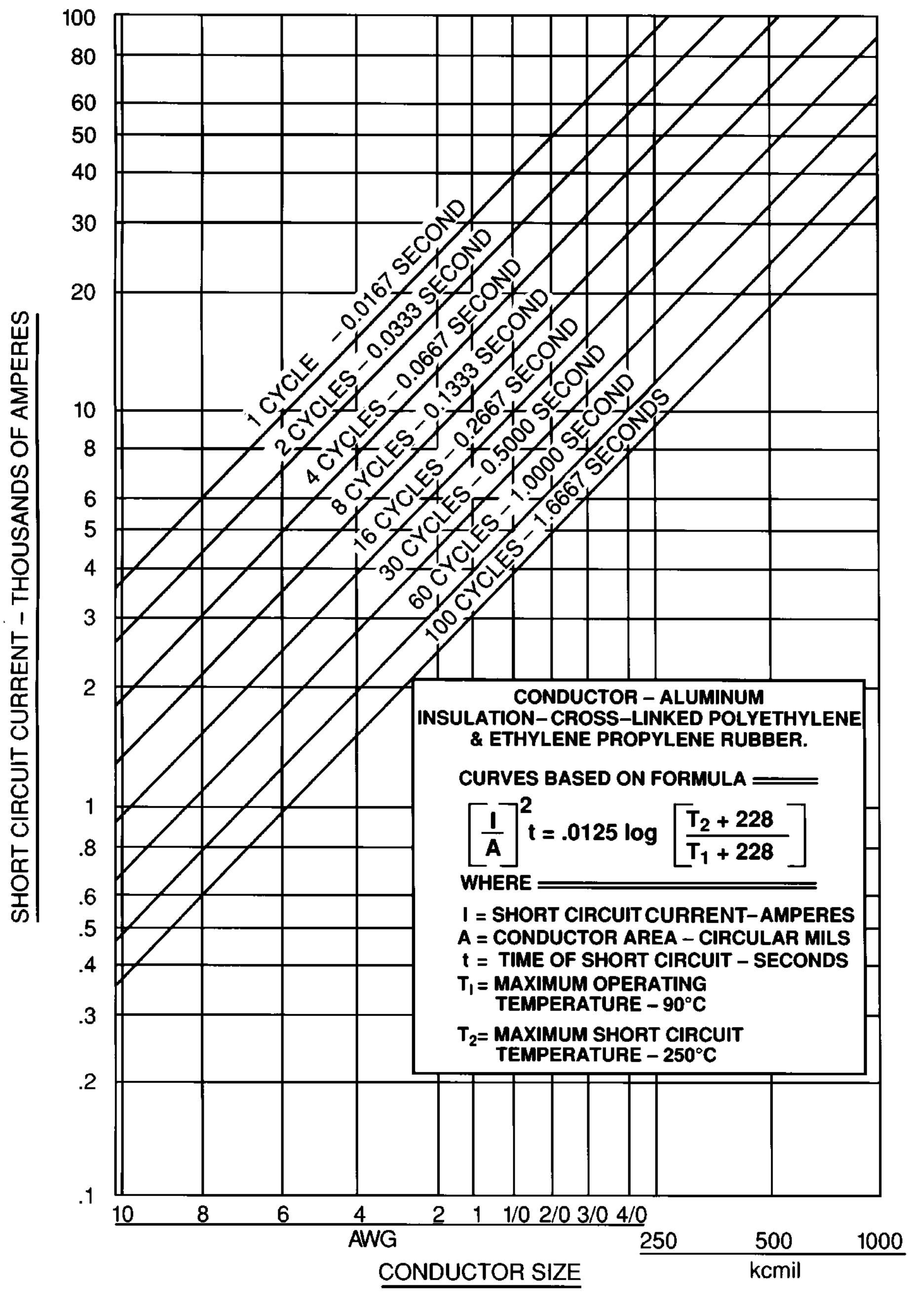
7.8 Maximum Conductor Short Circuit Current

Because of the large KVA capacity of many power systems, the high **short circuit current** that is possible should be considered in power system design. The short circuit current is the maximum allowable current that the cable can withstand without damage. The maximum allowable short circuit current for copper and aluminum conductors can be determined with the aid of Figures 7.1 and 7.2, respectively.



Source: ICEA P-32-382

Figure 7.1–Maximum conductor short circuit current for copper cables



Source: ICEA P-32-382

Figure 7.2 –Maximum conductor short circuit current for aluminum cables

7.9 Maximum Shield Short Circuit Current

Table 7.11–Maximum short circuit current for copper shielding tape (amperes)

Shield Diam.	Effective Shield Area	Short Circuit Time in Number of Cycles (60 Hz)						
Inches	Circular Mils	1	2	4	8	16	30	60
½	7,484	4,016	2,840	2,008	1,420	1,004	733	518
¾	11,264	6,044	4,274	3,022	2,137	1,511	1,104	780
1	15,044	8,073	5,708	4,036	2,854	2,018	1,474	1,042
1¼	18,824	10,101	7,143	5,051	3,571	2,525	1,844	1,304
1½	22,604	12,130	8,577	6,065	4,289	3,032	2,215	1,566
1¾	26,384	14,158	10,011	7,079	5,006	3,540	2,585	1,828
2	30,164	16,187	11,446	8,093	5,723	4,047	2,955	2,090
2¼	33,944	18,215	12,880	9,107	6,440	4,554	3,326	2,352
2½	37,724	20,243	14,314	10,122	7,157	5,061	3,696	2,613
2¾	41,504	22,272	15,749	11,136	7,874	5,568	4,066	2,875
3	45,284	24,300	17,183	12,150	8,591	6,075	4,437	3,137

Source: ICEA P-45-482

Based on initial temperature of 65°C, final temperature of 200°C, 5 mil copper tape with 12.5% overlap.

7.10 Resistance and Ampacity At 400 & 800 Hz

Table 7.12 – 400 & 800 Hz ampacity factors for 600 volt cables with Class B strand, installed with minimum triangular spacing in air or in nonmetallic conduit

Conductor Size	Conductor Diameter	Cable Diameter	DC Resistance 75°C	400 Hertz		800 Hertz	
AWG/ kcmil	Inches	Inches		AC/DC Resistance Ratio	Ampacity Derating Factor*	AC/DC Resistance Ratio	Ampacity Derating Factor*
14	0.073	0.21	3.14	1.00	1.00	1.00	1.00
12	0.092	0.23	1.97	1.00	1.00	1.00	1.00
10	0.116	0.25	1.24	1.00	1.00	1.00	1.00
8	0.146	0.32	0.780	1.00	1.00	1.00	1.00
6	0.184	0.39	0.490	1.00	1.00	1.00	1.00
4	0.232	0.44	0.310	1.00	1.00	1.05	0.98
2	0.292	0.50	0.194	1.03	0.98	1.12	0.94
1	0.332	0.61	0.154	1.05	0.98	1.16	0.93
1/0	0.372	0.65	0.122	1.08	0.96	1.25	0.89
2/0	0.418	0.69	0.097	1.15	0.93	1.40	0.84
3/0	0.470	0.75	0.0767	1.22	0.90	1.53	0.81
4/0	0.528	0.81	0.0608	1.33	0.87	1.70	0.77
250	0.575	0.92	0.0515	1.40	0.84	1.82	0.74
350	0.681	1.08	0.0368	1.56	0.80	2.05	0.70
500	0.813	1.16	0.0258	1.90	0.72	2.54	0.63
750	0.998	1.38	0.0172	2.30	0.66	3.06	0.57
1,000	1.152	1.54	0.0129	2.60	0.62	3.44	0.54

* These derating factors do not apply to cables with metallic sheath or armor, nor to cables installed in conduit or adjacent to steel structures. **Ampacity** equals the 60 Hertz ampacity multiplied by the derating factor.

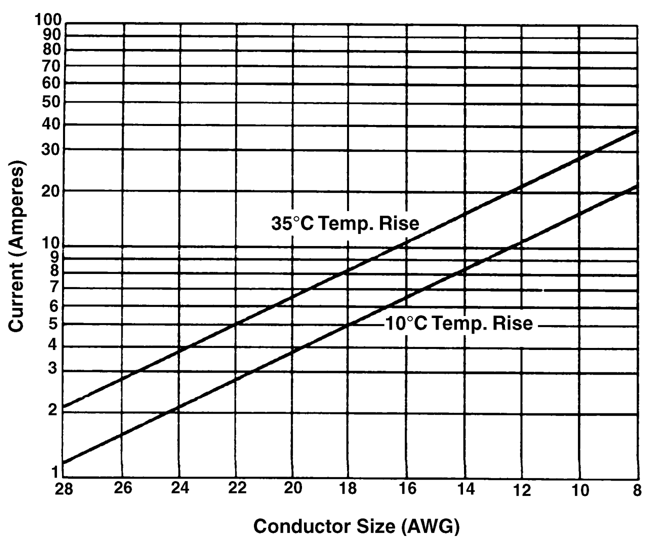
Source: ICEA P-43-457

7.11 Current Ratings for Electronic Cables

The maximum continuous current rating for an electronic cable is limited by conductor size, number of conductors contained within the cable, maximum temperature rating of the cable, and environmental conditions such as ambient temperature and air flow. To use the current capacity chart (Figure 7.3), first determine conductor gauge, temperature rating, and number of conductors for the cable of interest.

Next, find the current value on the chart for the proper temperature rise (temperature rating minus ambient temperature) and conductor size. To calculate the maximum current rating per conductor, multiply the chart value by the appropriate conductor factor. The chart assumes cable is surrounded by still air at an ambient temperature of 25°C. Current values are in RMS amperes and are valid for copper conductors only.

Note: Current ratings are intended as general guidelines for low power, electronic communications and control applications. Current ratings for power applications generally are set by regulatory agencies such as UL, CSA, NEC, and others.



No. of Conductors*	Factors
1	1.6
2 – 3	1.0
4 – 5	.8
6 – 15	.7
16 – 30	.5

*Do not count shields unless used as a conductor.

Figure 7.3 – Current ratings for electronic cables

7.12 Ampacity of Power Cables

The ampacity of a power cable depends primarily on its conductor size, conductor material (e.g., copper or aluminum), temperature rating, ambient temperature, installed cable configuration and other factors. Because so many external conditions affect ampacity, tables covering all situations are not possible. However, tables covering many common situations are available. The most frequently used **ampacity tables** are contained in the following publications:

NFPA Standard 70, *National Electrical Code*

CSA Standard C22.1, *Canadian Electrical Code*

IEEE Standard 835, *Power Cable Ampacity Tables*

ICEA P-53-426 (NEMA WC 50), *Ampacities Including Shield Losses for 15 Through 69 kV Cables*

ICEA P-54-440 (NEMA WC 51), *Ampacities of Cables in Open-top Cable Trays*

7.13 Basic Impulse Level (BIL) Ratings

Electrical equipment, including wire and cable, is designed to withstand short-term, but very high voltage pulses such as those sometimes caused by lightning and switching surges. These "spikes," as they are sometimes called, typically have a risetime in the range of 1.5 microseconds and a falltime around 40 microseconds. The **Basic Impulse Level** (**BIL**) is the maximum pulse voltage that a cable is designed to withstand. **BIL ratings** for various system voltage ratings are shown below:

Table 7.13 – Basic impulse level (BIL) ratings

System Voltage Rating (kV)	Basic Impulse Level (kV)
5	95
15	110
25	150
35	200
69	350
138	650