

# Appendix

**TABLE 17—Cables**

Approximate 60-cycle resistance and reactance of copper and aluminum cable, 75 C conductor temperature, 600 volts, 5 kV and 15 kV. Magnetic and non-magnetic conduit ohms/1000 ft l-n\*.

Cable Size	Copper Conductor								Aluminum Conductor								
	Cable in Magnetic Conduit				Cable in Nonmagnetic Conduit				Cable in Magnetic Conduit				Cable in Nonmagnetic Conduit				
	1/C Conductor		3/C Conductor		1/C Conductor		3/C Conductor		1/C Conductor		3/C Conductor		1/C Conductor		3/C Conductor		
	R	X	R	X	R	X	R	X	R	X	R	X	R	X	R	X	
<b>600 Volts</b>																	
8 AWG	0.7873	0.0514	0.7873	0.0394	0.7873	0.0411	0.7873	0.0343	1.2911	0.0514	1.2911	0.0394	1.2911	0.0411	1.2911	0.0343	
6 AWG	.4954	.0521	.4954	.0399	.4954	.0417	.4954	.0347	.8124	.0521	.8124	.0399	.8124	.0417	.8124	.0347	
4 AWG	.3114	.0492	.3114	.0377	.3114	.0393	.3114	.0328	.5107	.0492	.5107	.0377	.5107	.0393	.5107	.0328	
3 AWG	.247	.0479	.247	.0367	.247	.0383	.247	.0319	.4051	.0479	.4051	.0367	.4051	.0383	.4051	.0319	
2 AWG	.1959	.0466	.1959	.0357	.1959	.0373	.1959	.0311	.3212	.0466	.3212	.0357	.3212	.0373	.3212	.0311	
1 AWG	.1553	.0485	.1553	.0371	.1553	.0388	.1553	.0323	.2547	.0485	.2547	.0371	.2547	.0388	.2547	.0323	
1/0 AWG	.1231	.0457	.1231	.035	.1231	.0366	.1231	.0305	.2019	.0457	.2019	.035	.2019	.0366	.2019	.0305	
2/0 AWG	.0977	.0446	.0977	.0341	.0977	.0356	.0977	.0297	.1602	.0446	.1602	.0341	.1602	.0356	.1602	.0297	
3/0 AWG	.0775	.0435	.0775	.0333	.0775	.0348	.0775	.029	.127	.0435	.127	.0333	.127	.0348	.127	.029	
4/0 AWG	.0614	.0425	.0614	.0326	.0614	.034	.0614	.0283	.1007	.0425	.1007	.0326	.1007	.034	.1007	.0283	
250 MCM	.0534	.0428	.0534	.0328	.0529	.0342	.0529	.0285	.0868	.0428	.0868	.0328	.0854	.0342	.0854	.0285	
300 MCM	.0452	.042	.452	.032	.0443	.0336	.0443	.028	.0727	.042	.0727	.032	.0713	.0336	.0713	.028	
350 MCM	.0392	.0414	.0392	.0315	.0383	.0331	.0383	.0276	.0627	.0414	.0627	.0315	.0612	.0331	.0612	.0276	
400 MCM	.0348	.0409	.0348	.0311	.0337	.0327	.0337	.0273	.0553	.0409	.0553	.0311	.0536	.0327	.0536	.0273	
500 MCM	.0287	.0402	.0287	.0301	.0275	.0321	.0275	.0268	.0451	.0402	.0451	.0301	.0429	.0321	.0429	.0268	
600 MCM	.0249	.0404	.0249	.0299	.0234	.0323	.0234	.0269	.0384	.0404	.0384	.0299	.0358	.0323	.0358	.0269	
750 MCM	.0213	.0396	.0213	.0288	.0194	.0317	.0194	.0264	.0318	.0396	.0318	.0288	.0288	.0317	.0288	.0264	
1000 MCM	.0179	.0388	.0179	.0276	.0155	.031	.0155	.0259	.0254	.0388	.0254	.0276	.0219	.031	.0219	.0259	
1250 MCM	.0161	.0388	.0161	.0271	.0131	.031	.0131	.0258	.0215	.0388	.0215	.0271	.0178	.031	.0178	.0258	
1500 MCM	.0149	.0383	.0149	.0265	.0115	.0306	.0115	.0255	.0189	.0383	.0189	.0265	.0151	.0306	.0151	.0255	
1750 MCM	.0141	.0378	.0141	.026	.0104	.0302	.0104	.0252	.0171	.0378	.0171	.026	.0132	.0302	.0132	.0252	
2000 MCM	.0135	.0375	.0135	.0257	.0096	.03	.0096	.025	.0157	.0375	.0157	.0257	.0118	.03	.0118	.025	
<b>5 kV</b>																	
8 AWG	0.7873	0.0733	0.7873	0.0479	0.7873	0.0586	0.7873	0.0417	1.2911	0.0733	1.2911	0.0479	1.2911	0.0586	1.2911	0.0417	
6 AWG	.4954	.0681	.4954	.0447	.4954	.0545	.4954	.0389	.8124	.0681	.8124	.0447	.8124	.0545	.8124	.0389	
4 AWG	.3114	.0633	.3114	.0418	.3114	.0507	.3114	.0364	.5107	.0633	.5107	.0418	.5107	.0507	.5107	.0364	
3 AWG	.247	.0611	.247	.0405	.247	.0489	.247	.0353	.4051	.0611	.4051	.0405	.4051	.0489	.4051	.0353	
2 AWG	.1959	.0591	.1959	.0393	.1959	.0472	.1959	.0342	.3212	.0591	.3212	.0393	.3212	.0472	.3212	.0342	
1 AWG	.1553	.0571	.1553	.0382	.1553	.0457	.1553	.0332	.2547	.0571	.2547	.0382	.2547	.0457	.2547	.0332	
1/0 AWG	.1231	.0537	.1231	.036	.1231	.043	.1231	.0313	.2019	.0537	.2019	.036	.2019	.043	.2019	.0313	
2/0 AWG	.0977	.0539	.0977	.035	.0977	.0431	.0977	.0305	.1602	.0539	.1602	.035	.1602	.0431	.1602	.0305	
3/0 AWG	.0775	.0521	.0775	.0341	.0775	.0417	.0775	.0297	.127	.0521	.127	.0341	.127	.0417	.127	.0297	
4/0 AWG	.0614	.0505	.0614	.0333	.0614	.0404	.0614	.029	.1007	.0505	.1007	.0333	.1007	.0404	.1007	.029	
250 MCM	.0531	.049	.0531	.0324	.0531	.0392	.0531	.0282	.0868	.049	.0868	.0324	.0854	.0392	.0854	.0282	
300 MCM	.0462	.0478	.0462	.0317	.0446	.0383	.0446	.0277	.0727	.0478	.0727	.0317	.0713	.0383	.0713	.0277	
350 MCM	.0405	.0469	.0405	.0312	.0386	.0375	.0386	.0274	.0627	.0469	.0627	.0312	.0612	.0375	.0612	.0274	
400 MCM	.0359	.0461	.0359	.0308	.0341	.0369	.0341	.027	.0553	.0461	.0553	.0308	.0536	.0369	.0536	.027	
500 MCM	.0294	.045	.0294	.0299	.0279	.036	.0279	.0265	.0451	.045	.0451	.0299	.0429	.036	.0429	.0265	
600 MCM	.0252	.0439	.0252	.029	.0238	.0351	.0238	.0261	.0384	.0439	.0384	.029	.0358	.0351	.0358	.0261	
750 MCM	.0214	.0434	.0214	.0284	.0199	.0347	.0199	.026	.0318	.0434	.0318	.0284	.0288	.0347	.0288	.026	
1000 MCM	.0182	.0421	.0182	.0272	.0161	.0337	.0161	.0255	.0254	.0421	.0254	.0272	.0219	.0337	.0219	.0255	
1250 MCM	.0167	.0438	.0167	.027	.0139	.0342	.0139	.0257	.0215	.0428	.0215	.027	.0178	.0342	.0178	.0257	
1500 MCM	.016	.042	.016	.0264	.0125	.0336	.0125	.0254	.0189	.042	.0189	.0264	.0151	.0336	.0151	.0254	
1750 MCM	.0156	.0413	.0156	.0259	.0115	.033	.0115	.0251	.0171	.0413	.0171	.0259	.0132	.033	.0132	.0251	
2000 MCM	.0153	.0408	.0153	.0256	.0108	.0326	.0108	.0249	.0157	.0408	.0157	.0256	.0118	.0326	.0118	.0249	
<b>15 kV</b>																	
8 AWG	0.7873	0.0905	0.7873	0.0629	0.7873	0.0724	0.7873	0.0547	1.2911	0.0905	1.2911	0.0629	1.2911	0.0724	1.2911	0.0547	
6 AWG	.4954	.0842	.4954	.0584	.4954	.0674	.4954	.0508	.8124	.0842	.8124	.0584	.8124	.0674	.8124	.0508	
4 AWG	.3114	.0783	.3114	.0543	.3114	.0626	.3114	.0472	.5107	.0783	.5107	.0543	.5107	.0626	.5107	.0472	
3 AWG	.247	.0755	.247	.0523	.247	.0604	.247	.0455	.4051	.0755	.4051	.0523	.4051	.0604	.4051	.0455	
2 AWG	.1959	.0727	.1959	.0505	.1959	.0582	.1959	.0439	.3212	.0727	.3212	.0505	.3212	.0582	.3212	.0439	
1 AWG	.1553	.0701	.1553	.0487	.1553	.0561	.1553	.0424	.2547	.0701	.2547	.0487	.2547	.0561	.2547	.0424	
1/0 AWG	.1231	.0661	.1231	.0458	.1231	.0529	.1231	.0399	.2019	.0661	.2019	.0458	.2019	.0529	.2019	.0399	
2/0 AWG	.0977	.0637	.0977	.0442	.0977	.051	.0977	.0385	.1602	.0637	.1602	.0442	.1602	.051	.1602	.0385	
3/0 AWG	.0775	.0614	.0775	.0427	.0775	.0491	.0775	.0372	.127	.0614	.127	.0427	.127	.0491	.127	.0372	
4/0 AWG	.0614	.0592	.0614	.0413	.0614	.0474	.0614	.0359	.1007	.0592	.1007	.0413	.1007	.0474	.1007	.0359	
250 MCM	.0531	.0573	.0531	.04	.0531	.0458	.0531	.0348	.0868	.0573	.0868	.04	.0854	.0458	.0854	.0348	
300 MCM	.0462	.0557	.0462	.0387	.0446	.0446	.0446	.0339	.0727	.0557	.0727	.0387	.0713	.0446	.0713	.0339	
350 MCM	.0405	.0544	.0405	.0379	.0386	.0436	.0386	.0332	.0627	.0544	.0627	.0379	.0612	.0436	.0612	.0332	
400 MCM	.0359	.0534	.0359	.0371	.0341	.0427	.0341	.0326	.0553	.0534	.0553	.0371	.0536	.0427	.0536	.0326	
500 MCM	.0294	.0517	.0294	.0357	.0279	.0414	.0279	.0317	.0451	.0517	.0451	.0357	.0429	.0414	.0429	.0317	
600 MCM	.0252	.0516	.0252	.0343	.0238	.0413	.0238	.0309	.0384	.0516	.0384	.0343	.0358	.0413	.0358	.0309	
750 MCM	.0214	.05	.0214	.0328	.0199	.04	.0199	.0301	.0318	.05	.0318	.0328	.0288	.04	.0288	.0301	
1000 MCM	.0182	.0482	.0182	.0311	.0161	.0385	.0161	.0291	.0254	.0482	.0254	.0311	.0219	.0385	.0219	.0291	
1250 MCM	.0167	.0467	.0167	.0298	.0139	.0374	.0139	.0284	.0215	.0467	.0215	.0298	.0178	.0374	.0178	.0284	
1500 MCM	.016	.0457	.016	.029	.0125	.0366	.0125	.0279	.0189	.0457	.0189	.029	.0151	.0366	.0151	.0279	
1750 MCM	.0156	.0448	.0156	.0283	.0115	.0358	.0115	.0274	.0171	.0448	.0171	.0283	.0132	.0358	.0132	.0274	
2000 MCM	.0153	.0441	.0153	.0279	.0108	.0353	.0108	.0271	.0157	.0441	.0157	.0279	.0118	.0353	.0118	.0271	

\*These values are from IEEE Standard 141 and differ slightly from values used in earlier publications of this bulletin.

**TABLE 18—GE Busway Impedances**

Busway Type	Ampere Rating	Ohms Per 100 Feet, Line-To-Neutral		
		60-HZ Alternating Current		
		Resistance(R)	Reactance(X)	Impedance(Z)
LVD Feeder With Aluminum Bus Bars	600	0.00331	0.00228	0.00402
	800	.00210	.00081	.00226
	1000	.00163	.00079	.00181
	1350	.00143	.00052	.00153
	1600	.00108	.00051	.00119
	2000	.00081	.00037	.00089
	2500	.00064	.00030	.00071
	3000	.00054	.00024	.00059
	4000	.00041	.00018	.00045
5000	.00032	.00013	.00035	
LVD Feeder With Copper Bus Bars	800	0.00200	0.00228	0.00304
	1000	.00132	.00081	.00156
	1350	.00099	.00079	.00126
	1600	.00088	.00052	.00102
	2000	.00066	.00051	.00083
	2500	.00059	.00037	.00062
	3000	.00040	.00030	.00050
	4000	.00034	.00024	.00042
	5000	.00025	.00018	.00031
LVDP Plug-in With Aluminum Bus Bars	800	0.00210	0.00114	0.00238
	1000	.00163	.00110	.00197
	1350	.00143	.00069	.00159
	1600	.00108	.00066	.00127
	2000	.00081	.00044	.00092
	2500	.00064	.00035	.00073
	3000	.00054	.00028	.00061
	4000	.00041	.00021	.00046
	5000	.00032	.00016	.00036
LVDP Plug-in With Copper Bus Bars	800	0.00200	0.00460	0.00500
	1000	.00132	.00114	.00174
	1350	.00099	.00110	.00148
	1600	.00088	.00069	.00112
	2000	.00066	.00066	.00093
	2500	.00050	.00044	.00067
	3000	.00040	.00035	.00053
	4000	.00034	.00028	.00044
	5000	.00025	.00021	.00032
CL With Aluminum Bus Bars	1000	0.00220	0.0069	0.0072
	1350	.00200	.0064	.0067
	1600	.00148	.0064	.0066
	2000	.00112	.0058	.0059
	2500	.00090	.0054	.0055
	3000	.00077	.0050	.0051
	4000	.00059	.0042	.0042
CL With Copper Bus Bars	1000	0.00177	0.0069	0.0071
	1350	.00134	.0069	.0070
	1600	.00121	.0064	.0065
	2000	.00090	.0064	.0065
	2500	.00070	.0058	.0058
	3000	.00058	.0054	.0054
4000	.00041	.0046	.0046	
FVK With Copper Bus Bars	225	0.0052	0.0064	0.0082
	400	.0038	.0064	.0075
	600	.0021	.0048	.0052
	800	.0014	.0034	.0037
	1000	.0011	.0032	.0034

**TABLE 18—Busway Impedances (Cont'd)**

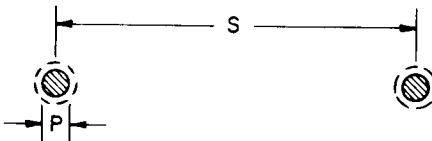
Busway Type	Ampere Rating	Ohms Per 100 Feet, Line-To-Neutral		
		60-HZ Alternating Current		
		Resistance(R)	Reactance(X)	Impedance(Z)
FVA With Aluminum Bus Bars	225	0.0074	0.0064	0.0098
	400	.0038	.0048	.0061
	600	.0022	.0034	.0041
	800	.0018	.0032	.0037
DH CU Al	100	0.0290	0.0050	0.0294
	100	0.0450	0.0050	0.0187
LTG	50	0.053	0.014	0.055
LW	30	0.093	0.003	0.093
	60	.051	.003	.051
ARMOR-CLAD Feeder Aluminum	600	0.00333	0.00135	0.00359
	800	.00221	.00097	.00241
	1000	.00166	.00065	.00178
	1200	.00133	.00053	.00143
	1350	.00110	.00045	.00119
	1600	.00102	.00045	.00112
	2000	.00078	.00031	.00084
	2500	.00055	.00023	.00059
	3000	.00049	.00020	.00053
4000	.00036	.00015	.00039	
ARMOR-CLAD Feeder Copper	600	0.00268	0.00168	0.00316
	800	.00206	.00135	.00246
	1000	.00135	.00097	.00166
	1200	.00100	.00065	.00119
	1350	.00096	.00061	.00114
	1600	.00083	.00053	.00099
	2000	.00068	.00049	.00084
	2500	.00051	.00032	.00060
	3000	.00041	.00027	.00049
	4000	.00030	.00020	.00036
5000	.00023	.00015	.00027	
ARMOR-CLAD Plug-in Aluminum	225	0.00951	0.00394	0.01029
	400	.00378	.00433	.00575
	600	.00358	.00380	.00522
	800	.00240	.00252	.00348
	1000	.00159	.00159	.00225
	1200	.00120	.00122	.00171
	1350	.00104	.00106	.00149
	1600	.00110	.00124	.00166
	2000	.00080	.00086	.00118
	2500	.00051	.00057	.00077
3000	.00043	.00048	.00068	
4000	.00036	.00019	.00041	
ARMOR-CLAD Plug-in Copper	225	0.00524	0.00394	0.00656
	400	.00273	.00276	.00388
	600	.00226	.00433	.00488
	800	.00210	.00380	.00434
	1000	.00142	.00252	.00289
	1200	.00109	.00182	.00212
	1350	.00088	.00144	.00169
	1600	.00072	.00117	.00137
	2000	.00066	.00124	.00141
	2500	.00049	.00086	.00099
3000	.00037	.00066	.00076	
4000	.00027	.00048	.00055	

## Overhead Lines

Practical transmission lines are often assumed to have a 60-cps positive- or negative-sequence reactance as high as 0.8 ohms/mile (or 0.15 ohms/1000 feet) line-to-neutral. Closer values can be obtained from Fig. 26-1 (page 44) if the conductor spacing is known. The values in Fig. 26-1 were calculated from the equation

$$X_L = 10^{-6} \omega \left( 15.2 + 140.4 \log \frac{2S}{d} \right)$$

with dimensions according to the following illustration where S and d are in the same units:



For an unsymmetrical arrangement of three conductors, an equivalent value of S can be derived from the relation

$$S = \sqrt{(S_1)(S_2)(S_3)}$$

There is a considerable amount of variation in the spacing of conductors of overhead lines. Fig. 26-2 gives representative values for current practice on an equivalent-delta basis.

## Bus

Site-assembled bus will have 60-cycle inductive reactance (positive- or negative-sequence) varying with conductor spacing according to Fig. 26-3 through 26-5.

The zero-sequence reactance of site-assembled bus, with respect to nearby grounded enclosures or material, will be indefinite because the spacings are not definite. Ratios of  $Z_0/Z_1$  tend to be very large.

# Appendix

## Conductor Constants

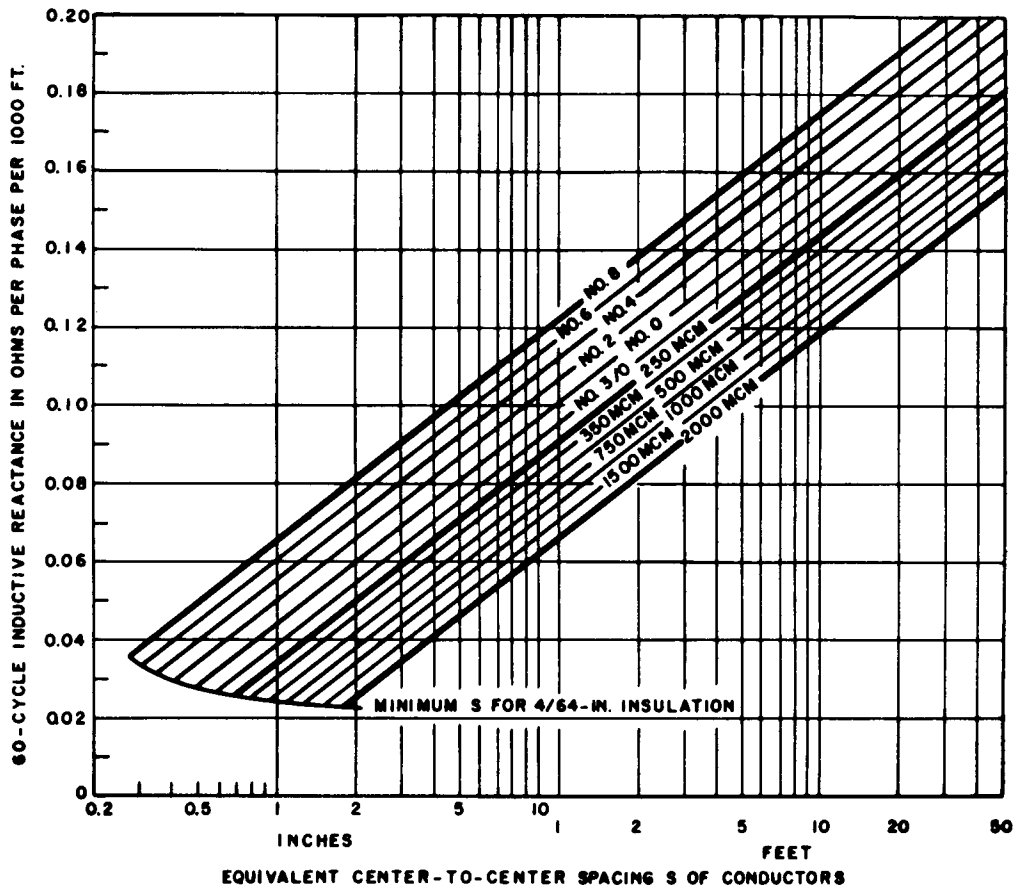


Fig. 26-1. Calculated inductive reactance for parallel conductors with standard stranding where values are per conductor for two-wire, single-phase circuits and line-to-neutral for three-phase circuits

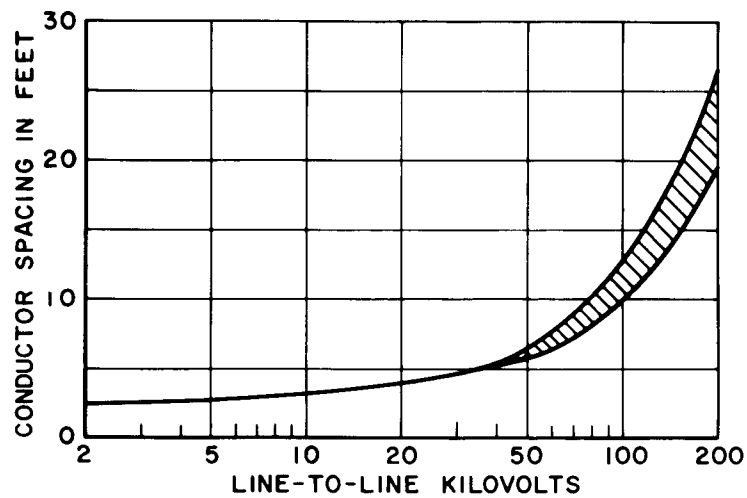


Fig. 26-2. Typical equivalent-delta spacing used for three-wire overhead transmission lines

## Conductor Constants (Cont'd)

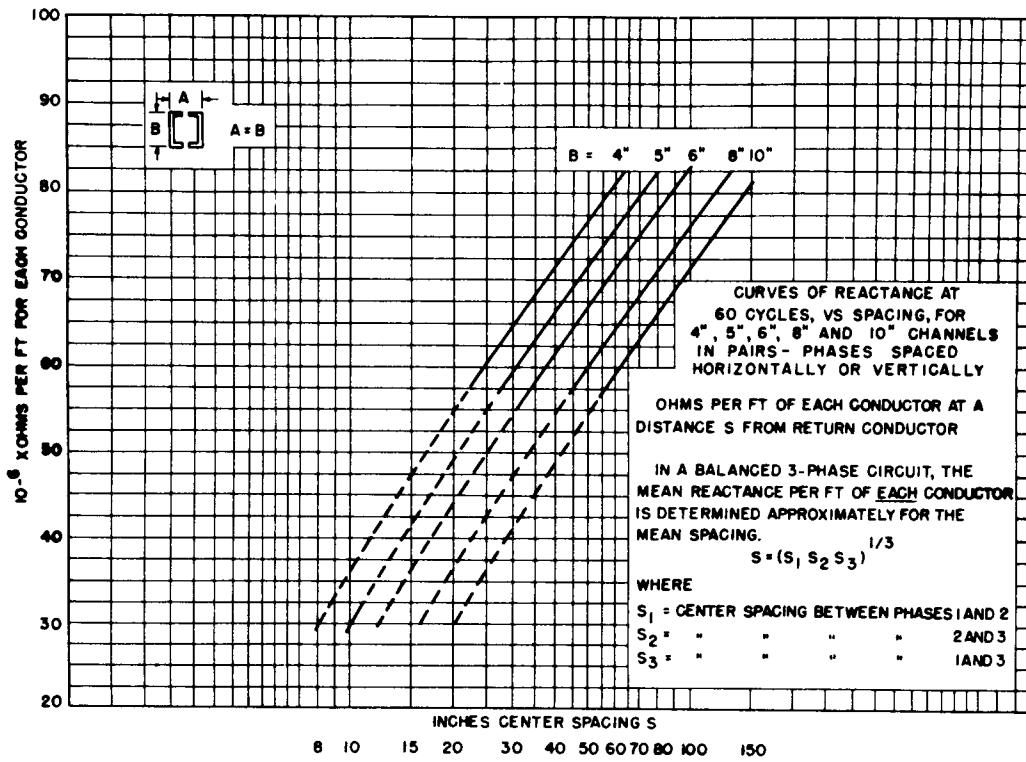


Fig. 26-3

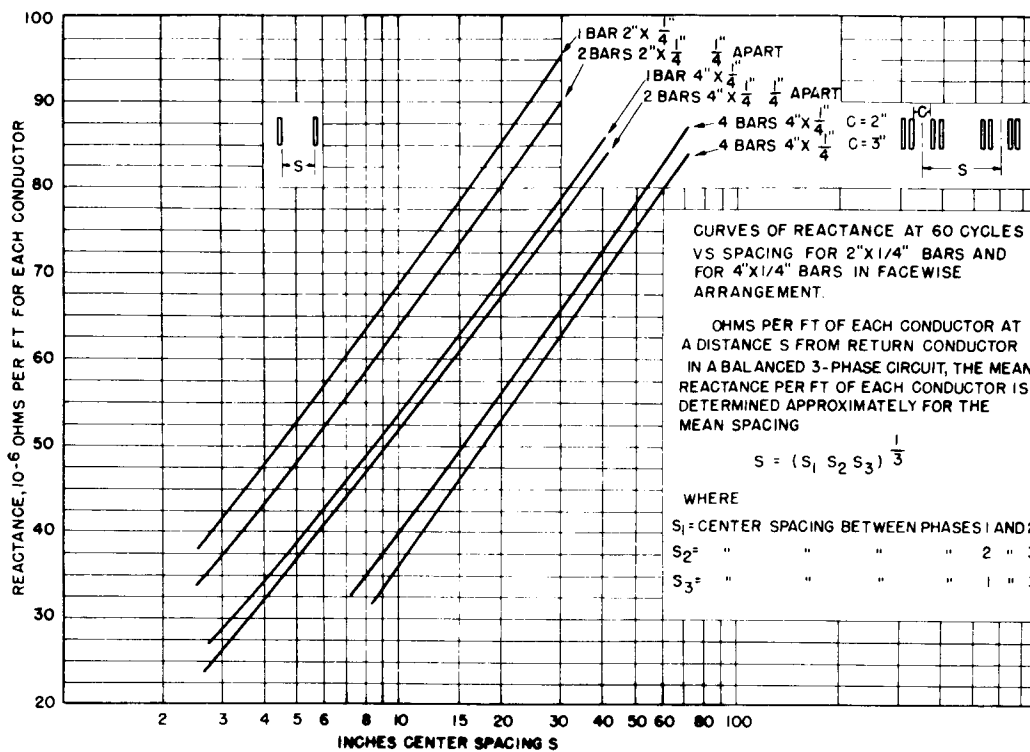


Fig. 26-4

# Appendix

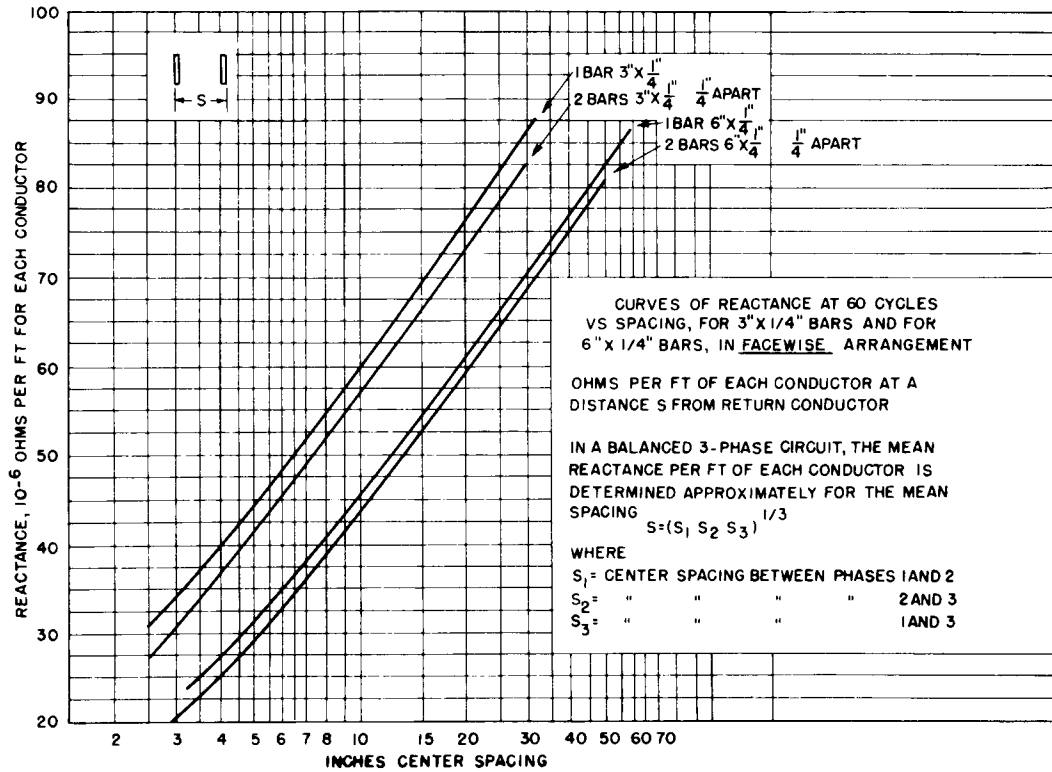


Fig. 26-5

## Part III Short-circuit Ratings of a.c. Components and Equipments

The short-circuit ratings listed in the following tables are representative of standard components or equipment in current production.

The short-circuit ratings may change from time to time and in addition new components or equipments are continually becoming

available so it is suggested that up-to-date short-circuit ratings be verified by consulting the appropriate product bulletin.

TABLE 19—Low Voltage Circuit Breakers

COMPONENT	BULLETIN NUMBER
Molded Case Circuit Breakers	GET-2779
Insulated Case Circuit Breakers	GET-6211
Low voltage Power Circuit Breaker	GET-6218
Coordinated Ratings	GIZ-2691-26

TABLE 20—Low-Voltage Safety and Disconnect Switches

TYPE	MAXIMUM VOLTAGE AC	CONTINUOUS CURRENT RMS AMPERES	INTERRUPTING RATINGS RMS SYMMETRICAL KILO-AMPERES				
			NO FUSE kA	FUUSED UNIT FUSE CLASS			
				H	R	J	L
TG	240	30	0.18	10	—	—	—
		60	0.36	10	—	—	—
		100	0.6	10	—	—	—
		200	1.2	10	—	—	—
		400	2.4	10	—	—	—
		600	3.6	10	—	—	—
TH	600	30	0.36	10	200	200	—
		60 or 100	1.2	10	200	200	—
		200	3.40	10	200	200	—
		400 or 600	10.0	10	200	200	—
		800	4.8	—	—	—	100
		1200	7.2	—	—	—	100
QMR	600	30	0.42	10	200	200	—
		60	0.9	10	200	200	—
		100	1.7	10	200	200	—
		200	3.4	10	200	200	—
		400	10.0	10	200	200	—
		600	10.0	10	200	200	—
QMW	600	30	0.95	10	200	200	—
		60	1.7	10	200	200	—
		100	1.8	10	200	200	—
		200	3.6	10	200	200	—
HPC	600	800-1600	19.2	—	—	—	200
		2000-4000	42	—	—	—	200