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Section 16 Technical Information and Glossary

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CONDUCTORS

The conductor is the metallic component of cables through which electrical power or electrical signals are transmitted. Conductor size is usually specified by American Wire Gauge (AWG), circular mil area or in square millimeters.

AWG

The American Wire Gauge (sometimes called Brown and Sharpe or B and S) is used almost exclusively in the USA for copper and aluminum wire. The Birmingham Wire Gauge (BWG) is used for steel armor wire.

The diameters according to the AWG are defined as follows: the diameter of size 4/0 (sometimes written 0000) equals 0.4600 inch and that of size #36 equals 0.0050 inch; the intermediate sizes are found by geometric progression. That is, the ratio of the diameter of one size to that of the next smaller size (larger gauge number) is:

$$\sqrt[39]{\frac{0.4600}{0.0050}} = 1.122932$$

Circular Mil

Sizes larger than 4/0 are specified in terms of the total area of a cross-section of the copper in circular mils (cmil). A circular mil is a unit of area equal to the area of a circle one mil in diameter. It is $\pi/4$ (equal to 0.7854) of a square mil (one mil = 0.001 inch). The area of a circle in circular mils is therefore equal to the square of its diameter in mils. A solid wire one inch in diameter has an area of 1,000,000 cmils, whereas one square inch equals $4/\pi \times 1,000,000$ cmils (equal to 1,273,200 cmils).

Square Millimeters

Metric sizes are given in terms of square millimeters (mm²).

Conductor Characteristics

Relative electrical and thermal conductivities of common metal conductors are as follows:

Table 1—Relative electrical and thermal conductivities of common conductor materials

Metal	Relative Electrical Conductivity at 20°C	Relative Thermal Conductivity at 20°C
Silver	106	108
Copper (annealed)	100	100
Copper (hard drawn)	97	—
Gold	72	76
Aluminum	62	56
Magnesium	39	41
Zinc	29	29
Nickel	25	15
Cadmium	23	24
Cobalt	18	17
Iron	17	17
Platinum	16	18
Tin	15	17
Steel	12	—
Lead	8	9

Technical Information

Conductors

STRAND TYPES

Concentric Strand

A concentric stranded conductor consists of a central wire or core surrounded by one or more layers of helically-laid wires. Each layer after the first has six more wires than the preceding layer. Except in compact stranding, each layer is usually applied in a direction opposite to that of the layer under it.

If the core is a single wire and if it and all of the outer strands have the same diameter, the first layer will contain six wires; the second, twelve; the third, eighteen; etc.

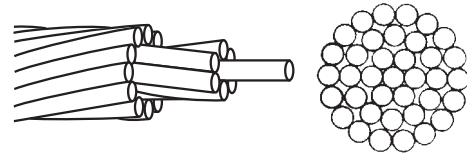


Figure 1—Concentric strand

Bunch Strand

The term bunch stranding is applied to a collection of strands twisted together in the same direction without regard to the geometric arrangement.

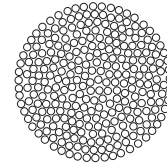


Figure 2—Bunch strand

Rope Strand

A rope stranded conductor is a concentric stranded conductor each of whose component strands is itself stranded. A rope stranded conductor is described by giving the number of groups laid together to form the rope and the number of wires in each group.

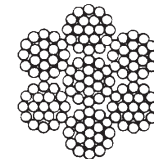


Figure 3—Rope strand

Sector Conductor

A sector conductor is a stranded conductor whose cross-section is approximately the shape of a sector of a circle. A multiple-conductor insulated cable with sector conductors has a smaller diameter than the corresponding cable with round conductors.

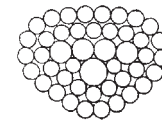


Figure 4—Sector conductor

Segmental Conductor

A segmental conductor is a round, stranded conductor composed of three or four sectors slightly insulated from one another. This construction has the advantage of lower AC resistance (less skin effect).

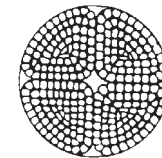


Figure 5—Segmental conductor

Annular Conductor

An annular conductor is a round, stranded conductor whose strands are laid around a suitable core. The core is usually made wholly or mostly of nonconducting material. This construction has the advantage of lower total AC resistance for a given cross-sectional area of conducting material by eliminating the greater skin effect at the center.

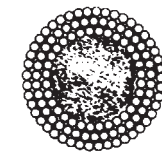


Figure 6—Annular conductor

Compact Strand

A compact stranded conductor is a round or sector conductor having all layers stranded in the same direction and rolled to a predetermined ideal shape. The finished conductor is smooth on the surface and contains practically no interstices or air spaces. This results in a smaller diameter.

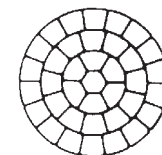


Figure 7—Compact strand

Conductors

Compressed Strand

Compressed conductors are intermediate in size between standard concentric conductors and compact conductors. A comparison is shown below:

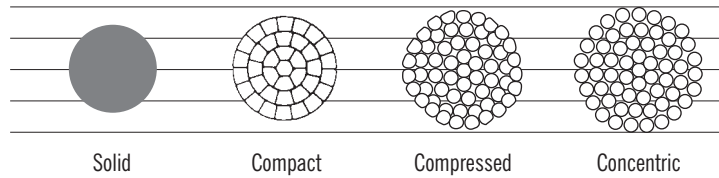


Figure 8—Comparative sizes and shapes of 1,000 kcmil conductors

In a concentric stranded conductor, each individual wire is round and considerable space exists between wires. In a compressed conductor, the conductor has been put through a die that “squeezes out” some of the space between wires. In a compact conductor each wire is preformed into a trapezoidal shape before the wires are stranded together into a finished conductor. This results in even less space between wires. A compact conductor is, therefore, the smallest in diameter (except for a solid conductor, of course). Diameters for common conductor sizes are given in the table below.

Table 2—Diameters for copper and aluminum conductors

Conductor Size		Nominal Diameters (in.)			
(AWG)	(kcmil)	Solid	Class B Compact	Class B Compressed	Class B Concentric
8	16.51	0.1285	0.134	0.141	0.146
6	26.24	0.1620	0.169	0.178	0.184
4	41.74	0.2043	0.213	0.225	0.232
3	52.62	0.2294	0.238	0.252	0.260
2	66.36	0.2576	0.268	0.283	0.292
1	83.69	0.2893	0.299	0.322	0.332
1/0	105.6	0.3249	0.336	0.361	0.373
2/0	133.1	0.3648	0.376	0.406	0.419
3/0	167.8	0.4096	0.423	0.456	0.470
4/0	211.6	0.4600	0.475	0.512	0.528
—	250	0.5000	0.520	0.558	0.575
—	300	0.5477	0.570	0.611	0.630
—	350	0.5916	0.616	0.661	0.681
—	400	0.6325	0.659	0.706	0.728
—	450	0.6708	0.700	0.749	0.772
—	500	0.7071	0.736	0.789	0.813
—	550	0.7416	0.775	0.829	0.855
—	600	0.7746	0.813	0.866	0.893
—	650	0.8062	0.845	0.901	0.929
—	700	0.8367	0.877	0.935	0.964
—	750	0.8660	0.908	0.968	0.998
—	800	0.8944	0.938	1.000	1.031
—	900	0.9487	0.999	1.061	1.093
—	1,000	1.0000	1.060	1.117	1.152

Sources: ASTM B8 and B496
ICEA S-95-658 (NEMA WC-70)

Conductors

COATINGS

There are three materials commonly used for coating a copper conductor. These are tin, silver and nickel.

Tin is the most common and is used for improved corrosion resistance and solderability.

Silver plated conductors are used in high-temperature environments (150°C–200°C). It is also used for high-frequency applications where silver's high conductivity (better than copper) and the "skin effect" work together to reduce attenuation at high frequencies.

Nickel coatings are used for conductors that operate between 200°C and 450°C. At these high temperatures, copper oxidizes rapidly if not nickel plated. One drawback of nickel, however, is its poor solderability.

Class B, C and D Copper Strand

Table 3—Class B concentric-lay-stranded copper conductors

Size (AWG or kcmil)	Number of Wires	Diameter of Each Strand (mils)	Weight (lb./1,000 ft.)	Nominal Overall Diameter (in.)
5,000	217	151.8	15,890	2.58
4,500	217	144	14,300	2.45
4,000	217	135.8	12,590	2.31
3,500	169	143.9	11,020	2.16
3,000	169	133.2	9,353	2.00
2,500	127	140.3	7,794	1.82
2,000	127	125.5	6,175	1.63
1,900	127	122.3	5,866	1.59
1,800	127	119.1	5,558	1.55
1,750	127	117.4	5,402	1.53
1,700	127	115.7	5,249	1.50
1,600	127	112.2	4,940	1.46
1,500	91	128.4	4,631	1.41
1,400	91	124.0	4,323	1.36
1,300	91	119.5	4,014	1.32
1,250	91	117.2	3,859	1.30
1,200	91	114.8	3,705	1.26
1,100	91	109.9	3,396	1.21
1,000	61	128.0	3,088	1.15
900	61	121.5	2,779	1.09
800	61	114.5	2,470	1.03
750	61	110.9	2,316	1.00
700	61	107.1	2,161	0.964
650	61	103.2	2,007	0.929
600	61	99.2	1,853	0.893
550	61	95.0	1,698	0.855
500	37	116.2	1,544	0.813
450	37	110.3	1,389	0.772
400	37	104.0	1,235	0.728
350	37	97.3	1,081	0.681
300	37	90.0	926.3	0.630
250	37	82.2	711.9	0.575
4/0	19	105.5	653.3	0.528

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Conductors

Table 3—Class B concentric-lay-stranded copper conductors (continued)

Size (AWG or kcmil)	Number of Wires	Diameter of Each Strand (mils)	Weight (lb./1,000 ft.)	Nominal Overall Diameter (in.)
3/0	19	94.0	518.1	0.470
2/0	19	83.7	410.9	0.419
1/0	19	74.5	325.8	0.373
1	19	66.4	258.4	0.332
2	7	97.4	204.9	0.292
3	7	86.7	162.5	0.260
4	7	77.2	128.9	0.232
5	7	68.8	102.2	0.206
6	7	61.2	81.05	0.184
7	7	54.5	64.28	0.164
8	7	48.6	50.97	0.146
9	7	43.2	40.42	0.130
10	7	38.5	32.06	0.116
12	7	30.5	20.16	0.0915
14	7	24.2	12.68	0.0726
16	7	19.2	7.974	0.0576
18	7	15.2	5.015	0.0456
20	7	12.1	3.154	0.0363

Source: ASTM B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

Conductors

Stranding, Diameter, Area, DC Resistance and Weight (20 AWG Through 2,000 kcmil)

Table 4—Copper conductor stranding, diameter, area, weight and DC resistance

Nominal Area		Size	Number/Diameter of Individual Wires		Overall Diameter		Nominal Weight		DC Resistance at 20°C (68°F)	
(mm ²)	(cmils)		(in.)	(mm)	(in.)	(mm)	(lb./1,000 ft.)	(kg/km)	(ohms/1,000 ft.)	(ohms/km)
0.50	987	—	1/0.032	1/0.613	0.032	0.81	3.100	4.613	10.13	32.33
—	1,020	20	7/0.0121	7/0.307	0.036	0.91	3.157	4.098	10.22	33.77
0.75	1,480	—	1/0.036	1/0.991	0.039	0.99	4.603	6.851	6.820	22.37
—	1,620	18	1/0.403	1/1.02	0.040	1.02	4.917	7.316	6.387	20.95
—	1,620	18	7/0.0152	7/0.386	0.046	1.16	4.980	7.410	6.523	21.40
1.0	1,970	—	1/0.045	1/1.14	0.045	1.14	6.130	9.122	5.127	16.80
1.0	1,970	—	7/0.017	7/0.432	0.051	1.30	6.293	9.266	5.213	17.11
—	2,580	16	1/0.0508	1/1.29	0.061	1.29	7.810	11.63	4.020	13.19
—	2,580	16	7/0.0192	7/0.488	0.058	1.46	7.877	11.82	4.087	13.41
1.5	2,960	—	1/0.055	1/1.40	0.055	1.40	9.157	13.63	3.430	11.25
1.5	2,960	—	7/0.021	7/0.533	0.063	1.60	8.837	14.14	3.417	11.21
—	4,110	14	1/0.641	1/1.63	0.064	1.63	12.44	18.51	2.524	8.281
—	4,110	14	7/0.0242	7/0.615	0.073	1.84	12.62	18.78	2.573	8.442
2.5	4,930	—	1/0.071	1/1.80	0.071	1.80	15.26	22.71	2.057	6.750
2.5	4,930	—	7/0.027	7/0.686	0.081	2.06	15.71	23.38	2.067	6.782
—	6,530	12	1/0.0808	1/2.05	0.081	2.05	19.76	29.41	1.589	5.212
—	6,530	12	7/0.0305	7/0.755	0.092	2.32	20.05	29.84	1.620	5.315
4	7,890	—	1/0.089	1/2.26	0.089	2.26	23.98	35.68	1.309	4.296
4	7,890	—	7/0.034	7/0.864	0.102	2.59	24.91	37.08	1.304	4.277
—	10,380	10	1/0.1019	1/2.59	0.102	2.59	31.43	46.77	0.999	3.277
—	10,380	10	7/0.0385	7/0.978	0.116	2.93	31.94	47.54	1.017	3.335
6	11,800	—	1/0.109	1/2.77	0.109	2.77	35.97	53.52	0.8730	2.864
6	11,800	—	7/0.042	7/0.107	0.126	3.21	38.00	56.55	0.8543	2.803
—	13,090	9	1/0.1144	7/2.91	0.1144	2.91	39.60	58.93	0.7923	2.600
—	13,090	9	7/0.0432	7/1.10	0.130	3.30	40.23	59.86	0.8073	2.649
—	16,510	8	1/0.1285	1/3.26	0.128	3.26	50.17	74.36	0.6147	2.061
—	16,510	8	7/0.0486	7/1.23	0.146	3.70	50.90	75.75	0.6380	2.093
10	19,700	—	1/0.141	1/3.58	0.141	3.58	60.17	89.54	0.5217	1.711
10	19,700	—	7/0.054	7/1.37	0.162	4.12	62.83	93.51	0.5167	1.695
—	20,820	7	1/0.1443	1/3.67	0.144	3.67	63.03	93.80	0.4980	1.634
—	20,820	7	7/0.0545	7/1.38	0.164	4.15	64.00	95.24	0.5073	1.664
—	26,240	6	1/0.162	1/4.11	0.162	4.11	79.43	118.2	0.3950	1.296
—	26,240	6	7/0.0612	7/1.55	0.184	4.66	80.73	120.1	0.4023	1.320
16	31,600	—	7/0.068	7/1.73	0.204	5.18	99.67	148.3	0.3259	1.069
—	33,090	6	7/0.0688	7/1.75	0.206	5.24	102.0	151.8	0.3183	1.044
—	41,740	4	7/0.0772	7/1.96	0.232	5.88	128.4	191.1	0.2528	0.8295
25	49,300	—	7/0.065	7/2.16	0.255	6.48	155.7	231.7	0.2176	0.6843
—	52,620	3	7/0.0867	7/2.20	0.260	6.61	162.0	241.1	0.2005	0.6577
35	69,100	—	7/0.100	7/2.54	0.300	7.62	215.5	320.7	0.1507	0.4944
35	69,100	—	19/0.061	19/1.55	0.305	7.75	218.1	324.5	0.1495	0.4909

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Conductors

Table 4—Copper conductor stranding, diameter, area, weight and DC resistance (continued)

Nominal Area		Size	Number/Diameter of Individual Wires		Overall Diameter		Nominal Weight		DC Resistance at 20°C (68°F)	
(mm ²)	(cmils)	(AWG)	(in.)	(mm)	(in.)	(mm)	(lb./1,000 ft.)	(kg/km)	(ohms/1,000 ft.)	(ohms/km)
—	83,690	1	19/0.0664	19/1.63	0.332	8.43	258.4	384.5	0.1261	0.4139
50	98,700	—	19/0.073	19/1.85	0.365	9.27	312.3	464.8	0.1044	0.3424
—	105,400	1/0	19/0.0745	19/1.89	0.373	9.46	325.3	484.1	0.10020	0.3288
—	133,100	2/0	19/0.0837	19/2.13	0.419	10.6	410.7	611.1	0.07940	0.2605
70	138,000	—	19/0.086	19/2.18	0.430	10.9	433.3	645.0	0.07520	0.2467
—	167,800	3/0	19/0.094	19/2.39	0.470	11.9	517.7	770.4	0.06293	0.2065
—	167,800	3/0	37/0.0673	37/1.71	0.471	12.0	517.0	769.4	0.06310	0.2070
95	187,000	—	19/0.101	19/2.57	0.505	12.8	597.7	889.4	0.05453	0.1789
—	211,600	4/0	19/0.1055	19/2.68	0.528	13.4	652.3	970.8	0.04997	0.1639
120	237,000	—	37/0.0811	37/0.0811	0.567	14.4	749.0	1,115	0.04357	0.1429
—	250,000	—	37/0.0822	37/0.0822	0.575	14.6	771.3	1,148	0.04230	0.1388
150	300,000	—	37/0.090	37/2.29	0.630	16.0	924.7	1,376	0.03527	0.1157
—	350,000	—	37/0.0973	37/2.47	0.681	17.3	1,081	1,609	0.03018	0.09903
185	365,000	—	37/0.100	37/2.54	0.700	17.8	1,142	1,699	0.02857	0.09375
—	400,000	—	37/0.104	37/2.64	0.728	18.5	1,235	1,838	0.02642	0.06668
240	474,000	—	37/0.114	37/2.90	0.798	20.3	1,484	2,206	0.02199	0.07214
240	474,000	—	61/0.089	61/2.26	0.801	20.3	1,491	2,219	0.02189	0.07181
—	500,000	—	37/0.1162	37/2.95	0.813	20.7	1,608	2,294	0.02116	0.06943
—	500,000	—	61/0.0905	61/2.30	0.814	20.7	1,549	2,295	0.02117	0.06944
300	592,000	—	61/0.099	61/2.51	0.891	22.6	1,842	2,746	0.02102	0.05803
—	600,000	—	61/0.0992	61/2.52	0.893	22.7	1,853	2,757	0.01762	0.05780
—	700,000	—	61/0.1071	61/2.72	0.964	24.5	2,160	3,214	0.01511	0.04959
—	750,000	—	61/0.1109	61/2.82	0.998	25.4	2,316	3,446	0.01410	0.04625
—	750,000	—	91/0.0908	91/2.31	0.999	25.4	2,316	3,447	0.01410	0.04625
400	789,000	—	61/0.114	61/2.90	1.026	26.1	2,447	3,642	0.01334	0.04377
—	800,000	—	61/0.1145	61/2.91	1.031	26.2	2,468	3,673	0.01322	0.04338
—	800,000	—	91/0.0938	91/2.38	1.032	26.2	2,471	3,678	0.01321	0.04334
500	1,000,000	—	61/0.1280	61/3.25	1.152	29.3	3,085	4,590	0.01058	0.03472
—	1,000,000	—	91/0.1048	91/2.66	1.153	29.3	3,085	4,591	0.01058	0.03472
625	1,234,000	—	91/0.117	91/2.97	1.287	32.7	3,845	5,722	0.00849	0.02786
—	1,250,000	—	91/0.1172	91/2.98	1.289	32.7	3,858	5,742	0.008460	0.02776
—	1,250,000	—	127/0.0992	127/2.52	1.290	32.8	3,858	6,741	0.008463	0.02777
—	1,500,000	—	91/0.1284	91/3.26	1.412	35.9	4,631	6,892	0.007050	0.02313
—	1,500,000	—	127/0.1087	127/2.76	1.413	35.9	4,632	6,894	0.007183	0.02312
800	1,580,000	—	91/0.132	91/3.35	1.452	36.9	4,894	7,284	0.006670	0.02188
1,000	1,970,000	—	91/0.147	91/3.73	1.617	41.1	6,070	9,033	0.005380	0.01765
—	2,000,000	—	127/0.1255	127/3.19	1.632	41.5	6,175	9,189	0.005287	0.01735
—	2,000,000	—	169/0.1088	169/2.76	1.632	41.5	6,176	9,191	0.005287	0.01735

Based on British (BSA), Canadian (CSA), American (ASTM and ICEA) and German (VDE) Standards

Insulation and Jacket Materials

Conductors need to be electrically isolated from other conductors and from the environment to prevent short circuits. Insulation is applied around a conductor to provide this isolation. Most wire and cable insulations consist of polymers (plastics), which have a high resistance to the flow of electric current. A jacket is the outermost layer of a cable whose primary function is to protect the insulation and conductor core from external physical forces and chemical deterioration.

TYPES AND APPLICATIONS

Thermoplastics

Chlorinated Polyethylene (CPE)

CPE is one of the few polymers available in both thermoplastic and thermoset (cross-linked) versions. As a rule, thermoset formulations have better high-temperature properties than thermoplastics but are also higher in cost. Thermoplastic CPE is more common than thermoset CPE.

Polyvinyl Chloride (PVC)

Sometimes referred to simply as “vinyl,” PVC does not usually exhibit extremely high- and low-temperature properties in one formulation. Certain formulations may have a -55°C to 105°C rating, while other common vinyls may have a -20°C to 60°C rating. The many varieties of PVC also differ in pliability and electrical properties. The price range can vary accordingly. Typical dielectric constant values range from 3.5 to 6.5.

When properly formulated, thermoplastic jackets of PVC provide cables with the ability to resist oils, acids, alkalis, sunlight, heat, weathering and abrasion. This range of properties makes PVC a suitable outer covering for such cable types as underground feeders (Type UF), control, aerial, street lighting and cables for direct burial.

PVC is frequently used as an impervious jacket over and/or under metal armor where the installation requires PVC's protective characteristics. Flamarrest is a plenum grade, PVC-based jacketing material with low smoke and low flame spread properties. Plenum-rated cables jacketed with Flamarrest meet NFPA 262 (formerly UL Standard 910).

Fluoropolymers

Fluoropolymers, with the exception of PTFE Teflon (sometimes called TFE), are extrudable thermoplastics used in a variety of low-voltage insulating situations. Fluoropolymers contain fluorine in their molecular composition, which contributes to their excellent thermal, chemical, mechanical and electrical characteristics. The most commonly used fluoropolymers are Teflon (PTFE, FEP and PFA), Tefzel (ETFE), Halar (ECTFE) and Kynar or Solef (PVDF).

Teflon has excellent electrical properties, temperature range and chemical resistance. It is not suitable where subjected to nuclear radiation and does not have good high-voltage characteristics. FEP Teflon is extrudable in a manner similar to PVC and polyethylene. This means that long wire and cable lengths are available. PTFE Teflon is extrudable in a hydraulic ram type process. Lengths are limited due to the amount of material in the ram, thickness of the insulation and preform size. PTFE must be extruded over a silver- or nickel-coated wire. The nickel- and silver-coated designs are rated 260°C and 200°C maximum, respectively. The cost of Teflon is approximately 8 to 10 times more per pound than PVC compounds.

Teflon PTFE is the original Teflon resin invented by DuPont in 1938. It is an opaque, white material, although some forms are translucent in thin sections. It does not melt in the usual sense. To coat wire for insulating purposes, Teflon PTFE is extruded around the conductor as a paste, then sintered. Conductors can also be wrapped with tape of Teflon PTFE. Maximum continuous service temperature of Teflon PTFE is 260°C (500°F).

Specific advantages of wire insulated with Teflon PTFE include:

- Nonflammability
- Extremely high insulation resistance
- Very low dielectric constant
- Small size compared to elastomer insulated wires
- Excellent lubricity for easier installation
- Chemical inertness.

Insulation and Jacket Materials

Teflon FEP was also invented by DuPont and became commercially available in 1960. It has a glossy surface and is transparent in thin sections. Teflon FEP is a true thermoplastic. Wire insulated with Teflon FEP can be melt extruded by conventional methods. Maximum continuous service temperature is 400°F (205°C). Teflon FEP is an excellent nonflammable jacketing material for multiconductor cables.

Specific advantages of wire insulated with Teflon FEP include:

- High current carrying ability (ampacity)
- Easy color coding
- Smallest diameter of any high-temperature wire
- Nonflammability
- Very low moisture absorption.

Teflon PFA is a perfluoroalkoxy copolymer resin supplied by DuPont. Wire insulated with PFA is rated up to 250°C (482°F) and has excellent high-temperature creep resistance, low-temperature toughness and flame resistance.

Tefzel (ETFE) is commonly used in computer backplane wiring and has the highest abrasion and cut-through resistance of any fluoropolymer. Tefzel is a thermoplastic material having excellent electrical properties, heat resistance, chemical resistance, toughness, radiation resistance and flame resistance. Tefzel's temperature rating is -65°C to 150°C.

Halar (ECTFE) is similar to Tefzel and is also used in wirewrap applications, but because it is less expensive than Tefzel, it is often used as insulation on multipair plenum telephone cables. It has a maximum operating temperature of 125°C (UL). Halar has excellent chemical resistance, electrical properties, thermal characteristics and impact resistance. Halar's temperature rating is -70°C to 150°C.

Kynar (PVDF) is one of the least expensive fluoropolymers and is frequently used as a jacketing material on plenum cables. Because of its high dielectric constant, however, it tends to be a poor insulator. PVDF has a temperature maximum of 135°C (UL).

Polyolefins (PO)

Polyolefin is the name given to a family of polymers. The most common polyolefins used in wire and cable include polyethylene (PE), polypropylene (PP) and ethylene vinyl acetate (EVA).

Polyethylene (PE)

Polyethylene has excellent electrical properties. It has a low dielectric constant, a stable dielectric constant over a wide frequency range, and very high insulation resistance. However, polyethylene is stiff and very hard, depending on molecular weight and density. Low density PE (LDPE) is the most flexible, with high-density, high-molecular weight formulations being least flexible. Moisture resistance is excellent. Properly formulated PE has excellent weather resistance. The dielectric constant is 2.3 for solid and 1.6 for cellular (foamed) insulation. Flame retardant formulations are available, but they tend to have poorer electrical properties.

Polypropylene (PP)

Similar in electrical properties to polyethylene, this material is primarily used as an insulation material. Typically, it is harder than polyethylene. This makes it suitable for thin wall insulations. The UL maximum temperature rating may be 60°C or 80°C, but most UL styles call for 60° C maximum. The dielectric constant is typically 2.25 for solid and 1.55 for cellular designs.

Thermoplastic Elastomer (TPE)

TPE, sometimes called TPR (thermoplastic rubber), has excellent cold temperature characteristics, making it an excellent insulating and jacketing compound in cold climates. It is resistant to aging from sunlight, oxidation and atmospheric ozone. It retains most of its physical and electrical properties in the face of many severe environmental conditions such as a salt water environment. TPE compounds can be rated as high as 125°C (257°F).

TPE has good chemical resistance to all substances except hydrocarbons. It has a tendency to swell in a hydrocarbon environment, causing the material to degrade. It has good abrasion resistance. It will resist wear, cutting and impact. These properties make TPE jackets an excellent choice for use in control cables that are dragged around or frequently moved.

TPE compounds are used as insulating materials up to a 600-volt rating. The most common cables using TPE insulation are portable control cables such as SEO and SJE0.

Polyurethane (PUR)

Polyurethane is used primarily as a cable jacket material. It has excellent oxidation, oil and ozone resistance. Some formulations also have good flame resistance. It has excellent abrasion resistance. It has outstanding "memory" properties, making it an ideal jacket material for retractile cords.

Technical Information

Insulation and Jacket Materials

Thermosets

Chlorinated Polyethylene (CPE)

Cross-linked chlorinated polyethylene is a material with outstanding physical and electrical properties for many cable jacket applications. It is highly resistant to cold flow (compression set) and other forms of external loading as well as heat, light and chemical attack. CPE is also often supplied in a thermoplastic (non-cross-linked) version.

CPE compares favorably with most other synthetic elastomers currently used for cable jacketing. It is resistant to ozone and ultraviolet (sunlight) degradation. Properly compounded, CPE will withstand prolonged immersion in water. It will not support combustion, but under the right conditions of excessive heat, oxygen supply and flame source, it will burn slowly. Removal of the ignition source, will extinguish the flame. CPE jacketed cables pass the IEEE 383, UL, CSA and ICEA flame tests.

CPE maintains its flexibility at -18°C (0°F) and does not become brittle unless temperatures are below -40°C (-40°F). Its low temperature impact resistance is excellent. CPE jackets are suited to 105°C (221°F) and intermittently to higher temperatures. They will maintain adequate flexibility after repeated aging at elevated temperatures. They are known for abrasion resistance and long life in mining cable applications. CPE does not support the growth of mold, mildew or fungus.

CPE is resistant to most strong acids and bases and many solvents except for chlorinated organics. It is particularly well-suited to chemical plant use where both above ground (ultraviolet and flame retardancy) and below ground (water and chemical resistance) properties are desired. CPE's resistance to oils and fuels is good. CPE can be conveniently colored over a wide range and will maintain color upon aging.

Neoprene (CP)

Neoprene is a vulcanized synthetic rubber also referred to as chloroprene. It provides a resilient jacket that resists permanent deformation under heat and load, and does not embrittle at low temperatures. It is highly resistant to aging from sunlight and oxidation, and is virtually immune to atmospheric ozone.

Samples of neoprene-jacketed cable, tested outdoors under constant exposure for 40 years, have remained tough, resilient, uncracked and completely serviceable. Neoprene jackets are "flame resistant," i.e., not combustible without directly applied heat and flame. Neoprene will burn slowly as long as an outside source of flame is applied, but is self-extinguishing as soon as the flame is removed. Neoprene-jacketed power cable can be flexed without damage to the jacket at -40°C (-40°F) and will pass a mandrel wrap test down to about -45°C (-49°F). Neoprene jackets resist degradation for prolonged periods at temperatures up to 121°C (250°F). Satisfactory performance at even higher temperatures is possible if the exposures are brief or intermittent.

Neoprene jackets have excellent resistance to soil acids and alkalis. Mildew, fungus and other biological agents do not deteriorate properly compounded neoprene. These jackets perform well in many chemical plants. They are tough, strong, resilient and have excellent resistance to abrasive wear, impact, crushing and chipping. Because of these properties, neoprene is the jacketing material frequently used for mine trailing cables and dredge cables.

Cross-linked Polyethylene (XLP or XLPE)

Cross-linked polyethylene is a frequently used polymer in wire and cable. It is most often used as the insulation of 600 volt building wire (e.g., Type XHHW), as the insulation in 5 to 69 kV and higher rated power cables and as the insulation in many control cables.

XLP has very high insulation resistance (IR), high dielectric strength and low dielectric constant (2.3). It also is a very tough material at temperatures below 100°C , so it is resistant to cutting, impact and other mechanical forces. Its low-temperature performance is also very good: down to -40°C and below. XLP's fire resistance, however, is poor unless flame retardants are added. XLP is lower in cost than EPR.

Ethylene Propylene Rubber (EP, EPR or EPDM)

Ethylene propylene rubber is a common synthetic rubber polymer used as an insulation in electrical wire and cable. EPR is used as the insulation in 600 volt through 69 kV power cables, as an integral insulation/jacket on welding cables and as an insulation in many cords, portable mining cables and control/instrumentation cables.

Because of its rubber-like characteristics, EPR is used in many highly flexible cables. Its dielectric strength is good but not as high as that of PE or XLP. Dielectric constant ranges from 2.8 to 3.2 depending on the specific EPR formulation. EPR is abrasion resistant and is suitable for use at temperatures down to -60°C . It is fairly flame retardant and can be made even more flame retardant by careful formulation. Flame retardant versions are often referred to as "FREPR" or "flame retardant EP." EPR's high-temperature characteristics are very good. Some formulations can withstand continuous temperatures as high as 150°C .

Hypalon* (CSPE)

Hypalon is a thermosetting, cross-linked, chlorosulfonated polyethylene made by DuPont with many excellent physical and electrical properties. It is inherently resistant to cold flow (compression set) resulting from clamping pressures and other forms of external loading; it is immune to attack by ozone; and it is highly resistant to aging from sunlight and oxidation. Water absorption of properly compounded Hypalon cable sheathing is extremely low.

Hypalon sheathing will not support combustion. It will burn slowly as long as an outside source of flame is applied but is self-extinguishing as soon as the flame is removed. It remains flexible at -18°C (0°F) and will not become brittle at -40°C (-40°F). Hypalon jacketed constructions pass both the Underwriters Laboratories' vertical flame test and the U.S. Bureau of Mines' flame test for mining cable.

*DuPont discontinued the production of Hypalon in 2009. However, CSPE is still available from other sources.

Insulation and Jacket Materials

At high temperatures, Hypalon will perform satisfactorily after short-term exposure at up to 148°C (300°F) — even higher if compounded for maximum heat resistance. It is well-known for its resistance to chemicals, oils, greases and fuels. It is particularly useful as a cable sheathing in plant processing areas, where airborne chemicals attack ordinary jacketing materials and metal conduit.

Hypalon surpasses most elastomers in resistance to abrasion. It is highly resistant to attack by hydrocarbon oils and fuels. It is especially useful in contact with oils at elevated temperatures. Sheathing of Hypalon provides high resistance to impact, crushing and chipping. Hypalon's electrical properties make it appropriate as insulation for low-voltage applications (up to 600 volts) and as jacketing for any type of wire and cable.

Silicone

Silicone is a soft, rubbery insulation that has a temperature range from -80°C to 200°C. It has excellent electrical properties plus ozone resistance, low moisture absorption, weather resistance, and radiation resistance. It typically has low mechanical strength and poor scuff resistance.

Fibrous Coverings

Fibrous coverings are commonly used on high-temperature cables due to their excellent heat resistance. They are normally constructed of a textile braid (e.g., fiberglass or K-fiber) impregnated with a flame and heat-resistant finish.

K-fiber insulating materials are a blend of polyaramid, polyamid, phenolic-based and fiberglass fibers. They are available as roving and yarn for insulating applications and as rope for use as fillers. They provide a non-asbestos, abrasion-, moisture-, flame- and temperature-resistant, non-melting insulating material for all applications requiring a 250°C (482°F) temperature rating, which would have previously utilized asbestos.

Additional Information

Additional information on the selection of cable jackets is available in IEEE 535 "Guide for Selecting and Testing Jackets for Power, Instrumentation and Control Cables."

COLOR CODING

Power, Control, Instrumentation and Thermocouple

ICEA standard S-73-532 (NEMA WC57) contains several methods for providing color coding in multiconductor power and control cables. Methods 1, 3 and 4 are the most widely used.

- Method 1 — Colored compounds with tracers
- Method 2 — Neutral colored compounds with tracers
- Method 3 — Neutral or single-color compounds with surface printing of numbers and color designations
- Method 4 — Neutral or single-color compounds with surface printing of numbers
- Method 5 — Individual color coding with braids
- Method 6 — Layer identification
- Method 7 — Paired conductors

Historically, ICEA has established the sequence of colors used for Method 1 color coding, which consists of six basic colors, then a repeat of the colors with a colored band or tracer. This sequence of colors is referred to as K-1 color coding because it was formerly found in Table K-1 of many ICEA standards. (See Tables 5 through 9.) The latest ICEA standard lists the color sequences in Tables E-1 through E-7.

The National Electrical Code (NEC) specifies that a conductor colored white can only be used as a grounded (neutral) conductor and that a conductor colored green can only be used as an equipment grounding conductor. The use of Table E-1 (formerly K-1) color coding would therefore be in violation of the Code in a cable having more than six conductors if conductors #7 (white/black), #9 (green/black), #14 (green/white), etc. are energized.

To address this issue, a different color coding sequence was developed by ICEA for cables that are used in accordance with the NEC. Table E-2 (formerly K-2) of the ICEA standard provides this color sequence. The ICEA standard provides further guidance stating that if a white conductor is required, this color may be introduced into Table E-2 as the second conductor in the sequence. If a green insulated conductor is required, it likewise can be introduced into the table. However, the white and green colors may only appear once.

The most popular multiconductor control cables in sizes 14 AWG–10 AWG have Method 1, Table E-2 color coding. The cables do not contain a white or green conductor. The most popular control cables used in sizes 8 AWG and larger are three conductor cables having black insulation surface ink printed with the numbers 1, 2 and 3. This is Method 4 color coding in the ICEA standards.

The electric utility industry often specifies control cables with the E-1 color coding sequence.

For applications where the NEC is applicable, such as in industrial and commercial applications, the E-2 color sequence is normally used.

ICEA standard S-82-552 (NEMA WC 55) contains methods and color sequence tables for instrumentation and thermocouple cables.

Insulation and Jacket Materials

Table 5–E-1 (Formerly K-1) color sequence for control cables

Conductor Number	Background or Base Color	First Tracer Color	Second Tracer Color	Conductor Number	Background or Base Color	First Tracer Color	Second Tracer Color
1	Black	—	—	31	Green	Black	Orange
2	White	—	—	32	Orange	Black	Green
3	Red	—	—	33	Blue	White	Orange
4	Green	—	—	34	Black	White	Orange
5	Orange	—	—	35	White	Red	Orange
6	Blue	—	—	36	Orange	White	Blue
7	White	Black	—	37	White	Red	Blue
8	Red	Black	—	38	Black	White	Green
9	Green	Black	—	39	White	Black	Green
10	Orange	Black	—	40	Red	White	Green
11	Blue	Black	—	41	Green	White	Blue
12	Black	White	—	42	Orange	Red	Green
13	Red	White	—	43	Blue	Red	Green
14	Green	White	—	44	Black	White	Blue
15	Blue	White	—	45	White	Black	Blue
16	Black	Red	—	46	Red	White	Blue
17	White	Red	—	47	Green	Orange	Red
18	Orange	Red	—	48	Orange	Red	Blue
19	Blue	Red	—	49	Blue	Red	Orange
20	Red	Green	—	50	Black	Orange	Red
21	Orange	Green	—	51	White	Black	Orange
22	Black	White	Red	52	Red	Orange	Black
23	White	Black	Red	53	Green	Red	Blue
24	Red	Black	White	54	Orange	Black	Blue
25	Green	Black	White	55	Blue	Black	Orange
26	Orange	Black	White	56	Black	Orange	Green
27	Blue	Black	White	57	White	Orange	Green
28	Black	Red	Green	58	Red	Orange	Green
29	White	Red	Green	59	Green	Black	Blue
30	Red	Black	Green	60	Orange	Green	Blue

Note: The former K-1 color sequence was the same as E-1 through conductor number 21. K-1 then repeated. The above table is only applicable to control cables. The color sequence for instrumentation cables can be found in ICEA S-82-552 (NEMA WC 55).

Insulation and Jacket Materials

Table 6—E-2 (Formerly K-2) color sequence for control cables

Conductor Number	Background or Base Color	Tracer Color
1	Black	—
2	Red	—
3	Blue	—
4	Orange	—
5	Yellow	—
6	Brown	—
7	Red	Black
8	Blue	Black
9	Orange	Black
10	Yellow	Black
11	Brown	Black
12	Black	Red
13	Blue	Red
14	Orange	Red
15	Yellow	Red
16	Brown	Red
17	Black	Blue
18	Red	Blue
19	Orange	Blue
20	Yellow	Blue
21	Brown	Blue
22	Black	Orange
23	Red	Orange
24	Blue	Orange
25	Yellow	Orange
26	Brown	Orange
27	Black	Yellow
28	Red	Yellow
29	Blue	Yellow
30	Orange	Yellow
31	Brown	Yellow
32	Black	Brown
33	Red	Brown
34	Blue	Brown
35	Orange	Brown
36	Yellow	Brown

Note: The above table is only applicable to control cables. The color sequence for instrumentation cables can be found in ICEA S-82-552 (NEMA WC 55).

Table 7—E-3 (Formerly K-3) color sequence for control cables

Conductor Number	First Tracer Color (e.g., Wide Tracer)	Second Tracer Color (e.g., Narrow Tracer)
1	Black	—
2	White	—
3	Red	—
4	Green	—
5	Orange	—
6	Blue	—
7	White	Black
8	Red	Black
9	Green	Black
10	Orange	Black
11	Blue	Black
12	Black	White
13	Red	White
14	Green	White
15	Blue	White
16	Black	Red
17	White	Red
18	Orange	Red
19	Blue	Red
20	Red	Green
21	Orange	Green

Note: The above table is only applicable to control cables. The color sequence for instrumentation cables can be found in ICEA S-82-552 (NEMA WC 55).

Insulation and Jacket Materials

Table 8—E-4 (Formerly K-4) color sequence for control cables

Conductor Number	First Tracer Color (e.g., Wide Tracer)	Second Tracer Color (e.g., Narrow Tracer)
1	Black	—
2	Red	—
3	Blue	—
4	Orange	—
5	Yellow	—
6	Brown	—
7	Red	Black
8	Blue	Black
9	Orange	Black
10	Yellow	Black
11	Brown	Black
12	Black	Red
13	Blue	Red
14	Orange	Red
15	Yellow	Red
16	Brown	Red
17	Black	Blue
18	Red	Blue
19	Orange	Blue
20	Yellow	Blue
21	Brown	Blue
22	Black	Orange
23	Red	Orange
24	Blue	Orange
25	Yellow	Orange
26	Brown	Orange
27	Black	Yellow
28	Red	Yellow
29	Blue	Yellow
30	Orange	Yellow
31	Brown	Yellow
32	Black	Brown
33	Red	Brown
34	Blue	Brown
35	Orange	Brown
36	Yellow	Brown

Note: The above table is only applicable to control cables. The color sequence for instrumentation cables can be found in ICEA S-82-552 (NEMA WC 55).

Table 9—E-5 (Formerly K-5) color sequence for control cables

Conductor Number	Background or Base Color	First Tracer Color	Second Tracer Color
1	Black	—	—
2	White	—	—
3	Red	—	—
4	Green	—	—
5	Orange	—	—
6	Blue	—	—
7	White	Black	—
8	Red	Black	—
9	Green	Black	—
10	Orange	Black	—
11	Blue	Black	—
12	Black	White	—
13	Red	White	—
14	Green	White	—
15	Blue	White	—
16	Black	Red	—
17	White	Red	—
18	Orange	Red	—
19	Blue	Red	—
20	Red	Green	—
21	Orange	Green	—
22	Black	White	Red
23	White	Black	Red
24	Red	Black	White
25	Green	Black	White
26	Orange	Black	White
27	Blue	Black	White
28	Black	Red	Green
29	White	Red	Green
30	Red	Black	Green
31	Green	Black	Orange
32	Orange	Black	Green
33	Blue	White	Orange
34	Black	White	Orange
35	White	Red	Orange
36	Orange	White	Blue
37	White	Red	Blue

Note: The above table is only applicable to control cables. The color sequence for instrumentation cables can be found in ICEA S-82-552 (NEMA WC 55).

Insulation and Jacket Materials

Belden Electronic Color Code

Table 10—Belden color code chart No. 1

Cond. No.	Color
1	Black
2	White
3	Red
4	Green
5	Brown
6	Blue
7	Orange
8	Yellow
9	Purple
10	Gray
11	Pink
12	Tan

Table 11—Belden color code chart Nos. 2 and 2R — ICEA (Insulated Cable Engineers Association) standard*

Cond. No.	Color	Cond. No.	Color	Cond. No.	Color	Cond. No.	Color
1	Black	13	Red/White Stripe	25	Green/Black/White	37	White/Red/Blue
2	White	14	Green/White Stripe	26	Orange/Black/White	38	Black/White/Green
3	Red	15	Blue/White Stripe	27	Blue/Black/White	39	White/Black/Green
4	Green	16	Black/Red Stripe	28	Black/Red/Green	40	Red/White/Green
5	Orange	17	White/Red Stripe	29	White/Red/Green	41	Green/White/Blue
6	Blue	18	Orange/Red Stripe	30	Red/Black/Green	42	Orange/Red/Green
7	White/Black Stripe	19	Blue/Red Stripe	31	Green/Black/Orange	43	Blue/Red/Green
8	Red/Black Stripe	20	Red/Green Stripe	32	Orange/Black/Green	44	Black/White/Blue
9	Green/Black Stripe	21	Orange/Green Stripe	33	Blue/White/Orange	45	White/Black/Blue
10	Orange/Black Stripe	22	Black/White/Red	34	Black/White/Orange	46	Red/White/Blue
11	Blue/Black Stripe	23	White/Black/Red	35	White/Red/Orange	47	Green/Orange/Red
12	Black/White Stripe	24	Red/Black/White	36	Orange/White/Blue	48	Orange/Red/Blue
						49	Blue/Orange/Red
						50	Black/Orange/Red

18 Gage conductors in cables 8446 through 8449 are Black and White.

*2 = Spiral Stripe
2R = Ring Band Striping

Table 12—Belden color code chart No. 3

Pair No.	Color Combination	Pair No.	Color Combination	Pair No.	Color Combination	Pair No.	Color Combination
1	Black & Red	10	Red & Blue	19	White & Blue	28	Orange & Yellow
2	Black & White	11	Red & Yellow	20	White & Yellow	29	Purple & Orange
3	Black & Green	12	Red & Brown	21	White & Brown	30	Purple & Red
4	Black & Blue	13	Red & Orange	22	White & Orange	31	Purple & White
5	Black & Yellow	14	Green & White	23	Blue & Yellow	32	Purple & Green
6	Black & Brown	15	Green & Blue	24	Blue & Brown	33	Purple & Blue
7	Black & Orange	16	Green & Yellow	25	Blue & Orange	34	Purple & Yellow
8	Red & White	17	Green & Brown	26	Brown & Yellow	35	Purple & Brown
9	Red & Green	18	Green & Orange	27	Brown & Orange	36	Purple & Black
						37	Gray & White

Table 13—Belden color code chart No. 4

Pair No.	Color Combination	Pair No.	Color Combination	Pair No.	Color Combination	Pair No.	Color Combination
1	White & Blue	6	Red & Blue	11	Black & Blue	16	Yellow & Blue
2	White & Orange	7	Red & Orange	12	Black & Orange	17	Yellow & Orange
3	White & Green	8	Red & Green	13	Black & Green	18	Yellow & Green
4	White & Brown	9	Red & Brown	14	Black & Brown	19	Yellow & Brown
5	White & Gray	10	Red & Gray	15	Black & Gray	20	Yellow & Gray
						21	Purple & Blue
						22	Purple & Orange
						23	Purple & Green
						24	Purple & Brown
						25	Purple & Gray

Insulation and Jacket Materials

Table 14—Belden color code chart No. 5

Pair No.	Color Combination	Pair No.	Color Combination	Pair No.	Color Combination	Pair No.	Color Combination	Pair No.	Color Combination
1	White/Blue Stripe & Blue/White Stripe	6	Red/Blue Stripe & Blue/Red Stripe	11	Black/Blue Stripe & Blue/Black Stripe	16	Yellow/Blue Stripe & Blue/Yellow Stripe	21	Purple/Blue Stripe & Blue/Purple Stripe
2	White/Orange Stripe & Orange/White Stripe	7	Red/Orange Stripe & Orange/Red Stripe	12	Black/Orange Stripe & Orange/Black Stripe	17	Yellow/Orange Stripe & Orange/Yellow Stripe	22	Purple/Orange Stripe & Orange/Purple Stripe
3	White/Green Stripe & Green/White Stripe	8	Red/Green Stripe & Green/Red Stripe	13	Black/Green Stripe & Green/Black Stripe	18	Yellow/Green Stripe & Green/Yellow Stripe	23	Purple/Green Stripe & Green/Purple Stripe
4	White/Brown Stripe & Brown/White Stripe	9	Red/Brown Stripe & Brown/Red Stripe	14	Black/Brown Stripe & Brown/Black Stripe	19	Yellow/Brown Stripe & Brown/Yellow Stripe	24	Purple/Brown Stripe & Brown/Purple Stripe
5	White/Gray Stripe & Gray/White Stripe	10	Red/Gray Stripe & Gray/Red Stripe	15	Black/Gray Stripe & Gray/Black Stripe	20	Yellow/Gray Stripe & Gray/Yellow Stripe	25	Purple/Gray Stripe & Gray/Purple

Table 15—Belden color code chart No. 6

Position No.	Color	Position No.	Color
1	Brown	13	White/Orange
2	Red	14	White/Yellow
3	Orange	15	White/Green
4	Yellow	16	White/Blue
5	Green	17	White/Purple
6	Blue	18	White/Gray
7	Purple	19	White/Black/Brown
8	Gray	20	White/Black/Red
9	White	21	White/Black/Orange
10	White/Black	22	White/Black/Yellow
11	White/Brown	23	White/Brown/Green
12	White/Red	24	White/Black/Blue

Table 16—Belden color code chart No. 9: IBM RISC System/6000

Cond. No.	Color	Cond. No.	Color
1	White over Blue	1	White over Blue & Blue over White
2	White over Orange	2	White over Orange & Orange over White
3	White over Green	3	White over Green & Green over White
4	White over Brown		
5	White over Gray		
6	White over Red		
7	White over Yellow		

Table 17—Belden color code chart No. 10: fiber optics*

Fiber/Tube No.	Color
1	Blue
2	Orange
3	Green
4	Brown
5	Gray
6	White
7	Red
8	Black
9	Yellow
10	Purple
11	Rose
12	Aqua

*Per ANSI/TIA 598-A

Table 18—Belden color code chart No. 7 for snake cables

Pair No.	Color Combination	Pair No.	Color Combination	Pair No.	Color Combination	Pair No.	Color Combination
1	Brown	16	Gray/Yellow Stripe	31	Blue/Purple Stripe	46	Lime/Black Stripe
2	Red	17	Gray/Green Stripe	32	Blue/Gray Stripe	47	Lime/Tan Stripe
3	Orange	18	Gray/Blue Stripe	33	Blue/White Stripe	48	Lime/Pink Stripe
4	Yellow	19	Gray/Purple Stripe	34	Blue/Black Stripe	49	Aqua/Brown Stripe
5	Green	20	Gray/Gray Stripe	35	Blue/Tan Stripe	50	Aqua/Red Stripe
6	Blue	21	Gray/White Stripe	36	Blue/Pink Stripe	51	Aqua/Orange Stripe
7	Purple	22	Gray/Black Stripe	37	Lime/Brown Stripe	52	Aqua/Yellow Stripe
8	Gray	23	Gray/Tan Stripe	38	Lime/Red Stripe	53	Aqua/Green Stripe
9	White	24	Gray/Pink Stripe	39	Lime/Orange Stripe	54	Aqua/Blue Stripe
10	Black	25	Blue/Brown Stripe	40	Lime/Yellow Stripe	55	Aqua/Purple Stripe
11	Tan	26	Blue/Red Stripe	41	Lime/Green Stripe	56	Aqua/Gray Stripe
12	Pink	27	Blue/Orange Stripe	42	Lime/Blue Stripe	57	Aqua/White Stripe
13	Gray/Brown Stripe	28	Blue/Yellow Stripe	43	Lime/Purple Stripe	58	Aqua/Black Stripe
14	Gray/Red Stripe	29	Blue/Green Stripe	44	Lime/Gray Stripe	59	Aqua/Tan Stripe
15	Gray/Orange Stripe	30	Blue/Blue Stripe	45	Lime/White Stripe	60	Aqua/Pink Stripe

Insulation and Jacket Materials

Table 19—Belden color code chart No. 8 for DataTwist cables

Pair No.	Color Combination	Pair No.	Color Combination	Pair No.	Color Combination	Pair No.	Color Combination	Pair No.	Color Combination
1	White/Blue Stripe & Blue	6	Red/Blue Stripe & Blue/Red Stripe	11	Black/Blue Stripe & Blue/Black Stripe	16	Yellow/Blue Stripe & Blue/Yellow Stripe	21	Purple/Blue Stripe & Blue/Purple Stripe
2	White/Orange Stripe & Orange	7	Red/Orange Stripe & Orange/Red Stripe	12	Black/Orange Stripe & Orange/Black Stripe	17	Yellow/Orange Stripe & Orange/Yellow Stripe	22	Purple/Orange Stripe & Orange/Purple Stripe
3	White/Green Stripe & Green	8	Red/Green Stripe & Green/Red Stripe	13	Black/Green Stripe & Green/Black Stripe	18	Yellow/Green Stripe & Green/Yellow Stripe	23	Purple/Green Stripe & Green/Purple Stripe
4	White/Brown Stripe & Brown	9	Red/Brown Stripe & Brown/Red Stripe	14	Black/Brown Stripe & Brown/Black Stripe	19	Yellow/Brown Stripe & Brown/Yellow Stripe	24	Purple/Brown Stripe & Brown/Purple Stripe
5	White/Gray Stripe & Gray/White Stripe	10	Red/Gray Stripe & Gray/Red Stripe	15	Black/Gray Stripe & Gray/Black Stripe	20	Yellow/Gray Stripe & Gray/Yellow Stripe	25	Purple/Gray Stripe & Gray/Purple

Table 20—Stripe ICEA table E1*

Cond. No.	Base Color	Tracer	Tracer	Cond. No.	Base Color	Tracer	Tracer
1	Black	—	—	26	Orange	Black	White
2	White	—	—	27	Blue	Black	White
3	Red	—	—	28	Black	Red	Green
4	Green	—	—	29	White	Red	Green
5	Orange	—	—	30	Red	Black	Green
6	Blue	—	—	31	Green	Black	Orange
7	White	Black	—	32	Orange	Black	Green
8	Red	Black	—	33	Blue	White	Orange
9	Green	Black	—	34	Black	White	Orange
10	Orange	Black	—	35	White	Red	Orange
11	Blue	Black	—	36	Orange	White	Blue
12	Black	White	—	37	White	Red	Blue
13	Red	White	—	38	Black	White	Green
14	Green	White	—	39	White	Black	Green
15	Blue	White	—	40	Red	White	Green
16	Black	Red	—	41	Green	White	Blue
17	White	Red	—	42	Orange	Red	Green
18	Orange	Red	—	43	Blue	Red	Green
19	Blue	Red	—	44	Black	White	Blue
20	Red	Green	—	45	White	Black	Blue
21	Orange	Green	—	46	Red	White	Blue
22	Black	White	Red	47	Green	Orange	Red
23	White	Black	Red	48	Orange	Red	Blue
24	Red	Black	White	49	Blue	Red	Orange
25	Green	Black	White	50	Black	Orange	Red

Pair cables are Black, White and numbered. Triad cables are Black, White, Red and numbered.

* Reference ICEA S-73-532

Table 21—ICEA Method 4: All conductors black*

Cond.	Conductor Printing	Cond.	Conductor Printing
1st	"1-ONE-1"	26th	"26-TWENTY-SIX-26"
2nd	"2-TWO-2"	27th	"27-TWENTY-SEVEN-27"
3rd	"3-THREE-3"	28th	"28-TWENTY-EIGHT-28"
4th	"4-FOUR-4"	29th	"29-TWENTY-NINE-29"
5th	"5-FIVE-5"	30th	"30-THIRTY-30"
6th	"6-SIX-6"	31st	"31-THIRTY-ONE-31"
7th	"7-SEVEN-7"	32nd	"32-THIRTY-TWO-32"
8th	"8-EIGHT-8"	33rd	"33-THIRTY-THREE-33"
9th	"9-NINE-9"	34th	"34-THIRTY-FOUR-34"
10th	"10-TEN-10"	35th	"35-THIRTY-FIVE-35"
11th	"11-ELEVEN-11"	36th	"36-THIRTY-SIX-36"
12th	"12-TWELVE-12"	37th	"37-THIRTY-SEVEN-37"
13th	"13-THIRTEEN-13"	38th	"38-THIRTY-EIGHT-38"
14th	"14-FOURTEEN-14"	39th	"39-THIRTY-NINE-39"
15th	"15-FIFTEEN-15"	40th	"40-FORTY-40"
16th	"16-SIXTEEN-16"	41st	"41-FORTY-ONE-41"
17th	"17-SEVENTEEN-17"	42nd	"42-FORTY-TWO-42"
18th	"18-EIGHTEEN-18"	43rd	"43-FORTY-THREE-43"
19th	"19-NINETEEN-19"	44th	"44-FORTY-FOUR-44"
20th	"20-TWENTY-20"	45th	"45-FORTY-FIVE-45"
21st	"21-TWENTY-ONE-21"	46th	"46-FORTY-SIX-46"
22nd	"22-TWENTY-TWO-22"	47th	"47-FORTY-SEVEN-47"
23rd	"23-TWENTY-THREE-23"	48th	"48-FORTY-EIGHT-48"
24th	"24-TWENTY-FOUR-24"	49th	"49-FORTY-NINE-49"
25th	"25-TWENTY-FIVE-25"	50th	"50-FIFTY-50"

* Reference ICEA S-73-532

Insulation and Jacket Materials

Table 22—ICEA table E2*

Cond. No.	Base Color	Tracer	Cond. No.	Base Color	Tracer
1	Black	—	19	Orange	Blue
2	Red	—	20	Yellow	Blue
3	Blue	—	21	Brown	Blue
4	Orange	—	22	Black	Orange
5	Yellow	—	23	Red	Orange
6	Brown	—	24	Blue	Orange
7	Red	Black	25	Yellow	Orange
8	Blue	Black	26	Brown	Orange
9	Orange	Black	27	Black	Yellow
10	Yellow	Black	28	Red	Yellow
11	Brown	Black	29	Blue	Yellow
12	Black	Red	30	Orange	Yellow
13	Blue	Red	31	Brown	Yellow
14	Orange	Red	32	Black	Brown
15	Yellow	Red	33	Red	Brown
16	Brown	Red	34	Blue	Brown
17	Black	Blue	35	Orange	Brown
18	Red	Blue	36	Yellow	Brown

Pair cables are Black, Red and numbered. Triad cables are Black, Red, Blue and numbered. Colors repeat after 36 conductors. There are no Green or White conductors or stripes.

*Reference ICEA S-73-532

Table 23—Anixter high-temperature building wire color code

Cond. No.	Color	Cond. No.	Color
00	Chrome	60	Green/Yellow
01	White	61	Green/White
02	Black	62	Green/Black
03	Red	63	Pink/Black
04	Green	64	Gray/Black
05	Yellow	65	Red/Green
06	Blue	66	Red/Yellow
07	Brown	69	Blue/White
08	Orange	71	Brown/Black
09	Gray (Slate)	73	Brown/Red
10	Purple (Violet)	74	Brown/Green
11	Tan	75	Brown/Yellow
12	Pink	76	Blue/Yellow
13	Clear	77	Blue/Orange
14	Gold	81	Purple/White
15	Natural	82	Purple/Black
16	Maroon	85	Purple/Yellow
17	Dark Blue	87	Tan/White
18	Pink/Violet	88	Tan/Black
19	Pink/Orange	89	Tan/Red
20	White/Tan	93	Green/Red
21	White/Black	94	Green/Orange
22	White/Red	95	Red/Pink
23	White/Pink	97	Gray/White
24	White/Yellow	98	Gray/Red
25	White/Blue	100	Black/Green
27	White/Orange	101	Black/Gray
28	White/Gray	104	Blue/Pink
29	White/Violet	107	Gray/Yellow
30	Black/Pink	108	Gray/Orange
31	Black/White	109	Gray/Brown
32	Black/Red	110	Orange/White
33	Black/Blue	112	Brown/Blue
34	Black/Yellow	119	Orange/Blue
35	Black/Orange	120	Orange/Brown
36	Red/White	121	Pink/White
37	Red/Black	127	Pink/Red
38	Red/Blue	129	Pink/Gray
39	Yellow/Black	131	Red/Orange
40	Yellow/White	134	Yellow/Orange
41	Blue/Black	147	Ivory
42	Blue/Red	160	Pink/Black/Black
43	Blue/Green	165	Orange/Violet
44	Blue/Brown	170	Tan/Black/Black
45	Orange/Black	172	Violet/White
46	Yellow/Green	173	Violet/Red
47	Green/Tan	184	Gray/Silver
48	Light Green	189	Light Blue/White
49	Yellow/Red	194	Dark Green
50	Brown/White	47A	Yellow/Blue
56	White/Black/Gray	48A	Orange/Red
59	White/Black/Red		

Insulation and Jacket Materials

PROPERTIES

Thermoplastic

Table 24—Properties of thermoplastic insulation and jacket materials

	PVC	Low-Density Polyethylene	Cellular Polyethylene	High-Density Polyethylene	Polypropylene
Oxidation resistance	E	E	E	E	E
Heat resistance	G-E	G	G	E	E
Oil resistance	F	G-E	G	G-E	F
Low-temperature flexibility	P-G	E	E	E	P
Weather, sun resistance	G-E	E	E	E	E
Ozone resistance	E	E	E	E	E
Abrasion resistance	F-G	G	F	E	F-G
Electrical properties	F-G	E	E	E	E
Flame resistance	E	P	P	P	P
Nuclear radiation resistance	F	G-E	G	G-E	F
Water resistance	F-G	E	E	E	E
Acid resistance	G-E	G-E	G-E	E	E
Alkali resistance	G-E	G-E	G-E	E	E
Gasoline, kerosene, etc. (aliphatic hydrocarbons) resistance	P	G-E	G	G-E	P-F
Benzol, toluol, etc. (aromatic hydrocarbons) resistance	P-F	P	P	P	P-F
Degreaser solvents (halogenated hydrocarbons) resistance	P-F	G	G	G	P
Alcohol resistance	G-E	E	E	E	E
Underground burial	P-G	G	F	E	E

P = Poor, F = Fair, G = Good, E = Excellent, O = Outstanding

These ratings are based on average performance of general purpose compounds. Any given property can usually be improved by the use of selective compounding.

Source: Belden

Continued on next page >>

Insulation and Jacket Materials

Table 24—Properties of thermoplastic insulation and jacket materials (continued)

	Cellular Polypropylene	Polyurethane	Nylon	CPE	Plenum PVC
Oxidation resistance	E	E	E	E	E
Heat resistance	E	G	E	E	G-E
Oil resistance	F	E	E	E	F
Low-temperature flexibility	P	G	G	E	P-G
Weather, sun resistance	E	G	E	E	G
Ozone resistance	E	E	E	E	E
Abrasion resistance	F-G	O	E	E-O	F-G
Electrical properties	E	P	P	E	G
Flame resistance	P	P	P	E	E
Nuclear radiation resistance	F	G	F-G	O	F
Water resistance	E	P-G	P-F	O	F
Acid resistance	E	F	P-E	E	G
Alkali resistance	E	F	E	E	G
Gasoline, kerosene, etc. (aliphatic hydrocarbons) resistance	P	P-G	G	E	P
Benzol, toluol, etc. (aromatic hydrocarbons) resistance	P	P-G	G	G-E	P-F
Degreaser solvents (halogenated hydrocarbons) resistance	P	P-G	G	E	P-F
Alcohol resistance	E	P-G	P	E	G
Underground burial	F	G	P	E-O	P

P = Poor, F = Fair, G = Good, E = Excellent, O = Outstanding
 These ratings are based on average performance of general purpose compounds. Any given property can usually be improved by the use of selective compounding.
 Source: Belden

Continued on next page >>

Insulation and Jacket Materials

Table 24—Properties of thermoplastic insulation and jacket materials (continued)

	FEP Teflon	Tefzel (ETFE)	PTFE (TFE) Teflon	Solef/Kynar (PVDF)/PVF	Halar (ECTFE)
Oxidation resistance	O	E	O	O	O
Heat resistance	O	E	O	O	O
Oil resistance	O	E	E-O	E	O
Low-temperature flexibility	O	E	O	O	O
Weather, sun resistance	O	E	O	E-O	O
Ozone resistance	E	E	O	E	E
Abrasion resistance	E	E	O	E	E
Electrical properties	E	E	E	G-E	E
Flame resistance	O	G	E	E	E-O
Nuclear radiation resistance	P-G	E	P	E	E
Water resistance	E	E	E	E	E
Acid resistance	E	E	E	G-E	E
Alkali resistance	E	E	E	E	E
Gasoline, kerosene, etc. (aliphatic hydrocarbons) resistance	E	E	E	E	E
Benzol, toluol, etc. (aromatic hydrocarbons) resistance	E	E	E	G-E	E
Degreaser solvents (halogenated hydrocarbons) resistance	E	E	E	G	E
Alcohol resistance	E	E	E	E	E
Underground burial	E	E	E	E	E

P = Poor, F = Fair, G = Good, E = Excellent, O = Outstanding

These ratings are based on average performance of general purpose compounds. Any given property can usually be improved by the use of selective compounding.

Source: Belden

Insulation and Jacket Materials

THERMOSET

Table 25—Properties of thermoset insulation and jacket materials

	Neoprene	CSPE (Chlorosulfonated Polyethylene)	EPR (Ethylene Propylene Rubber)	XLPE	CPE	Silicone Rubber
Oxidation resistance	G	E	E	E	E	E
Heat resistance	G	E	E	G	E	O
Oil resistance	G	G	P	G	G-E	F-G
Low-temperature flexibility	F-G	F	G-E	O	F	O
Weather, sun resistance	G	E	E	G	E	O
Ozone resistance	G	E	E	G	G-E	O
Abrasion resistance	G-E	G	G	F-G	G-E	P
Electrical properties	P	G	E	E	F-G	G
Flame resistance	G	G	P	P	G	F-G
Nuclear radiation resistance	F-G	E	G	E	G	E
Water resistance	E	E	G-E	G-E	G-E	G-E
Acid resistance	G	E	G-E	G-E	E	F-G
Alkali resistance	G	E	G-E	G-E	E	F-G
Gasoline, kerosene, etc. (aliphatic hydrocarbons) resistance	G	F	P	F	F	P-F
Benzol, toluol, etc. (aromatic hydrocarbons) resistance	P-F	F	F	F	F	P
Degreaser solvents (halogenated hydrocarbons) resistance	P	P-F	P	F	P	P-G
Alcohol resistance	F	G	P	E	G-E	G
Underground burial	G-E	E	E	E	E	G

P = Poor, F = Fair, G = Good, E = Excellent, O = Outstanding

These ratings are based on average performance of general purpose compounds. Any given property can usually be improved by the use of selective compounding.

Source: Belden

Insulation and Jacket Materials

EPR Versus XLPE

Table 26—Properties of EPR compared with those of XLPE

Cross-linked Polyethylene (XLPE)	Ethylene Propylene Rubber (EPR)
Less deformation below 100°C	Less deformation above 100°C
Lower in cost	More heat resistance
Lower dissipation factor	Less shrinkback
Lower dielectric constant	Less thermal expansion
Higher dielectric strength	More corona resistant
Physically tougher	More flexible
More resistant to chemicals	More tree retardant
More oil resistant	More sunlight resistant

Thermal Characteristics

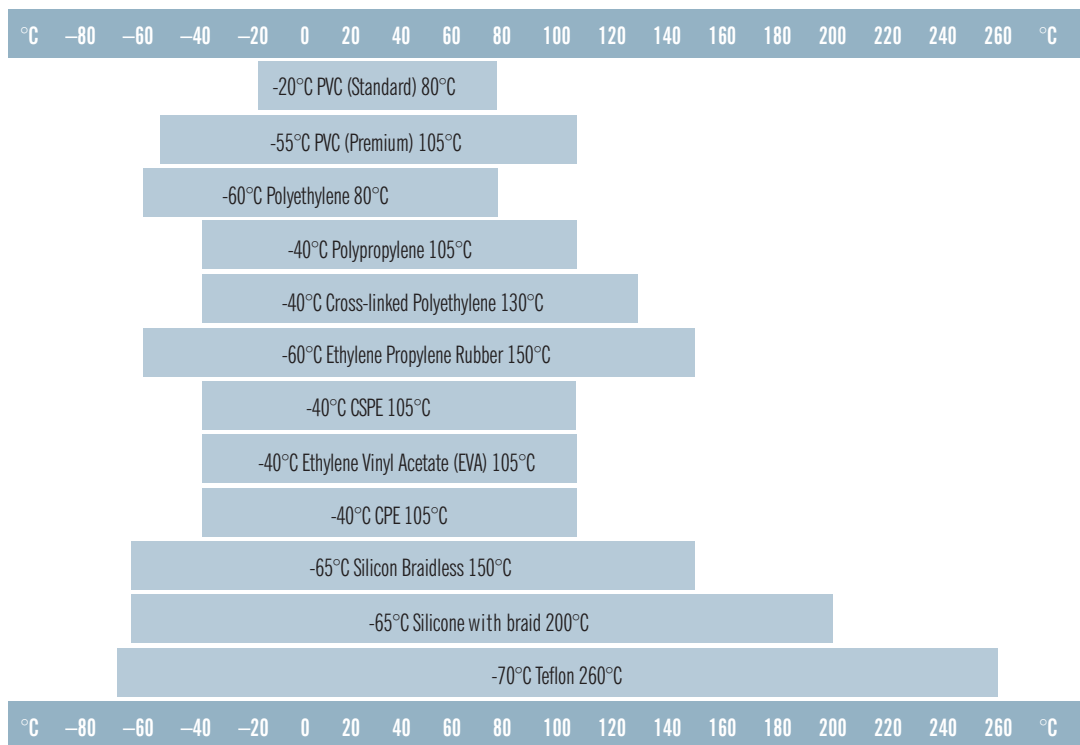


Figure 9—Nominal temperature range of cable polymers

Insulation and Jacket Materials

Halogen Content

Table 27—Halogen content in typical insulation and jacket materials

Material	Typical Halogen Content Percent by Weight
PE insulation or jacket	<0.02
XLP insulation 600 V (6 AWG and larger)	<0.02
XLP insulation 5–35 kV	<0.02
EPR insulation 5–35 kV	<0.02
Polyurethane jacket	<0.02
EVA jacket	<0.02
XLP insulation 600 V (14–8 AWG)	7–13
FR-EPR insulation	9–14
CSPE (insulation grade)	13–16
FR-XLP insulation	11–17
CSPE jacket (heavy duty)	16–26
Neoprene jacket	16–18
CPE jacket	14–28
CSPE jacket (extra heavy duty)	18–33
PVC jacket	22–29

NOTE: Halogen content can vary from manufacturer to manufacturer. The above values should be used for general comparisons only.

Limiting Oxygen Index (LOI)

LOI values are used to determine the relative flammability of polymers. Tests are usually conducted in accordance with ASTM D2863, which finds the percent oxygen required to sustain combustion. Typical values are shown below. The oxygen content of air is 20.9 percent.

Table 28—LOI of common wire and cable materials

Material	Percent Oxygen	Material	Percent Oxygen
Teflon	93	Neoprene	32
PVDF (Kynar)	43–85	Tefzel	30–32
Halar	55	PVC	28–32
Plenum grade PVC	38–42	Kevlar	29
FR-EP	30–40	NBR PVC	28
FR-XLP	30–40	XLP (Unfilled)	20–23
CPE	28–36	PE (Unfilled)	20–23
Ethylene Vinyl Acetate (EVA)	32–35		
CSPE	34		

Insulation and Jacket Materials

Dielectric Constant

Table 29—Dielectric constant of common wire and cable materials

Material	Dielectric Constant	Material	Dielectric Constant
Teflon (FEP, PFA or TFE)	2.1	Polyester (Mylar)	3.3–3.8
Polypropylene	2.2–2.3	Silicone	3–4
Cross-linked Polyethylene	2.3	Nylon	3.2–5
Polyethylene	2.3	Mica	6.9
TPE	2.3–2.5	PVC	3.5–8
Halar (ECTFE)	2.6	CSPE	8–10
Tefzel (ETFE)	2.6	Neoprene	9–10
EPR	2.8–3.5	Kynar (PVDF)	6–12
Ethylene Vinyl Acetate (EVA)	3.8		

Shields

A shield is a metallic covering enclosing an insulated conductor or group of conductors. Though sometimes similar in appearance, shields for electronic and power cables perform very different functions. Electronic cable shields serve to both minimize the effect of external electromagnetic signals on the conductors in the cable and to reduce the radiated signal from the cable to an acceptable level. Power cable shields, on the other hand, help protect the user from shock hazards and increase cable reliability by preventing partial discharges (corona) in cables rated above 2,400 volts.

POWER CABLE

The use of shields in power cables rated above 2,400 volts reduces electrical shock hazard to people and provides uniform distribution of electrical stresses throughout the insulation. A uniform distribution of electrical stress extends the life of the cable by eliminating partial discharges. The various components of a power cable shield are discussed below.

Conductor Shield (Strand Shield)

The nonround geometry of stranded conductors permits air gaps between the outer surface of the conductor and the inner surface of the insulation. Without a stress control layer, high electric fields cause partial discharges within these gaps, which can harm the insulation. Energetic ions bombard the insulation, break molecular bonds and degrade the insulation. Microscopic channels called “trees” may form and ultimately cause premature failure of the insulation. Thus, the primary purpose of the conductor shield is to provide a smooth, continuous and void-free interface between the conductor and insulation.

There are two basic types of conductor shields — “conductive” and “emission” shields. An emission shield uses a material with a high dielectric constant to do its job. The most popular type, however, is the conductive shield. It is a material (either an extruded carbon black loaded polymer or carbon black impregnated fabric tape) with electrical conductivity midway between that of a metallic conductor such as copper and that of an insulation such as XLP. Such a material is commonly referred to as a “semiconductive” shield (not to be confused with semiconductors, i.e., transistors, used in the electronics industry). AIEC document CS8 and ICEA publication T-25-425 contain detailed specifications on the electrical and physical performance of the conductor shield.

Semiconductive shields must be as smooth, cylindrical and clean as possible to avoid electrical stress concentrations that can lead to insulation damage.

Outer Shield (Insulation Shield)

The insulation shield plays much the same role as the conductor shield in protecting the insulation from the damaging effects of corona, but at the outside of the cable's insulation. It too must remain in intimate contact with the insulation and be free of voids and defects. The insulation shield material is either electrically conductive or made of a high dielectric constant material and provides a uniform electrical field within the insulation. The insulation shield also provides an important safety function at terminations and splices where the metallic part of the shield may not completely cover the cable insulation surface. Volume resistivity of the insulation shield is normally less than 500 ohm-meters.

Copper Tape Shields

The copper tape used in power cable shields is usually 5 mils thick and 1 to 1 ½ inches wide. It is generally helically applied over a semiconducting polymer insulation shield.

Power cables rated 5 to 35 kV and up frequently utilize copper tape as the metallic component of the metal/polymer shielding system. In combination with the extruded insulation shield, a copper tape shield increases insulation life by maintaining uniform electrical stress throughout the cable insulation and provides low end-to-end resistance of the shield system.

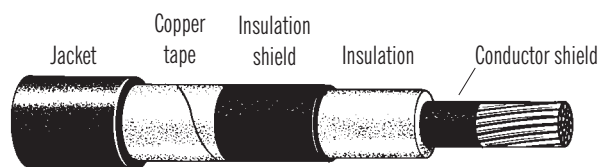


Figure 10—Typical copper tape shielded power cable

Table 30—Power cable shielding

Advantages	Disadvantages
<ul style="list-style-type: none"> • When properly grounded, provides protection from electrical shock • Increases life of the cable insulation • Reduces electromagnetic interference (EMI) 	<ul style="list-style-type: none"> • Must be terminated with a medium-voltage termination to control electrical stresses • Higher cost

Wire Shields

Metallic wire shields on power cables come in two basic types: helically applied copper wires and UniShield.

Helically applied copper wire shields are sometimes used on 5 through 35 kV and higher rated power cables. They are sometimes used in combination with copper tape to provide additional shield fault current capacity.

UniShield cables have six corrugated copper wires longitudinally imbedded in a conducting CPE jacket. The wires can be used as “rip cords” to reduce termination time during installation.

ELECTRONIC CABLE

Electronic cable shielding provides an efficient way to manage electromagnetic interference (EMI).

When a shielded cable is present in an ambient electromagnetic field, an interference current is induced in the shield. The incident energy is partially reflected from the shield and partially absorbed by the shield and a small amount penetrates through the shield into the cable. The small amount of energy that makes it all the way through the shield generates an interference voltage in the signal carrying conductors of the cable. The smaller the interference voltage, the better the shield.

In addition to shielding effectiveness, electronic cable shields must satisfy a long list of electrical, mechanical, chemical and cost requirements. As a result, a diversified line of shield designs has evolved in the wire and cable industry.

Foil Shield

Foil shields are usually constructed of aluminum foil with a 1/2-mil thick polyester backing. This backing provides mechanical strength. The shield can be overlapped (Figure 11) with the foil facing in or the foil facing out. This overlap creates a slot where signal leakage through the shield can occur. The “Z” fold (Figure 12) construction provides the best electrical isolation between shields of adjacent pairs as well as 100 percent coverage. A tinned copper drain wire is placed in contact with the foil side of the shield to provide easier grounding of the shield at the cable terminations.

Foil shields are most common in electronic and coaxial cables. Foil shields provide excellent protection from electromagnetic interference, especially at high frequencies.

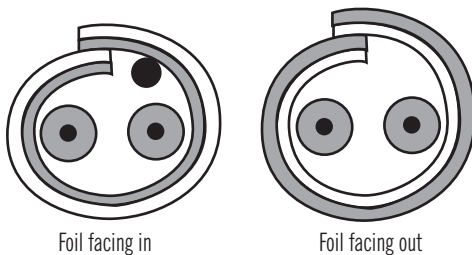


Figure 11—Foil shield



Figure 12—Z-Fold foil shield

Shields

Table 31—Foil shielding

Advantages	Disadvantages
<ul style="list-style-type: none"> • 100% coverage • Low cost • Ease of termination • Good flexibility • Excellent shielding at high frequencies 	<ul style="list-style-type: none"> • Poor mechanical strength • Short flex life • Less effective at low frequencies

Copper Braid Shield

A braid shield typically consists of copper wire ranging in size from 32 to 40 AWG braided into a mesh around the cable core. The tightness of the braid determines the percent coverage. Typical coverage ranges from 60 percent to 90 percent. Generally, the higher the coverage the better the shield.

Braid shields are typically used on coaxial cables and on low-speed communications cables. Braid shields are most effective at low frequencies. Braid shields are also commonly used on cables where increased flex life and mechanical strength are required.

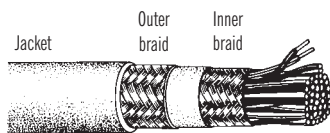


Figure 13—Dual braid shield construction on a multipair cable

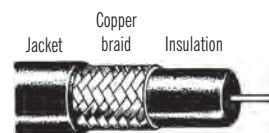


Figure 14—Copper braid construction on a coaxial cable

Table 32—Copper braid shields

Advantages	Disadvantages
<ul style="list-style-type: none"> • Best at low frequencies • Good mechanical strength • Increased flex life 	<ul style="list-style-type: none"> • Increased cost • More difficult to terminate

Spiral (Serve) Shield

Spiral or serve shields, as they are sometimes called, are typically constructed with bare or tinned copper wires from 32 to 40 AWG in size that are helically applied in a flat or ribbon configuration (Figure 15). Spiral shields range in coverage from 80 percent to about 97 percent.

Spiral shields are used primarily in audio, microphone and retractile cord cables where extreme flexibility and a long flex life are required. Spiral shields perform best when used at low (audio) frequencies.

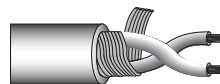
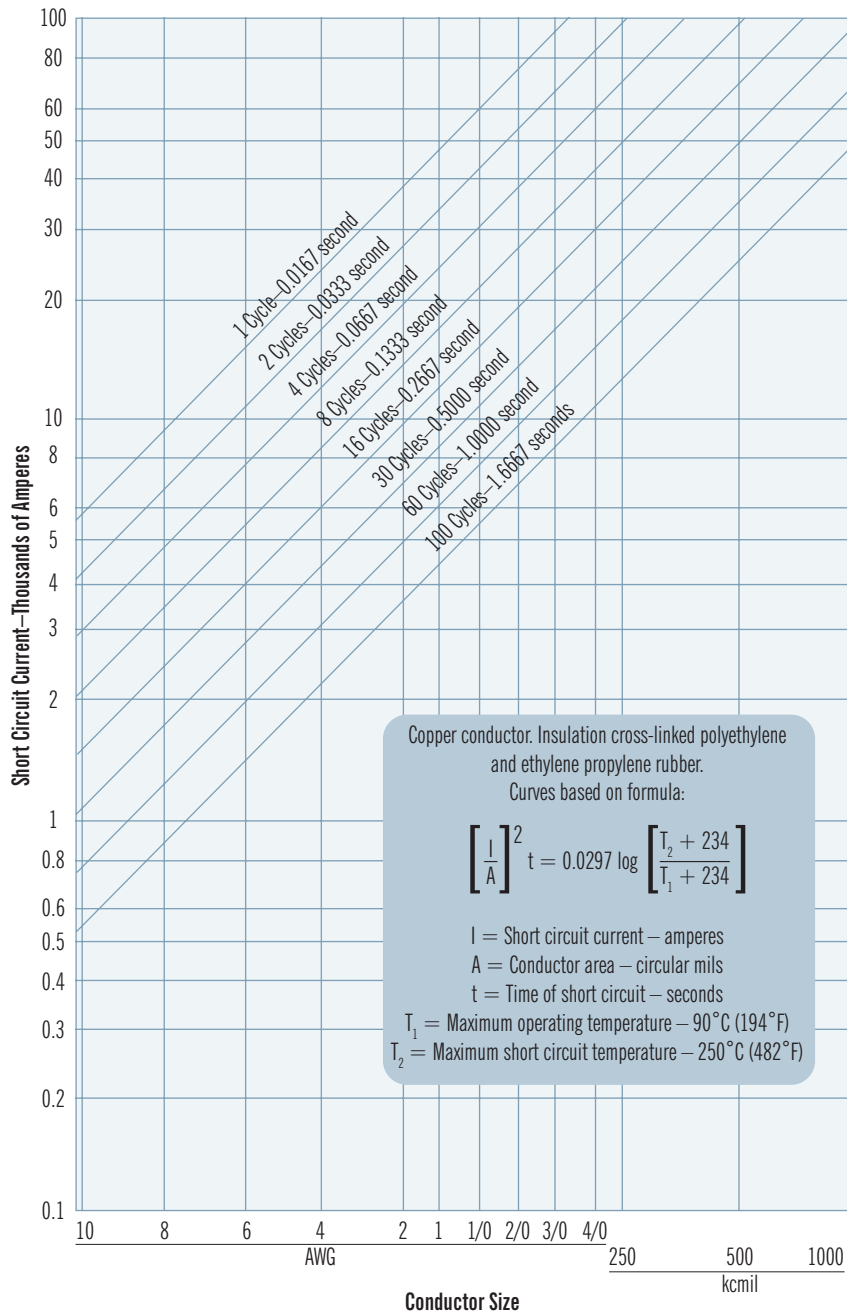


Figure 15—Spiral or serve shield

Table 33—Spiral Shields

Advantages	Disadvantages
<ul style="list-style-type: none"> • Excellent flexibility • Long flex life 	<ul style="list-style-type: none"> • Poor electrical performance at high frequencies

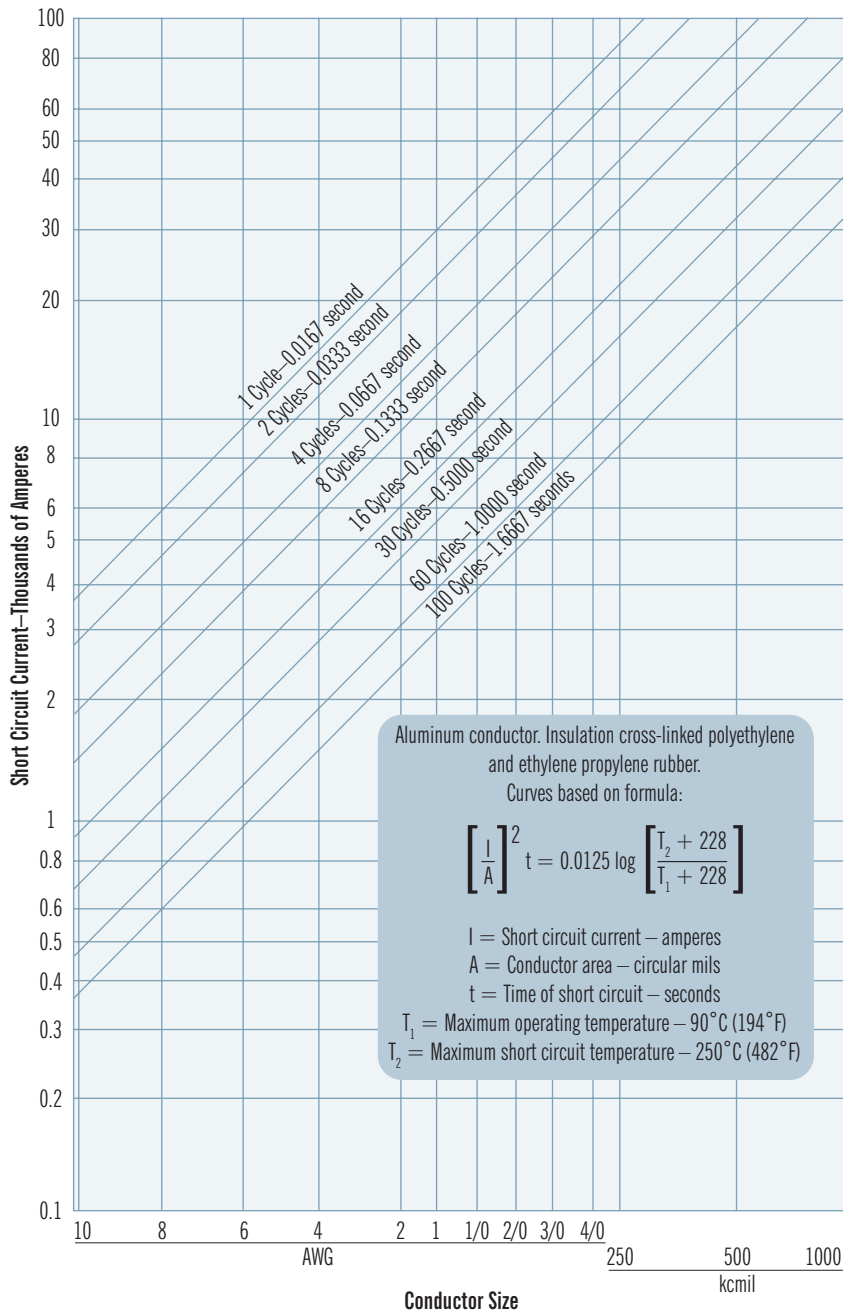
Maximum Short Circuit Current



Source: ICEA P-32-382

Figure 16—Maximum conductor short circuit current for copper cables

Maximum Short Circuit Current



Source: ICEA P-32-382

Figure 17—Maximum conductor short circuit current for aluminum cables

Installation and Testing

This section is intended as a guide for the installer's use in the field. The information has been obtained from many sources and covers some of the major considerations when installing and testing power, control, instrumentation, fiber and communications cable.

RECEIVING, HANDLING AND STORAGE

The following guidelines are recommended to prevent possible deterioration or damage of cable during handling or storage prior to installation.

Receiving

Before accepting any shipment, all reels should be visually inspected for both hidden and obvious damage. Contact your Anixter sales representative if you see any of the following:

- A reel is lying flat on its side
- Reels are poorly stacked
- Protective covering (packaging material) is removed or damaged
- Cable end seals are removed or damaged
- Reel flanges are broken
- A reel has been dropped
- Cable ties are loose
- Nails or staples have been driven into the reel flange.

Handling

Cable reels should always be rolled in the direction of the "roll this way" stenciled on the flanges. This prevents loosening of the cable turns, which may cause problems during installation. If the roll direction is not indicated, rotate the reel in the same direction it was rotated when the cable was wound onto the reel.

Cable reels should only be lifted by forklift trucks from the sides and only if the forks are long enough to cradle both flanges.

Steel lifting bars of a suitable diameter and length should be used when lifting cable reels by crane or other overhead lifting devices. With heavy reels or reels that may be unbalanced, the use of a lifting yoke is recommended to prevent reels from slipping or tipping during lifting.

Storage

Where possible, reels should be stored indoors on a hard, dry surface. If reels must be stored outside they should be supported off the ground and covered with a suitable weatherproof material.

- Each reel should be aligned flange to flange.
- Each reel should be chocked.
- Reels should be stored to allow easy access for lifting and moving.

When cable lengths are cut from a master cable reel, all exposed cable ends should be resealed with plastic weatherproof caps or tape to prevent the entrance of moisture.

Installation and Testing

PULLING

Methods of Gripping Cables

In general, insulated cables may be gripped either directly by the conductors or by a basket-weave pulling grip applied over the cables. The appropriate method to use depends on the anticipated maximum pulling tension. When pulls are relatively light a basket-weave grip can often be used. Heavier pulls usually require connecting directly to the conductor either by means of pulling eyes or by forming a loop with the conductor itself. In some instances it is desirable to use a grip over the outer covering in addition to the conductor connection to prevent any slippage of one with respect to the other.

Nonmetallic Sheathed Cables

Smaller sizes of nonmetallic sheathed cables can usually be gripped directly by the conductors by forming them into a loop to which the pull wire or rope can be attached. The insulation on each conductor is removed before the loop is formed. Larger sizes are more easily handled by applying a pulling grip over the cable or cables provided the pull is not too severe. If more than one cable is involved, the ends should be bound together with electrical tape before applying the grip overall. Long, hard pulls will necessitate the use of pulling eyes.

Interlocked Armor Cables

When pulling interlocked armor cable it is usually necessary to grip both the armor and the conductors. This can be accomplished in a number of ways. One method requires that a portion of the armor be removed. Electrical tape is then applied over the armor and down over the conductors and a long basket-weave grip is applied such that it grips both the armor and the conductors. Another method requires that two holes be drilled through the cable (armor and conductors) at right angles to each other and a loop formed by passing steel wires through the holes and out over the end of the cable. A third approach is to use a pulling eye and a grip together, the grip being applied over the armor to prevent it from slipping back. This latter approach provides the greatest strength.

Preassembled Aerial Cable

This type of cable should always be gripped by the messenger that is usually attached to a pulling swivel. In addition, a basket grip should be applied over the conductors to prevent any slippage and to facilitate guiding the conductors through the pulleys.

Tension Limitations

When the pulling force is applied directly to the conductor (e.g., when pulling eyes are used or when the conductor is formed into a loop) it should be limited to 0.008 lb. per circular mil area of cross-section for copper and 0.006 lb. per circular mil for aluminum.

When a grip is applied over nonmetallic sheathed cables, the pulling force should be limited to 1,000 pounds provided this is not in excess of the force calculated above using the 0.008 or 0.006 factors.

To limit the sidewall pressure to a safe value at bends in duct and conduit runs, the pulling force in pounds should not exceed 300 to 500 times the radius of the bend in feet.

The above limits are maximum values that should not be exceeded. However, it is possible to damage cables while applying lower tensions if, for example, there are sharp projections in a poorly constructed duct bank, or if an interlocked armor cable is pulled around too small a sheave. Every installation detail cannot be covered here but staying within the above tension limits will help ensure a successful installation.

Installation and Testing

Helpful Hints

The following suggestions – though not all-inclusive – will give greater assurance of success.

- (1) Be sure there is adequate clearance between conduit and cable. Clearance refers to the distance between the uppermost cable in the conduit and the inner top of the conduit. Clearance should be 1/4 inch at minimum and up to one inch for large cable installations or installations involving numerous bends. It is calculated as shown in [Figure 18](#) where “D” is the inner diameter of the conduit and “d” is the outer diameter of the cable. When calculating clearance, ensure all cable diameters are equal. Use the triplexed configuration formula if you are in doubt. The cables may be of single or multiple conductor construction. Do not exceed recommended “conduit fill” requirements.

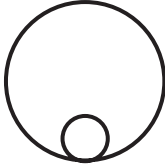
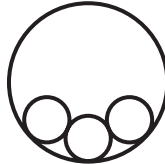
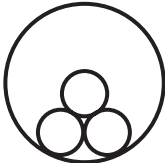
No. of Conductors/Cables	Configuration	Formula
1		Clearance = D - d
3	 Cradled	Clearance = $\frac{D}{2} - 1.366d + \frac{D - d}{2} \sqrt{1 - \left(\frac{d}{D - d}\right)^2}$
3	 Triplexed	Clearance = $\frac{D}{2} - \frac{d}{2} + \frac{D - d}{2} \sqrt{1 - \left(\frac{d}{2(D - d)}\right)^2}$

Figure 18—How to calculate clearance

- (2) Jamming is the wedging of three cables lying side by side in a conduit. This usually occurs when cables are being pulled around bends or when cables twist.

The jam ratio is calculated by slightly modifying the ratio D/d. A value of 1.05D is used for the inner diameter of the conduit because bending a cylinder creates an oval cross-section in the bend.

- If 1.05D/d is larger than 3.0, jamming is impossible.
- If 1.05D/d is between 2.8 and 3.0, serious jamming is probable.
- If 1.05D/d is less than 2.5, jamming is impossible but clearance should be checked.

Because there are manufacturing tolerances on cable, the actual overall diameter should be measured prior to computing the jam ratio.

- (3) Use adequate lubrication of the proper type to reduce friction in conduit and duct pulls. Grease and oil type lubricants should not be used on nonmetallic sheathed cables. There are a number of commercially available wire pulling compounds (many of which are UL Listed) that are suitable for use with polymer jacketed cables. They usually consist of soap, talc, mica or the like, and are designed to have no deleterious effect on the cable. Graphite and other electrically conducting lubricants should not be used on nonshielded cables rated 2 kV and above. These materials can lead to tracking of the cable jacket.
- (4) Avoid sharp bending of the cable at the first pulley in overhead installations by locating the payoff reel far enough away from the first pulley that the lead-in angle is kept relatively flat.
- (5) After installation, check that end seals are still intact and have not been damaged to the point where water could enter. Apply plastic or rubber tape to help protect against invisible damage if the cable will be subjected to immersion or rain. This is particularly important if there will be a delay of some time between the pulling operation and splicing and terminating.

Technical Information

Installation and Testing

(6) When installing interlocked armor cables in cable tray, use a sufficient number of rollers to prevent the cable from dragging on the tray, which might result in excessive tension. Avoid sharp bends in the cable by using a conveyor sheave with multiple small rollers at all 45- and 90-degree bends.

(7) Keep adequate tension on the messenger in aerial cable installations to prevent sharp bends at pulleys. Do not release the tension on the messenger until it is secured to poles on both ends.

Pulling Tension Calculations

Pulling tension calculations are recommended in the design stage of all cable installations that are expected to fall in the moderate to difficult category. Software programs are commercially available that can perform sophisticated modeling of expected pulling tensions and sidewall pressures. These programs are recommended over manual methods. Below is an overview of the basic calculations. Additional information is available in IEEE 1185, IEEE 971, IEEE 576 and AEIC CG5.

(1) Maximum Pulling Tension

a. With pulling eye attached to copper conductors, the maximum pulling tension in pounds should not exceed 0.008 times the circular mil area.

b. With pulling eye attached to aluminum conductors, the maximum pulling tension in pounds should not exceed 0.006 times the circular mil area.

Example: For copper

$$T_M = 0.008 \times n \times CM$$

Where:

T_M = maximum tension, lb.

n = number of conductors

CM = circular mil area of each conductor

(2) Maximum Permissible Pulling Length

$$L_M = \frac{T_M}{C \times W}$$

Where:

L_M = maximum pulling length, feet (valid only for straight sections)

T_M = maximum tension, lb.

W = weight of cable per foot, lb.

C = coefficient of friction (typically 0.5 but can vary from 0.2 to 1.0 depending on condition of the duct and the amount of lubricant used)

(3) Bend Multipliers

For a curved section, the multipliers given below are applied to the tension calculated for the straight section preceding the bend.

Table 34—Bend multipliers for pulling tension calculations

Bend Angle Degrees	Multiplier	Bend Angle Degrees	Multiplier
15	1.14	75	1.94
30	1.30	90	2.20
45	1.48	105	2.50
60	1.70	120	2.86

Note: These multipliers are based on a coefficient of friction of 0.5. If the coefficient of friction were 1.0 instead of 0.5, the multipliers would have to be squared. If the coefficient of friction were 0.75, the multipliers would be raised to the one and one-half power.

Installation and Testing

Pulling Lubricants

Many commercial lubricants are available and may be employed to reduce pulling tensions provided they do not affect electrical or mechanical characteristics of the cable. The primary function of a pulling lubricant is to reduce the tension on the cable as it is installed in a duct. This is accomplished by reducing the friction (technically the coefficient of friction) between the cable and the inside surface of the conduit, i.e., it makes the cable more slippery. Cable pulling lubricants should be formulated for the conditions of the pull, be safe for the environment, not degrade the cable jacket and be easy to work with. Some LSZH (low smoke zero halogen) cables require special pulling lubricants such as Polywater LZ to prevent chemical damage to the jacket.

The quantity of lubricant required depends on various factors: the pull length, the condition and size of the conduit and the difficulty of the pull. The recommended average quantity of lubricant per pull is equal to:

$$Q = 0.0015 \times L \times D$$

Where Q is the quantity of lubricant needed in gallons, L is the length of the pull in feet and D is the inner diameter of the conduit in inches.

The appropriate quantity to use can vary by ± 50 percent from the average depending on installation conditions. Follow the manufacturer's instructions for the conditions affecting each pull.

Sidewall Pressure (SWP)

To prevent damage to a cable from pressure that develops when a cable is pulled around a bend under tension, the pressure must be kept as low as possible and should not exceed specified values. Sidewall pressure = tension out of the bend divided by bend radius. Cable manufacturers generally recommend a maximum SWP of 500 lb./ft. for most 600 V and medium-voltage power cables.

Minimum Bending Radii

Power Cables without Metallic Shielding

The minimum bending radii for both single- and multiple-conductor cable without metallic shielding are as follows:

Table 35—Minimum bending radii for cables without metallic shielding

Thickness of Conductor Insulation (mils)	Minimum Bending Radius as a Multiple of Cable Diameter		
	Overall Diameter of Cable in Inches		
	1.00 and less	1.01 to 2.00	2.01 and Greater
169 and less	4	5	6
170 and larger	5	6	7

Installation and Testing

Example:

If minimum bending radius is six times cable O.D. and cable O.D. is 2.0 inches, the minimum bending radius is 12 inches (minimum bending diameter is 24 inches).

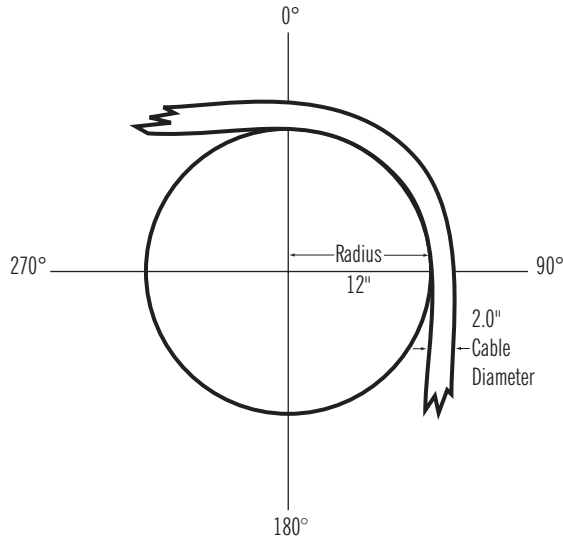


Figure 19—Calculating minimum bending radius

Power Cables with Metallic Shielding

The minimum bending radius for all single-conductor cables with metallic shielding is 12 times the overall diameter of the cable. For multiconductors, it is seven times the overall diameter or 12 times the individual conductor diameter, whichever is greater.

Portable Cables

The minimum bending radius for portable cables during installation and handling in service is six times the cable diameter for cables rated 5,000 volts and less. For cables rated over 5,000 volts use eight times the cable diameter. For flat twin cables, the minor diameter is used to determine the bending radius.

Fiber Optic Cables

Minimum bending radius for fiber optic cable is typically 10 times the cable diameter when under no tension and 15 times diameter at rated maximum tension. The manufacturer should be consulted for specific product limits.

Interlocked Armor or Corrugated Sheath (Type MC) Cables

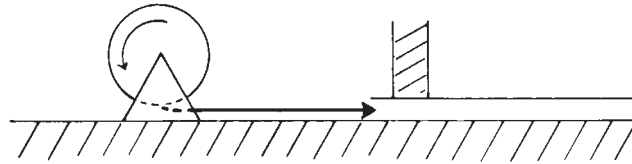
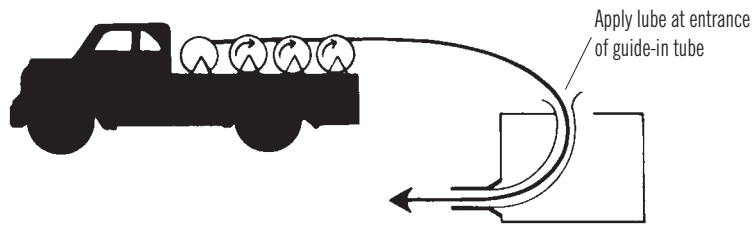
The minimum bending radius for Type MC cable is seven times the external diameter of the metallic sheath.

Sources: NEC Articles 300.34, 330.24, 336.24 and 727.10

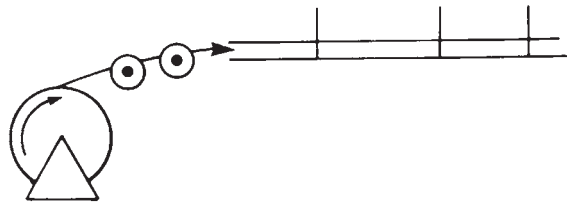
- NEMA WC58 (ICEA S-75-381)
- NEMA WC74 (ICEA S-93-639)
- IEEE 1185
- NEMA WC70 (ICEA S-95-658)

Installation and Testing

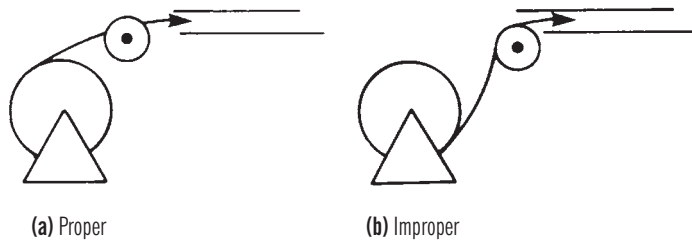
INSTALLATION METHODS



Setup for duct close to floor



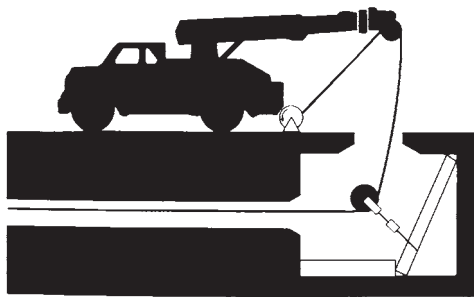
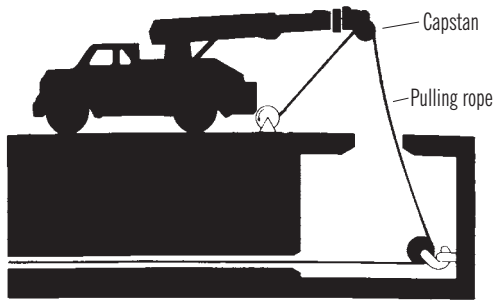
Setup for overhead into tray



The feed-in setup should unreele the cable with the natural curvature (a) as opposed to a reverse “S” curvature (b).

Figure 20—Cable pulling setups

Installation and Testing



A setup with timbers because pulling eyes were not available

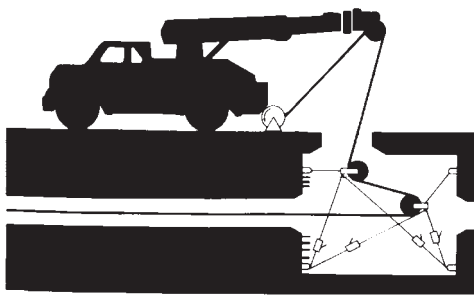


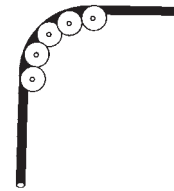
Figure 21—Cable Pulling Setups

Single sheave

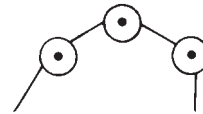


Single sheaves should be used only for guiding cables. Arrange multiple blocks if necessary to maintain minimum bending radii whenever cable is deflected.

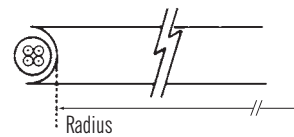
Sheave assembly



For pulling around bends, use multisheave assemblies (also called conveyor sheaves) of the appropriate radius.



The pulleys must be positioned to ensure that the effective curvature is smooth and deflected evenly at each pulley. Never allow a polygon curvature to occur as shown.



The fit of the pulley around the cable is also important when the pulling tension is high (for example, pulleys at the top of a vertical drop). Remember to use the radius of the surface over which the cable is bent, not the outside flange diameter of the pulley.

A 10-inch cable sheave typically has an inside (bending) radius of 3 inches!

Figure 22—Cable Pulling Setups

Installation and Testing

HIPOT TESTING

Overview

This section provides an overview of high-potential DC testing of power cables. For more details, see IEEE Standards 400 and 400.1. All tests made after cable installation and during the guarantee period should be made in accordance with applicable specifications. All safety precautions must be observed during testing at high voltage. Read and understand and follow the operator's manual for the particular test set being used!

It should be also noted that other field tests are growing in popularity – including VLF (very low frequency) and PD (partial discharge) test methods. IEEE 400.2 and 400.3 contain additional details.

Test Equipment

Direct current test equipment is commercially available with a wide range of voltages. Accessory equipment is necessary to safely conduct high-voltage tests such as safety barriers, rubber gloves and nonconducting hard hats. Consult appropriate safety officer.

Test Procedure

Refer to IEEE Standard 400. Acceptable procedures, although varying slightly in technique, have more or less been standardized as either a “withstand test” or a “time-leakage current test.”

Before performing any DC overpotential tests:

- All equipment must be disconnected from the cable circuit, e.g., disconnect transformers, switch taps, motors, circuit breakers, surge arrestors, etc. This will preclude damage to such equipment and will prevent test interruptions due to flashovers and/or trip-outs resulting from excessive leakage current.
- Establish adequate clearance between the circuit test ends and any grounded object, and to other equipment not under test (approximately 0.25 inches per kV).
- Ground all circuit conductors not under test and all cable shields as well as nearby equipment.
- Consult termination manufacturer for maximum test voltage recommendations and time limitations.

The direct current test may be applied either continuously or in predetermined steps to the maximum value in accordance with applicable specifications:

- Continuous Method – Apply test voltage at an approximate rise rate of 1 kV per second or 75 percent of the rated current input of the equipment, whichever is less. Some equipment will take longer to reach the maximum test voltage because of the amount of charging current.
- Step Method – Apply test voltage slowly in five to seven increments of equal value, to the maximum specified. Allow sufficient time at each step for the leakage current to stabilize. Normally this requires only a few seconds unless cable circuits of high capacitance are involved. Record leakage current at each step.
- Maintain the test voltage at the prescribed value for the time designated in applicable specifications.
- At the end of the test period, set the test set voltage control to zero. Allow the residual voltage on the circuit to decay then ground the conductor just tested.
- Caution – It should be recognized that DC charges on cable can build up to potentially dangerous levels if grounds are removed too quickly. Maintain solid grounds after the test on the cable for at least four times the duration of the test. It is a good safety practice to maintain these grounds longer and while reconnecting circuit components.

Acceptance Testing – After installation and before the cable is placed in regular service the specified test voltage is applied for 15 consecutive minutes.

Proof Testing – At any time during the period of guarantee, the cable circuit may be removed from service and tested at a reduced voltage (normally 65 percent of the original acceptance value) for five consecutive minutes.

Record the leakage current at one minute intervals for the duration of the test. A constant or decreasing leakage current with respect to time at maximum test voltage is the usual acceptance criterion for DC hipot testing.

Additional Considerations

High-potential testing of medium-voltage power cables is usually performed with negative polarity connected to the conductor.

High-potential testing is a tool for determining insulation resistance at high voltages. Effective insulation resistance of the cable system may be calculated by means of Ohm's Law: $R = V/I$. Restated another way the relation is:

$$\text{Megohms} = \frac{\text{Kilovolts}}{\text{Microamperes}} \times 1,000$$

Insulation resistance (IR) may also be measured with instruments that give a direct reading at 500 volts (or higher, depending on the model). IR in general has little or no direct relationship to breakdown strength.

Technical Information

Installation and Testing

The significance of conducting DC high-voltage tests on nonshielded, nonmetallic sheathed cable is dependent upon the environment in which it is installed because the characteristics of the return circuits are unknown. The environment must be carefully considered or test results may not be significant. In fact, these tests can result in damage to the cable insulation.

Humidity, condensation or actual precipitation on the surface of a cable termination can increase the leakage current by several orders of magnitude. Humidity also increases the termination leakage current, which is included in the total leakage current. Wind prevents the accumulation of space charges at all bare energized terminals. This results in an increase of corona. It is desirable to reduce or eliminate corona current at the bare metal extremities of cable or terminations. This may be accomplished by covering these areas with plastic envelopes, plastic or glass containers, plastic wrap (e.g., Saran® or Handiwrap®) or suitable electrical putty.

Routine periodic DC maintenance testing of cable for the evaluation of the insulation strength is not a common practice. Some power cable users have adopted a program of testing circuits during planned outages, preferring possible breakdowns during testing rather than experiencing a service outage. It is nearly impossible to recommend test voltage values for maintenance. An arbitrary test voltage level could break down a cable circuit that would otherwise render long trouble-free service at normal operating AC voltage.

One advantage of DC high-voltage testing is that it can detect conducting particles left on the creepage surface during splicing or termination.

Test equipment should be supplied from a stable, constant voltage source. Do not use the same source that is supplying arc welders or other equipment causing line voltage fluctuations. The output voltage of the test set must be filtered and regulated. Consider using a portable motor driven alternator to energize the test set.

Common Testing Problems

High-leakage current can be caused by:

- Failure to guard against corona
- Failure to clean insulation surface
- Failure to keep cable ends dry (high relative humidity, dampness, dew, fog, wind, snow)
- Failure to provide adequate clearance to ground
- Improper shield termination.

Erratic readings can be caused by:

- Fluctuating voltage to test set
- Improper test leads.

Test Voltage

DC hipot test voltages are specified by ICEA and NEMA for tests conducted during and after installation as follows:

- At any time during installation, a DC proof test may be made at a voltage not exceeding the test voltage specified below, applied for five consecutive minutes.
- After the cable has been completely installed and placed in service, a DC proof test may be made at any time within the first five years at the test voltage specified below, applied for five consecutive minutes. After that time, DC testing is not recommended.

Table 36—Maximum DC test voltages for shielded power cables

Rated Voltage Phase-to-Phase (kV)	Maximum DC Field Test Voltages in kV			
	During Installation		First 5 Years	
	100 Percent (Grounded)	133 Percent (Ungrounded)	100 Percent (Grounded)	133 Percent (Ungrounded)
5	28	36	9	11
8	36	44	11	14
15	56	64	18	20
25	80	96	25	30
28	84	100	26	31
35	100	124	31	39
46	132	172	41	54

Sources: ICEA S-94-649 Appendix E, NEMA WC 74 (ICEA S-93-639) Appendix F and ICEA S-97-682 Appendix E

Installation and Testing

Evaluation of Results

The test current will momentarily increase for each voltage increment due to the charging of capacitance and dielectric absorption characteristics of the cable – ultimately leaving only the conduction current plus any external surface leakage or corona currents. The time required to reach steady-state current depends on insulation temperature and material. If, without any increase in applied voltage, the current starts to increase slowly at first but at an increasing rate, gradual insulation failure may be in progress. This process will probably continue until eventual failure of the cable unless the voltage is rapidly reduced. Rubber and nonpressurized impregnated paper insulations will usually exhibit this type of insulation failure; other insulations rarely exhibit this type of failure.

If at any time during the test, a violent increase in current occurs accompanied by tripping of the test set, failure or flashover has probably occurred in the cable, a splice or termination. A failure can be confirmed by the inability to sustain the second application of the test voltage.

FAULT LOCATING

One of the many types of fault locating equipment is the time domain reflectometer (TDR). These units are portable, commercially available devices that can be used in the field to locate some types of conductor breaks or shorts. Connected to the end of a cable, the device functions much like radar, sending out low-voltage pulses that travel the length of the cable and echo back when an open, short or tap is encountered. The device can usually locate faults within ± 2 percent of the cable length. However, TDRs are only capable of locating breaks or shorts having an impedance different than that of the cable. For most cables, this includes shorts having a resistance of less than a few ohms and opens having a resistance greater than several hundred ohms. Splices, taps, etc., sometimes distort the echo and can mask the fault. Nevertheless, the method is nondestructive and is used successfully on faults having characteristics within the capabilities of the method.

MEGGER TESTING

If the DC voltage applied during an insulation resistance (IR) test on power cables is relatively low (0.6 to 2.5 kV), the test is often referred to as a “Megger” test. Low-voltage IR tests are particularly useful in detecting shorts due to installation or handling damage to 600-volt-rated cables.

An inherent limitation of low-voltage IR tests is their interpretation. The readings obtained from such testing on nonshielded, nonmetallic-sheathed cable is very dependent upon the environment because the environment determines the characteristics of the return circuit. Low resistance readings may be caused by contaminated or moist cable ends, high humidity, etc. Failure to clean water based cable pulling lubricants from the cable test ends has caused erroneous rejection of good cable. Refer to the figures below for suggested hook-up.

Reminders:

- **Safety** – Follow the test equipment supplier’s instructions. Stay clear of energized cable. Operators must know the equipment. Be sure shields are grounded! Remember that insulated conductors are capacitors.
- **Voltages** – Check cable and termination manufacturer’s guidelines.
- **Records** – Keep detailed records and provide a copy to the owner.

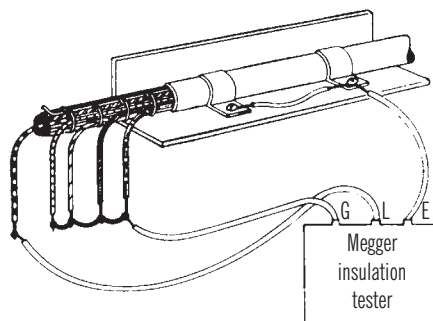


Figure 23—Connections for testing insulation resistance between one wire and ground, without being affected by leakage to other wires. Note use of the guard (G) connection

Installation and Testing

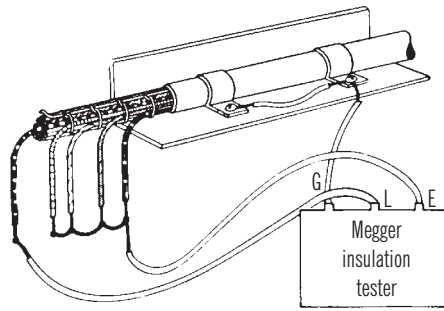


Figure 24—Connections for testing insulation resistance between one wire and all other wires, without being affected by leakage to ground

MOISTURE REMOVAL

Purging Water from Conductor Strand or Shield

Cables Not Yet Installed: Remove end seals. Position one cable end to its lowest possible elevation. At the cable end having the highest elevation, apply two layers of half-lapped HV insulating tape to act as a sealing cushion. Connect the cable ends to a dry nitrogen or dry air supply using hoses, valves, fittings and flow regulators as shown in **Figure 25**

Attach a one-gallon plastic bag to the exhaust end of the cable. Secure the bag with tape or clamps. Make a small vent hole by clipping one bag corner.

As shown, several cables may be connected to the gas supply. Dry nitrogen is available from welding gas suppliers. Apply 15–25 psi (gauge). Maintain gas flow for at least eight hours after all indications of moisture have stopped.

Water vapor may be readily detected by sprinkling one tablespoon of anhydrous cupric sulfate in the plastic bag, which turns blue instead of “off” white when wet. The sulfate is available from scientific laboratory supply houses. A hardware store humidity gauge may also be used.

Installed Cables: The splices and terminations must be removed if they interfere with the flow of air or nitrogen. The cable can then be purged as described above.

All Cables: Purge the shield separately from the insulated strands; otherwise the nitrogen gas will only flow through the path offering the least resistance.

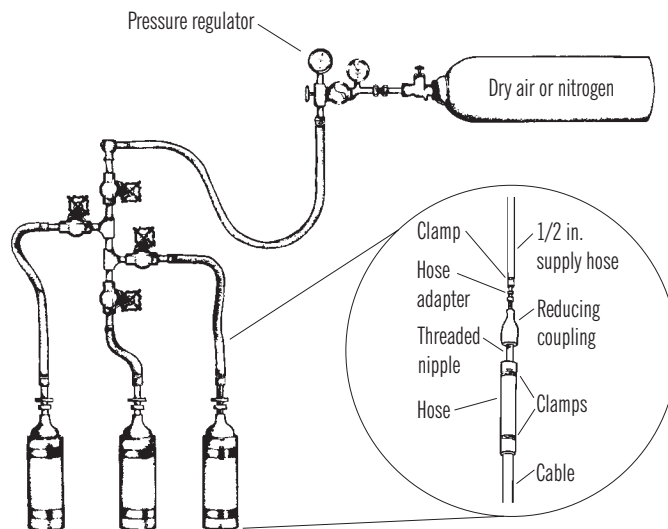


Figure 25—Moisture removal equipment

Installation and Testing

CABLE TRAY SYSTEMS

Support Span

The support span length is an important consideration as it affects the strength of the system and the length of the straight sections required. Tray types typically used for various span lengths include:

- Short span: 6- to 8-foot support spacing (use 12-foot sections)
- Intermediate span: 8- to 12-foot support spacing (use 12-foot sections)
- Long span: 16- to 20-foot support spacing (use 20-foot sections)
- Extra long span: over 20-foot to 30-foot support spacing (use 24- or 30-foot sections).

Working Load

The working load depends on tray size (width, loading depth and strength). Considerations include:

- Types and numbers of cables to support (total cable load in lb. per linear foot (lb./ft.))
- Power cables in a single layer — width is key issue (refer to applicable electrical code)
- Low-voltage cables in a stacked configuration — key issues are loading depth and width (refer to applicable electrical code).

Additional Load Considerations

- 200-lb. concentrated load — industrial installations
- Ice, wind, snow loads — outdoor installations

Installation Environment

Tray material and finish have a significant impact on tray performance in any given environment. Typical tray types used in various environments are shown below.

- Indoor dry (institutional, office, commercial, light industrial): aluminum, pregalvanized steel
- Indoor industrial (automotive, pulp and paper, power plants): aluminum, pregalvanized steel, possibly hot-dipped galvanized after fabrication (HDGAF)
- Outdoor industrial (petrochemical, automotive, power plants): aluminum, hot-dipped galvanized after fabrication (HDGAF)
- Outdoor marine (off shore platforms): aluminum, stainless steel, fiberglass
- Special (petrochemical, pulp and paper, environmental air): contact manufacturer

Installation and Testing

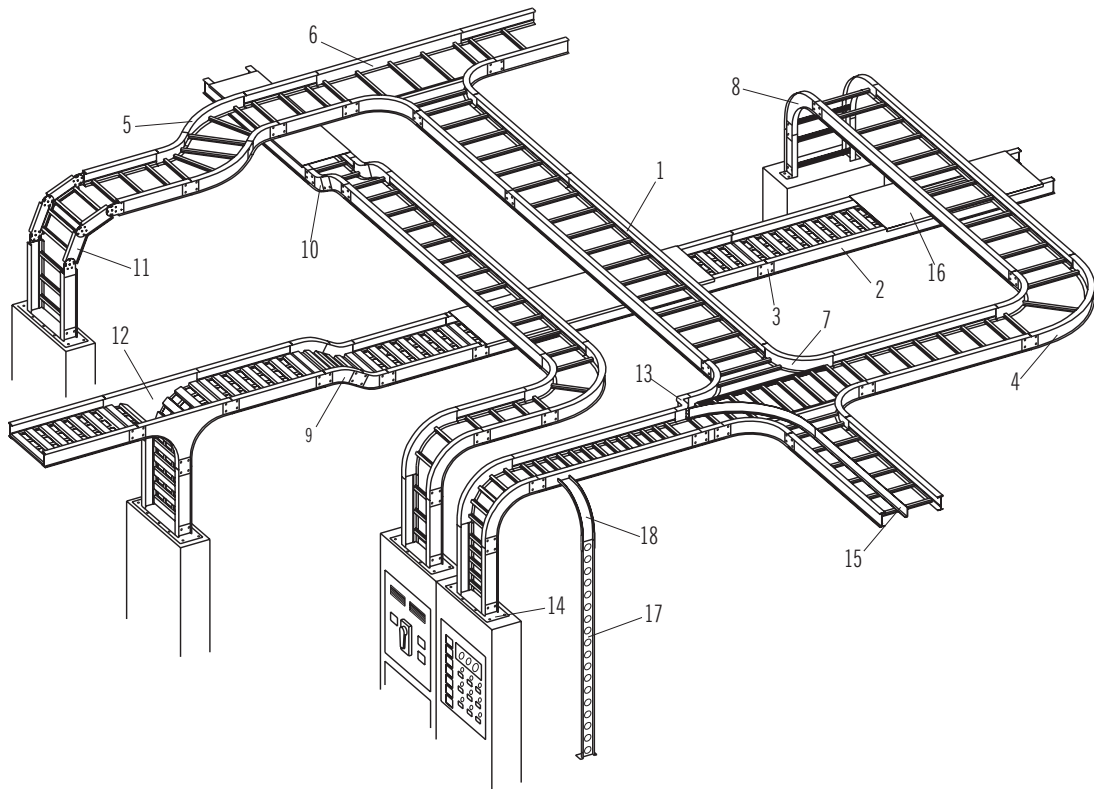


Figure 26—Cable tray system

Nomenclature

The following items are keyed by number to the parts illustrated in **Figure 26**:

- | | |
|---|---|
| 1. Ladder-type cable tray | 10. 30 degrees vertical inside bend, ladder-type cable tray |
| 2. Ventilated trough-type cable tray | 11. Vertical bend segment (VBS) |
| 3. Straight splice plate | 12. Vertical tee down, ventilated trough-type cable tray |
| 4. 90 degrees horizontal bend, ladder-type cable tray | 13. Left-hand reducer, ladder type cable tray |
| 5. 45 degrees horizontal bend, ladder-type cable tray | 14. Frame type box connector |
| 6. Horizontal tee, ladder-type cable tray | 15. Barrier strip straight section |
| 7. Horizontal cross, ladder-type cable tray | 16. Solid flanged tray cover |
| 8. 90 degrees vertical outside bend, ladder-type cable tray | 17. Ventilated channel straight section |
| 9. 45 degrees vertical outside bend, ventilated-type cable tray | 18. Channel cable tray, 90 degrees vertical outside bend |

Additional Information

Additional information on cable tray systems is contained in NEMA VE-1 "Metal Cable Tray Systems," NEMA VE-2 "Cable Tray Installation Guidelines," Article 392 of the National Electrical Code (NFPA 70) and on the Cable Tray Institute Web site at www.cabletrays.com.

Packaging of Wire and Cable

REEL SIZE

Selection of proper reel (spool) size depends on the length and overall diameter (O.D.) of the cable or wire to be rewound. A reel not matched to the weight of the cable wound on it may be damaged during shipment.

All wire and cable has a minimum safe bending radius when packaged on a reel. (These values are different than **installation** bending radius.) If cable is subjected to bends sharper than the minimum radius, damage to the material is likely. The minimum drum (hub) diameters given in [Table 37](#) should be observed.

Reel Terminology

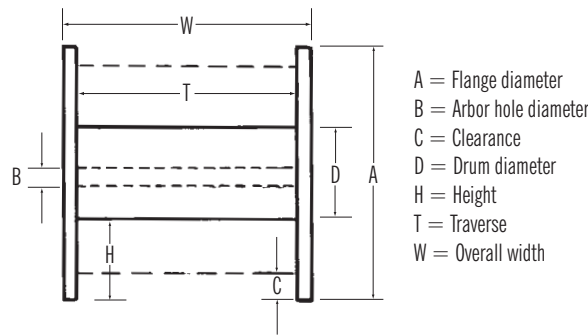


Figure 27—Reel terminology

Minimum Drum Diameter

Table 37—Minimum drum diameter for wire and cable

Type of Cable	Minimum Drum Diameter as a Multiple of Outside Diameter of Cable
A. Single- and multiple-conductor nonmetallic-covered cable	
1. Nonshielded and wire shielded, including cable with concentric wires	
a. 0–2,000 volts	10
b. Over 2,000 volts	
(1) Nonjacketed with concentric wires	12
(2) All others	14
2. Tape shielded	
a. Helically applied	14
b. Longitudinally applied flat tape	20
c. Longitudinally applied corrugated tape	14

Continued on next page >>

Packaging of Wire and Cable

Table 37—Minimum drum diameter for wire and cable (continued)

Type of Cable	Minimum Drum Diameter as a Multiple of Outside Diameter of Cable
B. Single- and multiple-conductor metallic-covered cable	
1. Tubular metallic sheathed	
a. Lead	14
b. Aluminum	
(1) Outside diameter — 1.750 in. and less	25
(2) Outside diameter — 1.751 in. and larger	30
2. Wire armored	16
3. Flat tape armored	16
4. Corrugated metallic sheath	14
5. Interlocked armor	14
C. Multiple single conductors cabled together without common covering, including self-supporting cables — the circumscribing overall diameter shall be multiplied by the factor given in item A or B and then by the reduction factor of 0.75.	
D. Combinations — For combinations of the types described in items A, B and C, the highest factor for any component type shall be used.	
E. Single- and multiple-conductor cable in coilable nonmetallic duct	
Outside diameter of duct, inches	
0.0–0.50	26
0.51–1.00	24
1.01–1.25	22
1.26–1.50	21
Over 1.50	19
F. Fiber optic cables	20*
G. Bare conductor	20

Notes to Table 37:

1. When metallic-sheathed cables are covered only by a thermosetting or thermoplastic jacket, the outside diameter is the diameter over the metallic sheath itself. In all other cases, the outside diameter is the diameter outside of all the material on the cable in the state in which it is to be wound upon the reel.
2. For “flat-twin” cables (where the cable is placed upon the reel with its flat side against the drum), the minor outside diameter shall be multiplied by the appropriate factor to determine the minimum drum diameter.
3. The multiplying factors given for item E refer to the outside diameter of the duct.

*Some manufacturers recommend 30.

Sources: NEMA WC 26 (EEMAC 201) Binational Wire and Cable Packaging Standard

Packaging of Wire and Cable

REEL HANDLING

Storage and Shipment

Except for reels less than two feet in diameter and weighing less than 200 pounds, reels should be stored and shipped upright, i.e., resting on both flanges. Do not store or ship reels on their side. Storage or shipment of the reel while lying on its side greatly increases the likelihood of tangling and damage to the cable.

Both cable ends should be sealed against the entrance of moisture. Cables larger than 1/2 inch in diameter should be sealed with tight-fitting heat-shrinkable or hot-dipped (peel coat) end caps designed for the purpose. Smaller diameter cables should be sealed with PVC tape such as 3M Scotch 33 or with end caps (end caps preferred).

CAUTION: Make sure staples are shorter than flange thickness so that they cannot extend through the flange and damage the cable. Caution must also be used to prevent damage to the cable end as it is frequently utilized for hipot, continuity, or other tests. Be sure all staples and nails that might damage the cable are removed.

If reels of cable will be stored for longer than one month, they should be protected from rain and direct exposure to sunlight to maximize service life.

Moving and Lifting

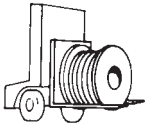
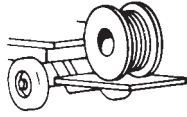

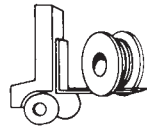
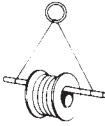
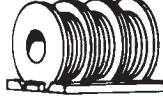
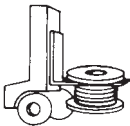
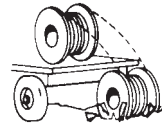
Yes		No	
			
<p>Cradle both reel flanges between forks.</p>	<p>Lower reels from truck using hydraulic gate, hoist or fork lift. Lower carefully.</p>	<p>Upended heavy reels will often arrive damaged. Refuse or receive subject to inspection for hidden damage.</p>	<p>Never allow fork to touch cable surface or reel wrap.</p>
			
<p>Reels can be hoisted with a shaft extending through both flanges.</p>	<p>Always load with flanges on edge and chock and block securely.</p>	<p>Do not lift by top flange. Cables or reel will be damaged.</p>	<p>Never drop reels.</p>

Figure 28—Proper handling of cable reels

Packaging of Wire and Cable

Table 38—Conversion factors

Frequently used conversions are shown in **bold type**. To convert in the reverse direction, divide by the factor given in the table.

To Convert From	To	Multiply By
Area		
Circular mils	Square inches	0.0000007854
Circular mils	Square mils	0.7854
Circular mils	Square millimeters	0.0005067
Square centimeters	Square inches	0.155
Square feet	Square meters	0.0929
Square inches	Circular mils	1,273,240.00
Square inches	Square centimeters	6.4516
Square inches	Square millimeters	645.16
Square inches	Square mils	1,000,000.00
Square meters	Square feet	10.764
Square millimeters	Square inches	0.00155
Square millimeters	Circular mils	1,973.53
Square mils	Circular mils	1.2732
Square mils	Square inches	0.000001
Length		
Centimeters	Inches	0.3937
Centimeters	Feet	0.03281
Feet	Centimeters	30.48
Feet	Meters	0.3048
Inches	Centimeters	2.54
Inches	Meters	0.0254
Inches	Millimeters	25.4
Inches	Mils	1,000.00
Kilometers	Miles	0.6214
Meters	Feet	3.2808
Meters	Inches	39.3701
Meters	Yards	1.0936
Miles	Kilometers	1.6093
Millimeters	Inches	0.03937
Millimeters	Mils	39.3701
Mils	Inches	0.001
Mils	Millimeters	0.0254
Yards	Meters	0.9144

Continued on next page >>

Technical Information

Conversion Tables

Table 38—Conversion factors (continued)

Frequently used conversions are shown in **bold type**. To convert in the reverse direction, divide by the factor given in the table.

To Convert From	To	Multiply By
Power		
Foot-pounds per minute	Horsepower	0.000303
Foot-pounds per minute	Watts	0.0226
Foot-pounds per second	Horsepower	0.001818
Foot-pounds per second	Watts	1.356
Horsepower	Foot-pounds per minute	33,000.00
Horsepower	Foot-pounds per second	550.00
Horsepower		
Kilogram-meters per sec.	Watts	746
Watts	Foot-pounds per minute	9.807
Watts	Foot-pounds per second	44.25
Watts	Foot-pounds per second	0.7375
Watts	Horsepower	0.001341
Watts	Kilogram-meters per sec.	0.1020
Energy		
British thermal units	Foot-pounds	778.00
British thermal units	Joules	1,055.00
British thermal units	Watt-hours	0.293
Foot-pounds	British thermal units	0.001285
Foot-pounds	Joules	1.356
Foot-pounds	Kilogram-meters	0.1383
Gram calories	Joules	4.186
Joules	British thermal units	0.000947
Joules	Ergs	107.00
Joules	Foot-pounds	0.7375
Joules	Gram-calories	0.2388
Joules	Kilogram-meters	0.10198
Kilogram-meters	Foot-pounds	7.233
Kilogram-meters	Joules	9.8117
Watt-hours	British thermal units	3.4126

To Convert From	To	Multiply By
Weight		
Kilograms	Pounds	2.205
Kilograms per kilometer	Pounds per 1,000 feet	0.6719
Ohms per kilometer	Ohms per 1,000 feet	0.3048
Ohms per 1,000 feet	Ohms per kilometer	3.2808
Ohms per 1,000 yards	Ohms per kilometer	1.0936
Pounds	Kilograms	0.4536
Pounds per 1,000 feet	Kilograms per kilometer	1.488
Pounds per 1,000 yards	Kilograms per kilometer	0.4960
Pounds per 1,000 yards	Pounds per kilometer	1.0936
Newton	Pound-force	0.2248
Pound-force	Newton	4.4482
Miscellaneous		
Diameter circle	Circumference	3.1416
Diameter circle	Side of equal square	0.8862
Diameter sphere cubed	Volume of sphere	0.5236
U.S. gallons	Imperial gallons (British)	0.8327
U.S. gallons	Cubic feet	0.1337
U.S. gallons	Pounds of water (20°C)	8.33
Cubic feet	Pounds of water (4°C)	62.427
Feet of water (4°C)	Pounds per square inch	0.4336
Inches of mercury (0°C)	Pounds per square inch	0.4912
Knots	Miles per hour	1.1516

Conversion Tables

KVA TO AMPERES

Table 39—kVA to amperes

kVA Rating	Single-phase Circuits			
	Current in Amperes at:			
	120 V	240 V	480 V	600 V
1	8.33	4.16	2.08	—
1.5	12.5	6.24	3.12	—
2	16.66	8.33	4.16	—
3	25	12.5	6.1	—
5	41	21	10.4	—
7.5	62	31	15.6	—
10	83	42	21	—
15	124	62	31	—
25	208	104	52	—
37.5	312	156	78	—
50	416	208	104	—
75	624	312	156	—
100	830	415	207	—
167	1,390	695	348	—
200	1,660	833	416	—
3	8.3	7.2	3.6	2.9
6	16.6	14.4	7.2	5.8
9	25.0	21.6	10.8	8.7
15	41.6	36	18	14.4
30	83.0	72	36	28.8
45	125	108	54	43
75	208	180	90	72
112.5	312	270	135	108
150	415	360	180	144
200	554	480	240	192
225	625	540	270	216
300	830	720	360	288
400	1,110	960	480	384
500	1,380	1,200	600	480
750	2,080	1,800	900	720

HORSEPOWER TO AMPERES

Table 40—Horsepower to amperes

Horsepower Rating	Three-phase Motor		
	Current in Amperes at:		
	208 V	240 V	480 V
1	2.9	2.5	1.2
2	5.8	5.0	2.5
5	14.4	12.5	6.2
10	28.8	25.0	12.5
20	57.6	49.9	25.0
50	144	125	62.4
100	288	250	125
200	576	500	250
300	—	—	624

Note: Based on a motor efficiency of 90 percent and system power factor of 0.8. Above values are theoretical values based solely on numerical calculations. Check with applicable codes for specific ampere values to size overcurrent protective devices or conductors. For example, see Table 430.250 of the 2008 National Electrical Code.

#

0–10 V—A common analog process control signal voltage range.
4–20 mA—A common analog process control signal current range.

A

A—Common abbreviation for ampere (see AMPERE).
AAAC—All-aluminum alloy conductor. A special high-strength aluminum alloy.
AAR—American Association of Railroads.
ABRASION RESISTANCE—Ability of a material to resist surface wear.
ABSORPTION—Physical phenomenon that attenuates light traveling in fibers by converting it into heat, thereby raising the fiber’s temperature. Absorption results from impurities and defects in the glass structure.
AB SWITCH—A coaxial cable switch capable of switching one cable to one of two branch cables, A or B.
AC—(1) Alternating current. (2) A UL cable type (armored cable) with flexible metal tape armor.
ACAR—Aluminum conductor, aluminum-reinforced cable. Used in overhead transmission and distribution.
ACCELERATED LIFE TEST—A test in which a cable is subjected to extreme conditions to determine the life of a cable.
ACCR—Aluminum conductor, composite reinforced aerial cable. Contains a ceramic strength member to reduce sag at high temperatures (up to 210°C).
ACRF—Attenuation to crosstalk ratio far-end. Communications cable specification. See ELFEXT.
ACSR—Aluminum conductor, steel reinforced. A bare composite of aluminum and steel wires, usually aluminum around steel.
ACSR/AW—Aluminum conductor, steel reinforced using aluminum clad steel wire.
ACSR/AZ—Aluminum conductor, steel reinforced using aluminum coated steel wire.
ACSR/GA—Aluminum conductor, steel reinforced using Class A zinc-coated steel wire.
ACSR/GB—Aluminum conductor, steel reinforced using Class B zinc-coated steel wire.
ACSR/GC—Aluminum conductor, steel reinforced, using Class C zinc-coated steel wire.
ACSS—Aluminum conductor steel supported. This transmission line has fully annealed aluminum for better sag and high-temperature performance than ACSR.
A/D CONVERTER—ANALOG/DIGITAL—An circuit device that converts analog signals to digital signals.
ADDRESS—The digital location of a terminal, a peripheral device, a node, or any other unit or component in a network, or process control system.
ADHESIVE-BONDED—Cables bonded by adding an adhesive coating to the surface of the cable components, then joining and curing the adhesive to form a cable. See BONDED CABLE.

ADMITTANCE—A measure of how easily alternating current flows in a circuit. Admittance is the reciprocal of impedance. It is expressed in mhos.
AEIC—Association of Edison Illuminating Companies. Electric energy industry association.
AERIAL CABLE—A cable suspended in the air on poles or other overhead structure.
AF—Audio frequency.
AFCI—Arc fault circuit interrupter. A protective device that detects arcing and breaks the circuit to protect the load when arcing is detected.
AGC—Automatic gain control. A feedback circuit that automatically adjusts the system gain.
AGING—The irreversible change of material properties after exposure to an environment for an interval of time.
AIA—Aluminum interlocked armor. A type of cable sheath consisting of interlocked pieces of aluminum armor.
AIR CORE CABLE—A cable in which the interstices in the cable core are not filled with a moisture barrier.
AIRCRAFT WIRE—An electrical wire primarily designed for the extreme conditions (temperature, altitude, solvents, fuels, etc.) of airborne equipment.
AIR SPACED COAX—A coaxial cable in which air is basically the dielectric material. The conductor may be centered by means of a spirally wound synthetic filament, beads or braided filaments. This construction is also referred to as an air dielectric.
AL—Aluminum
ALLOY—A substance (usually metallic) composed of two or more individual substances.
ALS—Aluminum sheathed. A type of cable consisting of insulated conductors enclosed in a continuous, closely fitting aluminum tube. Listed type in the Canadian Electric Code.
ALTERNATING CURRENT—Electric current that periodically reverses direction. Alternating current is generally abbreviated AC.
AM—Amplitude modulation. A method of adding information to an electronic signal where the amplitude of the wave is changed to convey the added information.
AMBIENT—Conditions existing at a location prior to energizing of equipment (example: ambient temperature).
AMPACITY—The rms current that a device can safely carry within specified temperature limitations in a specified environment: dependent upon a) temperature rating; b) power loss; c) heat dissipation; and d) applicable codes
AMPERE—A standard unit of current. Designated as the amount of current that flows when one volt of EMF (electromotive force) is applied across one ohm of resistance. An ampere of current is flowing when one coulomb of charge is passing a point every second.
AMPERE-TURN—The product of amperes times the number of turns in a coil.
AMPLIFIER—A device used to boost the strength of an electronic signal.
AMPLITUDE—The peak value of a electrical signal.
AMPLITUDE MODULATION (AM)—A method of adding information to an electronic signal where the amplitude of the wave is changed to convey the added information.
ANALOG—A continuously varying waveform that has not been digitized.

Glossary

ANNEAL—To soften and relieve strains in any solid material, such as metal or glass, by heating to just below its melting point and then slowly cooling it. This also generally lowers the tensile strength of the material, while improving its flex life.

ANNEALED WIRE—See SOFT WIRE.

ANNULAR CONDUCTOR—A number of wires stranded in reversed concentric layers around a core.

ANNUNCIATOR WIRE—Usually single solid copper, sometimes twisted pair or triplexed for open wiring of bell circuits and other low-voltage systems.

ANSI (American National Standards Institute)—A not-for-profit organization that publishes nationally recognized standards.

ANTENNA LEAD-IN WIRE—Not coaxial; parallel twin lead construction, plastic jacketed with fixed 300-ohm impedance for connecting a remote antenna to a receiver.

ANTENNA ROTOR CABLE—Multiconductor flat or round cable used to supply power to a motorized antenna and control wires for changing direction of rotation.

ANTIOXIDANT—Retards or prevents degradation of materials exposed to oxygen (air).

APPLIANCE WIRING MATERIALS (AWM)—A classification covering insulated wire and cable for internal wiring of appliances and equipment. UL 758 is the AWM standard. AWM comes in many different styles.

APPARENT POWER—The product of the voltage and amperage (VA) in a system. Wiring must be sized to handle the apparent power, and utilities charge extra for loads that require large amounts of reactive power. For this reason, large industrial loads are often power factor corrected using large capacitors to prevent drawing the reactive power needed from the utility distribution system, instead drawing from the capacitors and presenting a less reactive load to the grid.

ARAMID YARN—Strength elements that provide tensile strength, support and additional protection for fiber bundles. Kevlar is a brand name of aramid fiber.

ARC RESISTANCE—The ability of a material to resist the action of a high-voltage electrical arc, usually stated in terms of the time required to render the material electrically conductive.

ARMATURE—(1) Rotating machinery: the member in which alternating voltage is generated. (2) Electromagnet: the member which is moved by magnetic force.

ARMOR—Mechanical protector for cables; usually a helical winding of metal tape, formed so each convolution locks mechanically upon the previous one (interlocked armor); may be a formed metal tube (CCW) or a helical wrap of wires.

ARMOR-X—Southwire's trademark for CCW aluminum armor.

ARRHENIUS PLOT—A statistical method used to predict time-to-failure, based on a device's performance at different temperatures. One method for generating this plot is given in IEEE Standard 101.

ASCII—American National Standard Code for Information Interchange. A seven bit plus parity code established by the American National Standards Institute to achieve compatibility among data services and consisting of 96 displayed upper and lower case characters and 32 hidden control codes.

ASKAREL—Synthetic insulating oil that is nonflammable but very toxic. It has been replaced by silicone oils.

ASME—The American Society of Mechanical Engineering, a not-for-profit professional organization.

ASTM—American Society for Testing and Materials. An organization that sets standards on various material tests for industry.

ATTENUATION—The decrease in magnitude of a signal as it travels through any transmitting medium, such as a cable, circuitry or free air. Attenuation is measured as a ratio or as the logarithm of a ratio (decibel).

ATTENUATION CONSTANT—A rating for a cable or other transmitting medium, which is the relative rate of amplitude decrease of voltage or current in the direction of travel. It is measured in decibels per unit length of cable.

AUDIO—A term used to describe sounds within the range of human hearing. Also used to describe devices that are designed to operate within this range.

AUDIO FREQUENCY—The range of frequencies audible to the human ear. Usually 20–20,000 Hz.

AUI—Attachment unit interface. The interface between the Ethernet/IEEE 802.3 controller and the baseband transceiver or broadband modem.

AWG—American Wire Gauge. A common wire diameter specification.

AWM—Appliance Wiring Material. A UL 758 designation for a type of wire.

B

BACKBONE—The main portion of network cabling, connecting equipment rooms or communications closets. These cables often have the largest number of fibers and/or the longest continuous cable runs.

BACKFILL—The materials used to fill an excavation, such as sand in a trench.

BALANCED CIRCUIT—A circuit so arranged that the impressed voltages on each conductor of the pair are equal in magnitude but opposite in polarity with respect to ground.

BALANCED LINE—A cable having two identical conductors with the same electromagnetic characteristics in relation to other conductors and to ground.

BALLAST—A device designed to stabilize current flow.

BAND MARKING—A continuous circumferential band applied to a conductor at regular intervals for identification.

BANDWIDTH—The width of a communications channel, measured as frequency (in cycles per second, or hertz). A channel's bandwidth is a major factor in determining how much information it can carry.

BARE CONDUCTOR—A conductor having no insulation or jacket.

BARREL-PACKED—Method of coiling wire into a drum for shipment.

BASEBAND—A signaling technique in which the signal is transmitted in its original form and not changed by modulation.

BASEBAND LAN—A local area network employing baseband signaling.

BEDDING—A layer of material applied to a cable immediately below the armoring.

BELDFOIL—Belden trademark for a highly effective electrostatic shield using reinforced metallic foil.

BELT—Layers of insulation on a conductor, or layers of jacket on a cable.

BELTED-TYPE CABLE—Multiple conductor cable having a layer of insulation over the assembled insulated conductors.

BEND LOSS—A form of increased attenuation caused by (a) having an optical fiber curved around a restrictive radius of curvature or (b) micro bends caused by minute distortions in the fiber imposed by externally induced perturbations.

BENDING RADIUS—The radius of a circle that can be tightly fitted into the inside curvature of a bent wire or cable. Also, half the diameter of a drum around which a wire is wound. The manufacturer or industry standards specify the minimum bending radius for a cable.

BER—Bit error rate. The ratio of received bits that are in error, relative to a specific number of bits received; usually expressed as a number referenced to a negative power of 10.

BIL—Basic impulse level. The crest value of a lightning impulse voltage of a specified wave shape that a high-voltage cable or termination is required to withstand under specified conditions.

BIMETALLIC WIRE—A wire formed of two different metals joined together (not alloyed). It can include wire with a steel core, plated or coated wire.

BINDER—A tape or thread used for holding assembled cable components in place.

BINDING POST—A device for clamping or holding electrical conductors in a rigid position.

BIRDCAGE—The undesirable unwinding of a stranded cable.

BIT—Abbreviation for binary digit. A unit of information equal to one binary decision or the designation of one of two possible and equally likely states (such as 1 and 0) of anything used to store or convey information.

BITS PER SECOND (bps)—The number of bits of data transmitted through a digital process control cable in one second.

BNC—Common connector for coax. BNC is said to be an abbreviation for Bayonet-Neill-Concelman.

BONDED CABLE—Cable consisting of preinsulated conductors or multiconductor components laid in parallel and bonded into a flat cable.

BONDED CONSTRUCTION—An insulation construction in which the glass braid and nylon jacket are bonded together.

BONDING—The method used to produce good electrical contact between metallic parts of any device. Used extensively in automobiles and aircraft to prevent static buildup. Also refers to the connectors and straps used to ground equipment.

BOOSTER—A device inserted into a line (or cable) to increase the voltage. Boosting generators are also used to raise the level of a DC line. Transformers are usually employed to boost AC voltages. The term booster is also applied to antenna preamplifiers.

BOOT—(1) Protective coating over a cable, wire or connector in addition to the normal jacketing or insulation. (2) A form placed around the wire termination of a multicontact connector to contain the liquid potting compound before it hardens.

BORDER LIGHT CABLE—Same as stage cable but more than two conductors. Type SO cable is often used.

BORE HOLE CABLE—Power and/or communications cable suspended down a vertically drilled hole to equipment underground.

BRAID—Textile or metallic filaments interwoven to form a tubular structure that may be applied over one or more wires or flattened to form a strap.

BRAID ANGLE—The smaller of the angles formed by the shielding strand and the axis of the cable being shielded.

BRAID CARRIER—A spool or bobbin on a braiding machine that holds one group of strands or filaments consisting of a specific number of ends. The carrier revolves during braiding operations.

BRAID ENDS—The number of strands used to make up one carrier. The strands are wound side by side on the carrier bobbin and lie parallel in the finished braid.

BRAIDING MACHINE—Machine used to apply braids to wire and cable and to produce braided sleeving and braids for tying or lacing purposes. Braiding machines are identified by the number of carriers.

BRANCH JOINT—A cable joint used for connecting one or more cables to a main cable.

BRAZING—The joining of ends of two wires, rods, or groups of wires with nonferrous filler metal at temperatures above 800°F (427°C).

BREAKDOWN (PUNCTURE)—A disruptive discharge through insulation.

BREAKDOWN VOLTAGE—The voltage at which the insulation between two conductors breaks down and becomes conductive.

BREAKING STRENGTH—The maximum force that a conductor can withstand when tested under tension to rupture.

BREAKOUT—The point at which a conductor or group of conductors breaks out from a multiconductor cable to complete circuits at various points along the main cable.

BRIDGE—A circuit that measures by balancing four impedances through which the same current flows:

- Wheatstone measures resistance
- Kelvin measures low resistance
- Schering measures capacitance, dissipation factor, dielectric constant
- Wien measures capacitance, dissipation factor

BRIDGED TAP—Multiple appearances of the same cable pair at several distribution points (e.g., a telephone party line).

BRITISH STANDARD WIRE GAUGE—A modification of the Birmingham Wire Gauge and the legal standard of Great Britain for all wires. Also known as Standard Wire Gauge (SWG), New British Standard (NBS), English Legal Standard and Imperial Wire Guide.

BROADBAND LAN—LAN that uses FDM (frequency division multiplexing) to divide a single physical channel into a number of smaller independent frequency channels. The different channels created by FDM can be used to transfer different forms of information: voice, data and video.

BROADCAST—The act of sending a signal to all possible receivers in a system.

B and S—Brown and Sharpe wire gauge—same as AWG.

BSL (BASIC SWITCHING IMPULSE INSULATION LEVEL)—The crest value of a switching impulse voltage of a specified wave shape in which a high-voltage cable termination is required to withstand under specified conditions.

Glossary

BUFFER—A protective coating in intimate contact with an optical fiber.

BUFFER TUBE—A loose, crush-resistant polymer tube applied over optical fibers to provide mechanical protection.

BUILDING WIRE—Commercial wires used in the building trades because they are independently tested and listed in the National Electric Code, such as types RHH, RHW, THW and THHN wire.

BUNA—A synthetic rubber insulation of styrene butadiene; was known as GR-S, now known as SBR (Styrene Butadiene Rubber).

BUNCH STRAND—A conductor arrangement in which all individual wires are twisted in the same direction without regard for geometrical arrangement.

BUNCHER—A machine that twists wires together in a random arrangement.

BUOYANT CABLE—Originally military type MIL-C-2401 with built-in floatation ability. Many power and communications applications using numerous types and sizes have been developed using buoyancy.

BURIED CABLE—A cable installed directly in the earth without use of underground conduit. Also called “direct burial cable.”

BUS—A network topology in which a signal line is shared by a number of nodes using rules to control traffic on the bus.

BUS-BAR WIRE—Uninsulated tinned copper wire used as a common lead.

BUSHING—A mechanical device used as a lining for an opening to prevent abrasion to wire and cable.

BUTT SPLICE—A splice wherein two wire ends butt against each other, or against a stop, in the center of a splice.

BUTT WRAP—Tape wrapped around an object or conductor in an edge-to-edge condition.

BUTYL RUBBER—Synthetic rubber formerly used for electrical insulating purposes.

BX—A common type of armored building wire rated 600 volts.

BYTE—Generally, an 8-bit quantity of information, used mainly in referring to parallel data transfer, semiconductor capacity and data storage; also generally referred to in data communications as an octet or character.

C

C—Symbol for capacitance and Celsius.

CABLE—A cable may be a small number of large conductors or a large number of small conductors cabled together, usually color coded and with a protective overall jacket.

CABLE ASSEMBLY—A cable assembly is a cable with plugs or connectors on each end for a specific purpose. It may be formed in various configurations.

CABLE, BELTED—A multiconductor cable having a layer of insulation over the assembled insulated conductors.

CABLE CLAMP—A device used to give mechanical support to the wire bundle or cable at the rear of a plug or receptacle.

CABLE CLAMP ADAPTER—A mechanical adapter that attaches to the rear of a plug or receptacle to allow the attachment of a cable clamp.

CABLE CORE—The portion of an insulated cable lying under a protective covering.

CABLE CORE BINDER—A wrapping of tapes or cords around the conductors of a multiple-conductor cable used to hold them together.

CABLE FILLER—The material used in multiple-conductor cables to occupy the interstices formed by the assembly of the insulated conductors, thus forming a cable core.

CABLE JOINT—A completely insulated splice, or group of insulated splices, contained within a single protective covering or housing. In some designs, the insulating material may also serve as the protective covering.

CABLE LOSS—The amount of RF (radio frequency) signal attenuated by coaxial cable transmission. The cable attenuation is a function of frequency, media type and cable length. For coaxial cable, higher frequencies have greater loss than lower frequencies and follow a logarithmic function. Cable losses are usually calculated for the highest frequency carried on the cable.

CABLE, PRESSURIZED—A cable having a pressurized fluid (gas or oil) as part of the insulation; nitrogen and oil are the most common fluids.

CABLE SHEATH—The protective covering applied to cables.

CABLE SUPPORT—A device to mount a cable on a supporting member.

CABLING—The method by which a group of insulated conductors is mechanically assembled (or twisted together).

CAD—Computer-aided design.

CAM—Computer-aided manufacture.

CAPACITANCE—Capacitance is that property of a system of conductors and dielectrics that permits the storage of electricity when potential differences exist between the conductors.

CAPACITANCE, DIRECT—The capacitance measured from one conductor to another conductor through a single insulating layer.

CAPACITANCE, MUTUAL—The capacitance between two conductors (typically of a pair) with all other conductors, including shield, short circuited to ground.

CAPACITANCE, UNBALANCED—An inequality of capacitance between the wires of two or more pairs that result in a transfer of unwanted signal from one pair to others.

CAPACITANCE, UNBALANCED-TO-GROUND—An inequality of capacitance between the ground capacitance of the conductors of a pair, which results in a pickup of external noise energy, usually from power transmission lines.

CAPACITIVE COUPLING—Electrical interaction between two conductors caused by the potential difference between them.

CAPACITIVE REACTANCE—The opposition to alternating current due to the capacitance of a capacitor, cable or circuit. It is measured in ohms and is equal to $1/(2 \pi f C)$ where f is the frequency in Hz and C is the capacitance in farads.

CAPACITOR—Two conducting surfaces separated by a dielectric material. The capacitance is determined by the area of the surface, type of dielectric and spacing between the conducting surfaces.

CAPILLARY ACTION—Movement of a liquid along a small interstice due to surface tension.

CARRIER—(1) An AC electrical signal that is used to carry information. (2) The woven element of a braid consisting of one or more ends (strands) which creates the interlaced effect. (3) A spindle, spool, tube, or bobbin (on a braiding machine) containing yarn or wire, employed as a braid.

CATHODE—(1) The negative electrode through which current leaves a nonmetallic conductor, such as an electrolytic cell. (2) The positive pole of a storage battery.

CATHODIC PROTECTION—Reduction or prevention of corrosion by making the metal to be protected the cathode in a direct current circuit.

CATV—Community Antenna Television. Refers to the use of a coaxial or fiber cable to transmit television or other signals to subscribers from a single head-end location.

CATV CABLE—General term for all cables used for community antenna TV service and feeders, distribution and house drops.

CB—Citizens band. A type of two-way radio communication.

C CONDITIONING—A type of line conditioning that controls attenuation, distortion and delay distortion to within specific limits.

C CONNECTOR—A bayonet-locking connector for coax; C is named after Carl Concelman.

CCTV—Closed-circuit television. One of the services often found on broadband networks.

CCW—Continuously corrugated and welded. A type of cable armor.

CD—Carrier detect. An RS-232 control signal (on Pin 8) that indicates that the local modem is receiving a signal from the remote modem. Also called received line signal detector (RLSD) and data carrier detect (DCD).

GENELEC—Comité Européen de Normalisation Electrotechnique. One of the European Union's key electrical standards bodies.

CELLULAR POLYETHYLENE—Expanded or "foam" polyethylene, consisting of individual closed cells of inert gas suspended in a polyethylene medium, resulting in a desirable reduction of dielectric constant.

CERTIFICATE OF COMPLIANCE—A written statement normally generated by a quality control department that states that the product being shipped meets a particular specification.

CERTIFIED TEST REPORT (CTR)—A report reflecting actual test data on the cable shipped. Tests are normally conducted by the quality control department and show that the product being shipped meets the required test specifications.

CFR—Code of Federal Regulations.

CHANNEL—(1) A path for electrical transmission. Also called a circuit facility, line, link or path. (2) A specific and discrete bandwidth allocation in the radio frequency spectrum (for example, in a broadband LAN) used to transmit one information signal at a time.

CHANNEL TRANSLATOR—Device used in broadband LANs to increase carrier frequency, converting upstream (toward the head-end) signals into downstream signals (away from the head-end).

CHARACTERISTIC IMPEDANCE—An electrical characteristic of transmission lines. When terminated in its characteristic impedance, reflections from the end of a line are minimized.

CHEMICAL STRIPPING—Removal of insulation by chemical means.

CHLOROSULFONATED POLYETHYLENE (CSP)—A rubbery polymer used for insulations and jackets. Previously manufactured by E.I. DuPont under the trade name of Hypalon.

CI CABLE—Circuit Integrity cable. An optional rating for UL Listed cable types that meet the two-hour fire survival requirements of UL Standard 2196, e.g., FPLP-CI.

CIC CABLE—Circuit Integrity in Conduit cable. A generic term for cables that meet the two-hour fire survival requirements of UL Standard 2196 when installed in metallic conduit per UL category FHIT.

CIGARETTE WRAP—Tape insulation wrapped longitudinally instead of spirally over a conductor.

CIRCUIT SWITCHING—A switching technique in which an information path (i.e., circuit) between calling and receiving stations is established on demand for exclusive use by the connected parties until the connection is released.

CIRCUIT TRACING—Locating or identifying a specific conductive path.

CIRCULAR MIL (CM)—A term universally used to define cross-sectional areas of conductors. It is an area equal to the area of a circle 1/1000 of an inch in diameter. As the number of circular mils increase, the size of a wire increases.

CLAD WIRE—Different from coated wire, clad wire is any metal covered with a relatively heavy coating of different metal, such as copperweld (copper over steel) or alum-o-weld (aluminum over steel). See COATED WIRE.

CLOSED CELL—Foamed or cellular material with intact cell walls, usually filled with air. Generally harder, better insulating, but more expensive than open cell material.

COATED WIRE—Any metal covered by a relatively thin coating of a different metal such as tin, zinc or other alloy by a dip bath and wipe process, often at high speeds in line with insulating equipment. See TINNED WIRE.

COAXIAL CABLE—A cylindrical transmission line comprised of a conductor centered inside a metallic tube or shield, separated by a dielectric material and usually covered by an insulating jacket.

COHERENT SOURCE—A fiber optic light source that emits a very narrow, unidirectional beam of light of one wavelength (monochromatic).

COIL EFFECT—The inductive effect exhibited by a spiral wrapped shield, especially above audio frequencies.

COLD BEND—Generally refers to a test to determine cable or wire characteristics at low temperatures. The test specimen is cooled in a low-temperature box to a specified temperature. The wire specimen is then wound around a mandrel after which it is examined for cracks or other defects caused by bending at low temperatures.

COLD-DRAWING—Reducing the cross section by pulling through a die or dies, at a temperature lower than the recrystallization temperature.

COLD FLOW—Permanent deformation of the insulation due to mechanical pressure (not due to heat softening).

COLOR CODE—A color system for wire or circuit identification by use of solid colors, tracers, braids, surface printing, etc.

Glossary

COMBINATION STRANDED CONDUCTOR—A conventional concentric conductor in which the wires in the outer layer are larger in diameter than the wires in the inner layer or layers and the diameters of all wires are within plus and minus 5 percent of the nominal wire diameter for the same size noncombination stranded conductor.

COMMON AXIS CABLING—In multiconductor constructions, a twisting of all conductors about a “common axis” to result in smaller diameter constructions. Tends to result in greater susceptibility to electromagnetic and electrostatic interference.

COMMON MODE NOISE—Noise caused by a difference in ground potential. By grounding at either end rather than both ends (usually grounded at source) one can reduce this interference.

COMPACT STRANDED CONDUCTOR—A unidirectional or conventional concentric conductor manufactured to a specified diameter, approximately 8 to 10 percent below the nominal diameter of a noncompact conductor of the same cross-sectional area.

COMPOSITE CABLE—A cable containing more than one gauge size or a variety of circuit types, e.g., pairs, triples, quads, coaxials, etc.

COMPOSITE (CLAD) WIRE—A wire having a core of one metal with a fused outer shell of a different metal.

COMPOSITE CONDUCTOR—A conductor consisting of two or more types of wire, each type of wire being plain, clad, or coated-stranded together to operate mechanically and electrically as a single conductor.

COMPRESSED STRANDED CONDUCTOR—A conventional concentric conductor manufactured to a diameter not more than 3 percent below the nominal diameter of a noncompressed conductor of the same cross-sectional area.

COMPRESSION LUG OR SPLICE—A connection installed by compressing the connector onto the strand, ideally creating a cold weld.

CONCENTRICITY—The measurement of the location of the center of the conductor with respect to the geometric center of the circular insulation.

CONCENTRIC-LAY CONDUCTOR—A layer of uninsulated wires twisted around a central wire with subsequent layers spirally wrapped around the inner layers to form a single conductor.

CONDUCTANCE—The ability of a conductor to carry an electric charge. The ratio of the current flow to the potential difference causing the flow. The reciprocal of resistance.

CONDUCTIVITY—Capacity of a material to carry electrical current—usually expressed as a percentage of copper conductivity (copper being 100 percent).

CONDUCTOR—A material suitable for carrying an electric current. Several types are as follows:

COMPACT ROUND CONDUCTOR—A conductor constructed with a central wire surrounded by one or more preshaped (nonround) helically-laid wires and formed into final shape by rolling, drawing or other means.

CONCENTRIC-LAY CONDUCTOR—A conductor constructed with a central wire surrounded by one or more layers of helically-laid wires.

CONVENTIONAL CONCENTRIC CONDUCTOR—A conductor constructed with a central wire surrounded by one or more layers of helically-laid wires. The direction of lay is reversed in successive layers and generally with an increase in length of lay for successive layers.

EQUILAY CONDUCTOR—A conductor constructed with a central wire surrounded by more than one layer of helically-laid wires, all layers having a common length of lay, direction of lay being reversed in successive layers.

PARALLEL CORE CONDUCTOR—A conductor constructed with a central core of parallel-laid wires surrounded by one layer of helically-laid wires.

ROPE-LAY CONDUCTOR—A conductor constructed of a bunch-stranded or a concentric-stranded member or members, as a central wire, around which are laid one or more helical layers of such members.

UNIDIRECTIONAL CONDUCTOR—A conductor constructed with a central wire surrounded by more than one layer of helically-laid wires, all layers having a common direction of lay, with increase in length of lay for each successive layer.

UNILAY CONDUCTOR—A conductor constructed with a central wire surrounded by more than one layer of helically-laid wires, all layers having a common length and direction of lay.

CONDUCTOR CORE—The center strand or member about which one or more layers of wires or members are laid helically to form a concentric-lay or rope-lay conductor.

CONDUCTOR SHIELD—A conducting layer applied to make the conductor a smooth surface in intimate contact with the insulation; sometimes called Extruded Strand Shield (ESS).

CONDUIT—A tube or trough for protecting electrical wires or cables. Also referred to as raceway.

CONNECTION, DELTA—Interconnection of three electrical equipment windings in a DELTA (triangular) configuration.

CONNECTION, WYE—Interconnection of three electrical equipment windings in WYE (star) configuration.

CONNECTOR—A metallic device of suitable electric conductance and mechanical strength, used to splice the ends of two or more cable conductors, or as a terminal connector on a single conductor. Conductors are sometimes spliced without connectors, by soldering, brazing, or welding. Connectors usually fall into one of the following types:

- Solder
- Welded
- Mechanical
- Compression or indent

CONTACT—The part of a connector that carries the electrical current.

CONTACT SIZE—The largest size wire that can be used with the specific contact. Also, the diameter of the engagement end of the pin.

CONTINUITY CHECK—A test performed on a length of finished wire or cable to determine if an electrical current flows.

CONTINUOUS VULCANIZATION—Simultaneous extrusion and vulcanization (cross-linking) of wire insulating and jacketing materials. Also referred to as CV cured.

CONTRAHELICAL—Wire strands spiraling in an opposite direction than the preceding layer within a wire or cable.

CONTROL CABLE—A cable used for remote control operation of any type of electrical power equipment.

CONTROLLED IMPEDANCE CABLE—A package of two or more insulated conductors where impedance measurements between respective conductors are kept essentially constant throughout the entire length.

COPOLYMER—A compound resulting from the polymerization of two different monomers.

COPPER-CLAD STEEL—Steel with a coating of copper welded to it before drawing as opposed to copper-plated. Synonymous with Copperweld.

COPPERWELD—Trademark of Copperweld Steel Co. for copper-clad steel conductor.

CORD—A flexible insulated cable.

CORD SET—Portable cords fitted with a connector at one or both ends.

CORE—(1) In cables, a component or assembly of components over which other materials are applied, such as additional components, shield, sheath or armor. (2) In fiber optics, the transparent glass or plastic section with a high refractive index through which the light travels by internal reflections.

CORONA—A discharge due to ionization of the air around a conductor due to a potential gradient exceeding a certain critical value. See PARTIAL DISCHARGE.

CORONA RESISTANCE—The time that the insulation will withstand a specified level of ionization that does not result in the complete breakdown of the insulation.

CORROSION—The destruction of the surface of a metal by chemical reaction.

COULOMB—The derived SI unit for quantity of electricity or electrical charge: one coulomb equals one ampere-second.

COUNTER EMF—The voltage opposing the applied voltage and the current in a coil; caused by a flow of current in the coil; also known as back EMF.

COUNTERPOISE WIRE—Bare copper wire used to offset the impact of lightning surges along high-voltage overhead lines and around the base of towers. Buried counterpoise wire is connected to overhead ground wires and towers. Numerous methods of application are used, dependent upon resistance of the soil at the tower base.

COUPLING—The transfer of energy between two or more cables or components of a circuit.

COUPLING LOSS—Signal losses in an optical fiber due to small differences in numerical aperture, core diameter, core concentricity and tolerances in connectors when two fibers are spliced together. Also known as splicing loss and transfer loss.

COVERAGE—The calculated percentage that defines the completeness with which a metal braid covers the underlying surface. The higher percentage of coverage, the greater the protection against external interference.

CPE—Chlorinated polyethylene. A jacketing compound sold by Dow Chemical under the trademark Tyrin.

CROSS-LINKED—Intermolecular bonds created between long-chain thermoplastic polymers by chemical or electron bombardment means. The properties of the resulting thermosetting material are usually improved.

CROSS-LINKED POLYETHYLENE—A dielectric material used for insulating and jacketing. Also referred to as “XLP” or “XLPE.”

CROSSTALK—A type of interference caused by audio frequencies from one circuit being coupled into an adjacent circuit. The term is loosely used to also include coupling at higher frequencies.

CRT—Cathode-ray tube. A television-like picture tube used in terminals; CRT is commonly used as a synonym for the CRT terminal.

CRT WIRE—High-voltage lead wire for energizing cathode-ray tubes.

CSA (CANADIAN STANDARDS ASSOCIATION)—Standards body for Canada, similar to UL in the United States.

CSA Certified—A product that has been tested and found to comply with applicable Canadian standards.

CSPE—A jacketing compound based on DuPont’s chlorosulfonated polyethylene (Hypalon). Sometimes abbreviated CSP.

CT—Cable Tray, from NEC Article 392. A cable marking that indicates a cable is suitable for use in a cable tray.

CURE—To change the properties of a polymeric material into a more stable, usable condition by the use of heat, radiation or reaction with chemical additives.

CURING CYCLE—The time, temperature and pressure required for curing.

CURL—The degree to which a wire tends to form a circle after removal from a spool.

CURRENT—The rate of transfer of electricity. The unit of current is the ampere, a rate of one coulomb/second.

CURRENT, ALTERNATING (AC)—An electric current that periodically reverses direction of electron flow. The number of cycles in a given unit of time (generally a second) is called the frequency of the current.

CURRENT CARRYING CAPACITY—The maximum current an insulated conductor can safely carry without exceeding its insulation and jacket temperature limitations. Same as ampacity.

CURRENT, CHARGING—The current needed to bring the cable up to voltage; determined by the capacitance of the cable. The charging current will be 90° out of phase with the voltage.

CURRENT DENSITY—The current per cross sectional area. Usually in units of amperes/square meter.

CURRENT, DIRECT (DC)—Electrical current whose electrons flow in one direction only. It may be constant or pulsating as long as their movement is in the same direction.

CUT-THROUGH RESISTANCE—The ability of a material to withstand mechanical pressure without damage.

CV—Continuous vulcanization. An insulation and jacketing curing process.

CYCLE—The complete sequence, including reversal of the flow, of an alternating electric current.

D

D/A—Digital to analog.

DAC—Digital to analog converter. A device that converts a digital input signal to an analog output signal carrying equivalent information.

DATA—Digitally represented information including voice, text, images and video.

dB—Decibel. The standard unit used to express the relative strength of two signals. When referring to a single signal measured at two places in a transmission system, it expresses either a gain or loss in power between the input and output devices.

Glossary

dBmV—Decibel millivolt. The level at any point in a system expressed in dBs above or below a 1 millivolt/75 ohm standard is said to be the level in decibel-millivolts or dBmV. Zero dBmV is equal to 1 millivolt across an impedance of 75 ohms.

DC—Direct current. (see CURRENT, DIRECT.)

DCE—Data communications equipment. In common usage, synonymous with modem; the equipment that provides the functions required to establish, maintain and terminate a connection as well as the signal conversion required for communications between the DTE and the telephone line or data circuit.

DCL—Data carrier level.

DC RESISTANCE—See RESISTANCE.

DCS—Distributed control system. A type of industrial automation system in which the processors are distributed in various locations though out the facility.

DecaBDE—Decabromodiphenyl ether. A type of brominated flame retardant sometimes used in wire and cable and other products. A type of polybrominated diphenyl ether (PBDE).

DELAY SKEW—The difference between the propagation delay of any two pairs within the same cable sheath. Delay skew is caused primarily because twisted pairs are designed to have different twists per foot (lay lengths). Delay skew could cause data transmitted over one channel to arrive out of sync with data over another channel.

DEMAND—(1) The measure of the maximum load of a utility's customer over a short period of time. (2) The load integrated over a specified time interval.

DERATING FACTOR—A factor used to reduce the current carrying capacity of a wire when used in environments other than that for which the value was established.

DETECTOR—A fiber optic device that picks up light from the fiber and converts the information into an electrical signal.

DIELECTRIC—An insulating (nonconducting) medium.

DIELECTRIC BREAKDOWN—Any change in the properties of a dielectric that causes it to become conductive. Normally the failure of an insulation because of excessive voltage.

DIELECTRIC CONSTANT—The property of an insulation which determines the electrostatic energy stored per unit volume for unit potential gradient. It is expressed as a ratio. "K" for air is 1.0, while that for polyethylene is 2.3. Therefore, the capacitance of polyethylene is 2.3 times that of air. It is also referred to as specific inductive capacity or permittivity.

DIELECTRIC DISPERSION—The change in relative capacitance due to a change in frequency.

DIELECTRIC HEATING—The heating of an insulating material when placed in a radio-frequency field, caused by internal losses during the rapid polarization reversal of molecules in the material.

DIELECTRIC LOSS—The power dissipated in a dielectric as the result of the friction produced by molecular motion when an alternating electric field is applied.

DIELECTRIC STRENGTH—The maximum voltage that an insulation can withstand without breaking down; usually expressed as a gradient in V/mil (volts per mil). Polyethylene for example has a dielectric strength of about 800 V/mil.

DIELECTRIC STRENGTH TESTING—A common test performed on electrical products that is often called hi-pot testing. A voltage higher than normal operating voltage is applied across the insulation. This test can increase product reliability by detecting faulty workmanship.

DIGITAL—Refers to communications procedures, techniques and equipment by which information is encoded as either a binary "1" or "0"; the representation of information in discrete binary form, discontinuous in time, as opposed to the analog representation of information in variable, but continuous, waveforms.

DIN—Deutsches Institut für Normung (DIN), German standards body.

DIP COATING—An insulating coating applied to the conductor by passing the conductor through an applicator containing liquid insulating medium.

DIRECT BURIAL CABLE—A cable installed directly in the earth.

DIRECT CAPACITANCE—The capacitance measured directly from conductor to conductor through a single insulating layer.

DIRECTIONAL COUPLER—A passive device used in a cable system to divide or combine unidirectional RF power sources.

DIRECTION OF LAY—The lateral direction, designated as left-hand or right-hand, in which the wires of a conductor run over the top of the conductor as they recede from an observer looking along the axis of the conductor.

DISPERSION—The variation of the refractive index of an optical fiber with wavelength, causing light of different wavelengths to travel at different velocities in the fiber.

DISSIPATION FACTOR—Energy lost when voltage is applied across an insulation. The cotangent of the phase angle between voltage and current in a reactive component. Dissipation factor is quite sensitive to contamination and deterioration of insulation. Also known as power factor.

DISTORTION FACTOR—An undesirable change in waveform as a signal passes through a device.

DISTRIBUTION CABLE—(1) In a CATV system, the transmission cable from the distribution amplifier to the drop cable. (2) In an electric power system, provides low-voltage service to the customer.

DISTURBED CONDUCTOR—A conductor that receives energy generated by the field of another conductor or an external source such as a transformer.

DISTURBING CONDUCTOR—A conductor carrying energy whose field(s) create spurious energy in another conductor.

DOWNLOAD—The process of loading software into the nodes of a network from one node or device over the network media.

DRAIN WIRE—An uninsulated wire in contact with a shield throughout its length, used for terminating the shield.

DRAWING—In wire manufacturing, pulling the metal through a die or series of dies to reduce diameter to a specified size.

DROP CABLE—In a CATV system, the transmission cable from the distribution cable to a dwelling.

DSR—Data Set Ready. One of the control signals on a standard RS-232-C connector. It indicates whether the data communications equipment is connected and ready to start handshaking control signals so that transmission can start.

DTE—Data terminal equipment.

DTR—Data terminal ready. An RS-232 modem interface control signal (sent from the DTE to the modem on pin 20) that indicates that the DTE is ready for data transmission and which requests that the modem be connected to the telephone circuit.

DUAL CABLE—A two-cable system in broadband LANs in which coaxial cables provides two physical paths for transmission, one for transmit and one for receive, instead of dividing the capacity of a single cable.

DUCT—An underground or overhead tube for carrying electrical conductors.

DUOFOIL—Belden trademark for a shield in which metallic foil is applied to both sides of a supporting plastic film.

DUPLEX—Two-way data transmission on a four-wire transmission cable.

DUPLEX CABLE—A cable composed of two insulated single conductor cables twisted together.

E

E—(1) Symbol for voltage. Usually used to represent direct voltage or the effective (root-mean-square) value of an alternating voltage. (2) A UL cable type. Elevator lighting and control cable.

EARTH—British terminology for zero-reference ground.

ECCENTRICITY—Like concentricity, a measure of the center of a conductor's location with respect to the circular cross section of the insulation. Expressed as a percentage of displacement of one circle within the other.

ECTFE—Ethylene chlorotrifluoroethylene. Halar is a Solvay Solexis trademark for this material. Used as an insulation or jacketing material.

EDDY CURRENT—Circulating currents induced in conducting materials by varying magnetic fields.

ELASTOMER—Any material that will return to its original dimensions after being stretched or distorted.

ELECTROMAGNET—A device consisting of a ferromagnetic core and a coil that produces appreciable magnetic effects only when an electric current exists in the coil.

ELECTROMAGNETIC—Referring to the combined electric and magnetic fields caused by electron motion through conductors.

ELECTROMAGNETIC COUPLING—The transfer of energy by means of a varying magnetic field. Inductive coupling.

ELECTRO-MECHANICAL CABLES—Dual purpose composite cables made up of support strands capable of supporting predetermined loads together with communication, coaxial, or power as integral members of a finished cable.

ELECTROMOTIVE FORCE (EMF)—Pressure or voltage. The force that causes current to flow in a circuit.

ELECTRON—An elementary particle containing the smallest negative electric charge; charge = 0.16 attocoulomb. Diameter = 1 femtometer.

ELECTRON VOLT—A measure of the energy gained by an electron passing through an electric field produced by one volt.

ELECTRONIC WIRE AND CABLE—Wire or cable used in electronic applications.

ELECTRO-OSMOSIS—The movement of fluids through dielectrics because of electric current.

ELECTROSTATIC—Pertaining to static electricity, or electricity at rest. A static electric charge, for example.

ELECTROSTATIC COUPLING—The transfer of energy by means of a varying electrostatic field. Capacitive coupling.

ELECTROSTATIC DISCHARGE (ESD)—An instantaneous flow of an electrical charge on a nonconductor through a conductor to ground.

ELECTRO-TINNED—Electrolytic process of tinning wire using pure tin.

ELEXAR—Shell trademark for a thermoplastic elastomer (TPE).

ELFEXT—Equal-level far-end crosstalk. A measure of the unwanted signal coupling from a transmitter at the near-end into a neighboring pair measured at the far-end, relative to the received signal level measured on that same pair. Referred to as ACR-F (insertion loss to crosstalk ratio far-end) in the ANSI/TIA-568-B.2-Addendum 10 draft. (ELFEXT is FEXT adjusted to discount insertion loss.)

ELONGATION—The fractional increase in the length of a material stressed in tension.

EMA—Electrical moisture absorption. A water tank test during which sample cables are subjected to voltage and water maintained at rated temperature; the immersion time is long, with the object being to accelerate failure due to moisture in the insulation; simulates buried cable.

EMBOSSING—Identification by means of thermal indentation that leaves raised lettering on the sheath material of cable.

EMERGENCY OVERLOAD—A situation in which larger than normal currents are carried through a cable or wire for a limited period of time.

EMF—Electromotive force. A force that tends to cause electrons to flow. SI unit is the volt.

EMI—Electromagnetic interference. External signals that disrupt the data being transmitted on the local area network or electronic device being operated. Typically, these external signals emanate from universal motors with brushes, fluorescent lights, personal computers, printers or other devices using nonlinear, switch-mode power supplies, etc. The Federal Communications Commission (FCC) regulates these emissions in the U.S.

ENDOSMOSIS—The penetration of water into a cable by osmosis; aggravated and accelerated by DC voltage on the cable.

ENDS—In braiding, the number of essentially parallel wires or threads on a carrier.

ENERGIZE—To apply voltage to a circuit or device in order to activate it.

EO—A UL cable type. Elevator lighting and control cable with thermoset insulation.

EOT—End of transmission character. A transmission control character used to indicate the end of transmission, which may include one or more texts and any associated message headings.

Glossary

EP, EPR, EPM, EPDM—E-ethylene, P-propylene, M-monomer, D-diene. Designations for a synthetic rubber based upon the hydrocarbon ethylene propylene.

EPA—Environmental Protection Agency. The federal regulatory agency responsible for keeping and improving the quality of our living environment—mainly air and water.

EPDM—Ethylene propylene diene monomer.

EPROM—Erasable programmable read only memory.

EPR—Ethylene propylene rubber.

EQUILAY CONDUCTOR—See CONCENTRIC-LAY CONDUCTOR.

ER RATED—Exposed Run. An optional UL rating on UL Listed cable Types TC, ITC and PLTC that meet the same crush and impact requirements as metal clad (Type MC) cables. Formerly called Open Wiring rated. Permits exposed runs between cable tray and utilization equipment.

ET—A UL cable type. Elevator lighting and control cable with thermoplastic insulation, three braids, flame-retardant and moisture-retardant finish. May have steel supporting strand in the center, 300 V.

ETCHED WIRE—A process applied to Teflon wire in which the wire is passed through a sodium bath to create a rough surface to allow epoxy resin to bond to the Teflon.

ETFE—Ethylene tetrafluoroethylene. Tefzel is DuPont's trademark for this material.

ETHERNET—A baseband frame-based networking local area network (LAN) communication standard. Standardized as IEEE 802.3. One of the dominant LAN technologies.

ETL—Electrical Testing Laboratories, Inc. An independent testing laboratory that performs testing, similar to UL.

ETPC—Abbreviation for electrolytic tough pitch copper. It has a minimum conductivity of 99.9 percent.

EVA—Ethylene vinyl acetate. A polymer often used for the jacket in low smoke, zero halogen, flame retardant cables. Often referred to as a polyolefin.

EXIT ANGLE—The angle between the output radiation vectors and the axis of the fiber or fiber bundle.

EXPANDED DIAMETER—Diameter of shrink tubing as supplied. When heated the tubing will shrink to its extruded diameter.

EXTERNAL WIRING—Electronic wiring that interconnects subsystems within the system.

EXTRUDED CABLE—Cable that is insulated by applying insulation material in a continuous extrusion process.

EXTRUSION—A method of applying insulation to a conductor or jacketing to a cable. The process is continuous and uses rubber, neoprene or a variety of plastic compounds.

F

FACSIMILE—The remote reproduction of graphic material; an exact copy.

FARAD—A unit of capacitance when a difference of potential of 1 volt produces a displacement of one coulomb in a capacitor. The farad is a very large unit and much smaller units, like the microfarad (μF) or picofarad (pF) are more commonly used.

FATIGUE RESISTANCE—Resistance to metal crystallization, which leads to conductors or wires breaking during flexing.

FAULT, GROUND—A fault to ground.

FCC—Federal Communications Commission.

FDI (Fiber Distributed Data Interface)—An ANSI-defined token-passing ring using fiber optic media to attain a 100 Mbps transmission rate.

FDX—Full duplex. Transmission in two directions simultaneously, or, more technically, bidirectional simultaneous two-way communications.

FEF—Fluorinated ethylene propylene. Teflon is DuPont's trademark for this material.

FEFB—A UL cable type. Fluorinated ethylene propylene insulated wire with glass braid. 14 AWG to 2 AWG, 90°C dry/damp or 200°C dry maximum operating temperature.

FEXT—Far-end crosstalk. A measure of the unwanted signal coupling from a transmitter at the near-end into a neighboring pair measured at the far-end.

FFH-2—A UL type of heat-resistant rubber-covered fixture wire with flexible stranding. 600 V rating, 18 AWG–16 AWG, 75°C maximum operating temperature.

FIBER DISPERSION—Pulse spreading in an optical fiber caused by differing transit times of various modes (a mode is one ray of light).

FIBER OPTICS—Transmission of energy by light through glass fibers. A technology that uses light as an information carrier. Fiber optic cables (light guides) are a direct replacement for conventional cable and wire pairs. The glass-based transmission cable occupies far less physical volume for an equivalent transmission capacity; the fibers are immune to electrical interference.

FIBER TUBING—A loose, crush-resistant cylinder applied over individual fibers to provide mechanical protection. Also called a buffer tube.

FIELD COIL—A suitable insulated winding mounted on a field pole to magnetize it.

FIELD MOLDED SPLICE—A joint in which the solid dielectric joint insulation is fused and cured thermally at the job site.

FIELD TESTS—Tests that may be made on a cable system after installation as an acceptance or proof test. Various standards with test recommendations exist, like IEEE 400.

FIGURE 8 CABLE—An aerial cable configuration in which the conductors and the steel strands that supports the cable are integrally jacketed. A cross section of the finished cable approximates the figure "eight."

FILLED CABLE—A cable construction in which the cable core is filled with a material that will prevent moisture from entering or passing through the cable.

FILLER—Fillers are used in multiconductor cables that occupy the interstices formed by the assembled conductors. This is done so that the finished cable will be round.

FILLING COMPOUND—A dielectric material poured or injected into a splice housing or cable to prevent the entry of water. Filling compounds may require heating or mixing prior to filling. Some filling compounds may also serve as the insulation.

FINE STRANDED WIRE—Stranded wire with component strands of 36 AWG or smaller.

FLAME RESISTANCE—The ability of a material to not propagate flame once the heat source is removed.

FLAMMABILITY—The measure of a material's ability to support combustion.

FLASHOVER—A disruptive discharge around or over the surface of a solid or liquid insulator.

FLAT BRAID—A woven braid of tinned copper strands rolled flat at the time of manufacture to a specified width.

FLAT CABLE—A cable with two essentially flat surfaces.

FLAT CONDUCTOR—A wire having a rectangular cross section as opposed to a round or square conductor.

FLEX-LIFE—The measurement of the ability of a conductor or cable to withstand repeated bending, usually specified as expected total number of cycles before failure.

FLEXIBILITY—The ease with which a cable may be bent. In general, finer stranding gives greater flexibility. Various types of cables are available depending on the type of flexing required.

FLEXIBLE—That quality of a cable or cable component that allows for bending under the influence of an outside force, as opposed to limpness that is bending due to the cable's own weight.

FLOATING—Refers to a circuit that has no electrical connection to ground.

FLUOROPOLYMER—A class of polymers used as insulating and jacketing materials. Common ones include Teflon, Tefzel, Kynar and Halar.

FLUX—(1) The lines of force which make up an electrostatic field. (2) The rate of flow of energy across or through a surface. (3) A substance used to promote or facilitate fusion, commonly used in soldering.

FM—Frequency modulation. A modulation technique in which the carrier frequency is shifted by an amount proportional to the value of the modulating signal. The deviation of the carrier frequency determines the signal content of the message.

FOAMED INSULATION—Insulations having a cellular structure.

FOIL—A thin, continuous sheet of metal. Often used as a shield material in cables.

FREQUENCY—The number of cycles per second at which an (electrical) event occurs, expressed in hertz (Hz). One hertz is one cycle per second.

FREQUENCY ANALYZER—An instrument to measure the intensity of various component frequencies from a transmitting source. Also referred to as a spectrum analyzer.

FREQUENCY COUNTER—An electronic measuring instrument that precisely counts the number of cycles of a periodic electrical signal during a given time interval.

FREQUENCY MODULATION (FM)—Method of encoding a carrier wave by varying the frequency of the transmitted signal.

FREQUENCY PLAN—Specification of how the various frequencies available in a communications system are allocated for use. In the U.S. the FCC defines uses for various frequency bands.

"F" TYPE CONNECTOR—A low-cost connector used by the TV industry to connect coaxial cable to equipment. Used up to 1 GHz.

FULL DUPLEX—Two-way communications in which each modem simultaneously sends and receives data at the same rate.

FUSE WIRE—Wire made from an alloy that melts at a relatively low temperature to open a circuit when over-current conditions occur.

FUSED COATING—A metallic coating that has been melted and solidified, forming a metallurgical bond to the base material.

FUSED CONDUCTORS—Individual strands of heavily tinned copper wire stranded together and then bonded together by induction heating.

FUSED SPIRAL TAPE—A PTFE insulation often used on hook-up wire. The spiral wrapped tape is passed through a sintering oven where the overlaps are fused together.

G

G—A UL portable power cable type with thermoset insulation and thermoset fiber reinforced oil-resistant jacket. Two to five #8 AWG or larger conductors with ground wires. Rated 2,000 V, 60°C maximum operating temperature when exposed to oil, 90°C maximum dry.

GALVANIZED STEEL WIRE—Steel wire coated with zinc.

GANG STRIP—Stripping all or several conductors simultaneously.

GAS FILLED CABLE—A self-contained pressurized cable in which the pressure medium is an inert gas having access to the insulation.

GAUGE—A term used to denote the physical size of a wire. See AWG.

GAUSS—A unit of magnetic induction (flux density) equal to 1 Maxwell per square centimeter.

GENERAL PURPOSE INSTRUMENTATION BUS (GPIB)—A protocol standard defined by the IEEE. Often used on automated test and measurement equipment in manufacturing environments.

GFCI—Ground fault circuit interrupter. A protective device that detects abnormal current flowing to ground and then interrupts the circuit. Required by the NEC for some installations.

G-GC—A UL cable type. A portable power cable similar to Type G, but also having a ground check (GC) conductor to monitor the continuity of the grounding circuit.

GHz—Gigahertz frequency: 1,000,000,000 cycles per second.

GIGA—A numerical prefix denoting one billion (10^9).

GLAND—A device used to terminate, seal and/or ground the metallic armor of a cable as it enters a metal enclosure. Sometimes called a fitting or a connector.

GND—Common abbreviation for ground.

GREEN GOOP—A viscous liquid that occasionally oozes from the end of installed PVC cables after many years in service. Generally found to be plasticizer (a component of PVC) contaminated with a copper compound that is green in color.

GROUND—A voltage reference point that can be the same as earth or chassis ground.

Glossary

GROUND CHECK CONDUCTOR (GC)—An insulated conductor commonly used in mining cables to monitor the health of the grounding conductor(s) in the cable.

GROUND CONDUCTOR—A conductor in a transmission cable or line that is grounded.

GROUND FAULT—A type of electrical failure in which current flows to ground.

GROUND LOOP—The generation of undesirable current flow within a ground conductor, owing to the circulation currents which originate from a second source of voltage.

GROUND PLANE—Expanded copper mesh that is laminated into some flat cable constructions as a shield.

GROUND POTENTIAL—Zero potential with respect to the ground or earth.

GROUNDING NEUTRAL—The neutral wire that is metallically connected to ground.

GTO—Gas tube sign cable, UL Listed as single conductor Type GTO-5 (5,000 V), GTO-10 (10,000 V) or GTO-15 (15,000 V), in sizes 18-10 AWG copper. This cable is intended for use with gas-tube systems for signs, outline lighting, and interior lighting.

GUY—A tension wire connected to a tall structure and another fixed object to add strength to the structure.

H

HALAR—Solvay Solexis trademark for ethylene chlorotrifluoroethylene (ECTFE).

HALF DUPLEX—Two-way communications in which data are sent in only one direction at a time.

HALOGENATED—Containing halogen atoms such as chlorine, fluorine, bromine or iodine.

HALOGENS—Chemical elements such as chlorine and bromine that when present in a cable are released when burned. These materials can cause damage to human respiratory systems and to electrical equipment.

HARD-DRAWN WIRE—As applied to aluminum and copper, wire that has been cold drawn to final size so as to approach the maximum attainable strength.

HARNESS—An arrangement of wires and cables, usually with many breakouts, which have been tied together or pulled into a rubber or plastic sheath, used to interconnect an electric circuit.

HASH MARK STRIPE—A noncontinuous helical stripe applied to a conductor for identification.

HAZARDOUS LOCATION—An area of ignitable vapors, dust, or fibers that may cause fire or explosion as defined in Article 500 of the NEC. Only certain UL cable types are allowed to be used in hazardous in accordance with the NEC.

HDPE—High-density polyethylene.

HDTV—High-definition television.

HDX—Half-duplex transmission. Transmission in either direction but not in both directions simultaneously. Compare with FULL DUPLEX.

HEAD-END—A central point in broadband networks that receives signals on one set of frequency bands and retransmits them on another set of frequencies.

HEAT DISTORTION—Distortion or flow of a material or configuration due to the application of heat.

HEAT SEAL—Method of sealing a tape wrap jacket by means of thermal fusion.

HEAT SHOCK—A test to determine stability of material by sudden exposure to a high temperature for a short period of time.

HEAT SINK—A device that absorbs heat.

HEATER CORD—A group of cable types defined in Article 400 of the NEC such as types HPD, HPN, HS, HSJ, HSJO and HSO.

HELICAL STRIPE—A continuous, colored, spiral stripe applied to a conductor for circuit identification.

HELIX—Spiral winding.

HENRY—A unit of inductance equal to the inductance of a current changing at the rate of 1 ampere per second inducing a counter electromotive force of 1 volt.

HERTZ (Hz)—Cycles per second. A cycle that occurs once every second has a frequency of 1 hertz.

HF—High frequency.

HID—High-intensity discharge, mercury metal halide and sodium lamps.

HIGH BOND INSULATION—Insulation exhibiting great bond strength to the conductors.

HIGH-SPLIT—A broadband cable system in which the bandwidth used to send toward the head-end (reverse direction) is approximately 6 MHz to 180 MHz and the bandwidth used to send from the head-end (forward direction) is approximately 220 MHz to 400 MHz. The guard band between the forward and reverse directions (180 MHz to 220 MHz) provides isolation from interference.

HIGH-TEMPERATURE WIRE AND CABLE—Electrical wire and cables that have maximum operating temperatures of 150°C and higher.

HIGH-TENSION CABLES—Generally unshielded high-voltage ignition wires for combustion engines, gas and oil igniters, neon signs, etc. Usually Type GTO.

HIGH-VOLTAGE CABLE TERMINATION—A device used for terminating alternating current power cables having laminated or extruded insulation rated 2.5 kV and above.

HIGH-VOLTAGE POWER (system voltage ratings)—A class of system voltages equal to or greater than approximately 69,000 volts or less than 230,000 volts.

HINGE CABLE—A cable connected between a hinged or swinging device and a stationary object.

HIPOT—A DC high-potential test used on medium- and high-voltage cables. See DIELECTRIC STRENGTH TESTING.

HL—Hazardous location. An optional rating for UL Listed Type MC cables. Article 501 of the NEC permits Type MC-HL Listed cables to be used in Class I, Division 1 Hazardous Locations.

HMWPE—High molecular weight polyethylene.

HOLDING STRENGTH—Ability of a connector to remain assembled to a cable when under tension.

HOOK-UP WIRE—Small wires used to hook up instruments or electrical parts, usually 12 AWG and smaller.

HOT MODULUS—Stress at 100 percent elongation after 5 minutes of conditioning at a given temperature (normally 130°C).

HOT STAMPING—Method of alphanumeric coding. Identification markings are made by pressing heated tape and marking foil into softened insulation surfaces.

HOT STICK—A long insulated stick having a hook at one end that is used to open energized switchgear, high-voltage equipment, etc. Allows safe separation of user and high-voltage source.

HOT TIN DIP—A process of passing bare wire through a bath of molten tin to provide a coating.

HOUSING—A metallic or other enclosure for an insulated splice.

HPD—A UL portable heater cord type. 300 V rating with two, three or four 18-12 AWG conductors with thermoset insulation and a cotton or rayon outer covering. For use in dry, nonhard use locations, minimum maximum operating temperature of 90°C.

HPN—A UL portable heater cord type with parallel construction. 300 V rating with two or three 18-12 AWG conductors. Oil-resistant thermoset insulation and jacket. For use in nonhard usage and damp locations, minimum maximum operating temperature of 90°C.

HSJO—A UL thermoset jacketed heater cord type. 300 V rating with two, three, or four 18-12 AWG conductors. Oil-resistant thermoset insulation and jacket. For use in non-hard usage and damp locations, minimum maximum operating temperature of 90°C.

HV—High voltage.

HYBRID CABLE—Multiconductor cable containing two or more types of components.

HYDROSCOPIC—Used to describe material that absorbs and retains moisture.

HYPALON—DuPont's trademark for chlorosulfonated polyethylene (CSP).

HYPOT—Registered trade name of Associated Research, Inc. for its high-voltage tester. See HIPOT.

HYSTERESIS—The time lag between transitions in state exhibited by a body while reacting to changes in applied forces.

Hz—Hertz. A measure of frequency or bandwidth equal to one cycle per second. Named after experimenter Heinrich Hertz.

I

I—Symbol used to designate current. From the French word for current intensity (intensité du courant).

IACS—International Annealed Copper Standard for copper used in electrical conductors. 100 percent conductivity at 20°C is 0.017241 ohm-mm²/m.

ICEA—Insulated Cable Engineers Association. The association of cable manufacturing engineers who publish nationally recognized specifications for cables. Formerly IPCEA.

IEC—International Electrotechnical Commission.

IEEE—Institute of Electrical and Electronics Engineers. An international professional society that issues its own standards and is a member of ANSI and ISO.

IEEE 10BASE2 Network—A network conforming to the IEEE 802.3 local area network standard. The network is capable of carrying information at rates up to 10 Mbps over distances up to 2,800 meters (9,184 feet).

IEEE 10BROAD36—10 million bits per second over broadband coaxial cable with node-to-node coverage of 3,600 meters. The IEEE 802.3 specification for running Ethernet on broadband.

IEEE-488—An IEEE standard for a parallel interface bus consisting of eight bidirectional data lines, eight control lines and eight signal grounds, which provides for connection to an IEEE-488 device.

IEEE-802—Standards for the interconnection of local networking computer equipment. The IEEE-802 standard deals with the Physical Link Layers of the ISO Reference Model for OSL.

IEEE 802.3—An IEEE standard describing the physical and data link layers of a local area network based on bus topology and CSMA/CD. Ethernet.

IEEE 802.5—A physical layer standard specifying a LAN with a token-passing access method on a ring topology. Token ring.

IEEE 802.11—Wireless LAN. (Wi-Fi)

IEEE 802.15—Wireless PAN. (Bluetooth)

IF—Intermediate-frequency. In a frequency up-converter, this is the frequency between the baseband frequency and the higher frequency RF.

IMPACT TESTS—Tests designed to reveal the behavior of material of a finished part if it were subjected to impact or shock loading.

IMPEDANCE—The total opposition a circuit, cable or component offers to alternating current. It includes both resistance and reactance (frequency dependent resistance) and is generally expressed in ohms.

IMPEDANCE MATCH—A condition whereby the impedance of a particular cable or component is the same as the impedance of the circuit, cable or device to which it is connected. Matched impedances reduce reflections that decrease the power transfer efficiency.

IMPEDANCE MATCHING STUB—A section of transmission line or a pair of conductors cut to match the impedance of a load. Also called matching stub.

IMPEDANCE MATCHING TRANSFORMER—A transformer designed to match the impedance of one circuit to that of another.

IMSA—International Municipal Signal Association.

IN-BAND SIGNALING—The transmission of signaling information at some frequency or frequencies that lie within a carrier channel normally used for information transmission.

INCOHERENT SOURCE—A fiber optic light source that emits wide, diffuse beams of light of many wavelengths.

INDEX EDGE—Edge of a flat (ribbon) cable from which measurements are made, normally indicated by the location of the printing which is near the index edge. Sometimes indicated by a thread or other identification stripe.

Glossary

INDOOR TERMINATION—A cable termination intended for use where it is protected from direct exposure to both solar radiation and precipitation.

INDUCTANCE—A property of a conductor or circuit that resists a change in current. It causes current changes to lag behind voltage changes and is measured in henrys.

INDUCTION—The phenomenon of a voltage, magnetic field or electrostatic charge being produced in an object by lines of force from an outside source.

INDUCTION HEATING—Heating a conducting material by placing it in a rapidly changing magnetic field. The changing field induces electric currents in the material and I^2R losses account for the resultant heat.

INDUCTIVE COUPLING—Crosstalk resulting from the action of the electromagnetic field of one conductor on the other.

INDUSTRIAL ETHERNET CABLES—Cables specially designed to withstand the mechanical, chemical and electrical rigors of an industrial environment. Widely used in industrial process control networks.

INPUT—(1) A signal (or power) that is applied to a piece of electric apparatus. (2) The terminals on the apparatus to which a signal or power is applied.

INSERTION LOSS—A measure of the attenuation of a device by determining the output of a system before and after the device is inserted into the system.

INSERTION TOOL—A small, hand-held tool used to insert contacts into a connector.

INSULATED RADIANT HEATING WIRE—Similar to blanket wire but heavier construction for applications such as in ceiling panels, buried in ground or driveway and concrete walks.

INSULATED SPLICE—A splice with a dielectric medium applied over the connected conductors and adjacent cable insulation.

INSULATING (ISOLATING) JOINT—A cable joint that mechanically couples and electrically separates the sheath, shield and armor on contiguous lengths of cable.

INSULATION—A material having good dielectric properties that is used to separate close electrical components, such as cable conductors and circuit components.

INSULATION LEVEL—A thickness rating for power cable insulation. Circuits having fault detectors that interrupt fault currents within one minute are rated 100 percent level, within one hour are rated 133 percent level and over one hour are rated 173 percent level.

INSULATION TEMPERATURE RATING—A maximum operating temperature assigned to insulations based on laboratory testing.

INSULATION RESISTANCE—The electrical resistance of an insulating material at a specific time and condition as measured between two conductors.

INSULATION STRESS—The potential difference across an insulator. The stress on insulation is expressed in volts per mil (V/m) or kilovolts per meter (kV/m).

INSULATION THICKNESS—The wall thickness of wire insulation.

INSULATION VOLTAGE RATING—The nominal phase-to-phase operating voltage of a three-phase cable system.

INTERAXIAL SPACING—Center-to-center conductor spacing in paired wire or center-to-center spacing between conductors in a flat cable.

INTERCALATED TAPES—Two or more tapes helically wound and overlapped on a cable.

INTERCONNECTING CABLE—The wiring between modules, units or the larger portions of a system.

INTERCONNECTION—The joining of devices mechanically to complete an electrical circuit.

INTERFACE—The two surfaces on the contact side of both halves of a multiple-contact connector that face each other when the connector is assembled.

INTERFERENCE—Disturbances of an electrical or electromagnetic nature that introduce undesirable responses into other electronic equipment.

INTERMEDIATE FREQUENCY—A frequency to which a signal is converted for ease of handling. Receives its name from the fact that it is an intermediate step between the initial and final conversion or detection stages.

INTERMEDIATE TEMPER—As applied to aluminum, any temper between soft and hard drawn.

INTERNAL WIRING—Electronic wiring that interconnects components, usually within a sealed subsystem.

INTERSTICE—The space or void between assembled conductors and within the overall circumference of the assembly.

INTRINSICALLY SAFE—Incapable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture in its most ignitable concentration. See Article 504 of the NEC.

I/O—Input/Output. The process of transmitting data to and from the processor and its peripherals.

IONIZATION—(1) The creation of ions when polar compounds are dissolved in a solvent. (2) When a liquid, gas or solid is caused to lose or gain electrons due to the passage of an electric current.

IONIZATION FACTOR—This is the difference between percent dissipation factors at two specified values of electrical stress; the lower of the two stresses is usually so selected that the effect of the ionization on dissipation factor at this stress is negligible.

IONIZATION VOLTAGE—The potential at which a material ionizes. The potential at which an atom gives up an electron.

IR DROP—A method of designating a voltage drop in terms of both current and resistance.

IRRADIATION—In insulations, the exposure of the material to high-energy emissions for the purpose of favorably altering the molecular structure.

ISDN—Integrated Services Digital Network. A standard that covers a wide range of data communication issues but primarily the integration of voice and data.

ISO—International Organization for Standardization.

ISO 9000—A set of quality standards widely used around the world.

ISOLATION—The ability of a circuit or component to reject interference, usually expressed in dB.

ITU—International Telecommunications Union.

I^2R —Formula for power in watts, where I = current in amperes, R = resistance in ohms. See WATT.

J

- JACK**—A plug-in type terminal widely used in electronic apparatus for temporary connections.
- JACKET**—Pertaining to wire and cable, the outer sheath that protects against the environment and may also provide additional insulation.
- JAN SPECIFICATION**—Joint Army-Navy specification (replaced by current military specifications).
- JET STARTER CABLE**—Single conductor 600 V cable used for external aircraft power.
- JITTER**—The slight movement of a transmission signal in time or phase that can introduce errors and loss of synchronization in high-speed synchronous communications.
- JOINT**—That portion of the conductor where the ends of two wires, rods or groups of wires are joined by brazing, soldering, welding or by mechanical means.
- JOULE'S LAW**—When electricity flows through a material the rate of heating in watts will equal the resistance of the material in ohms times the square of the current in amperes. $W = I^2R$.
- JUMPER CABLE**—Extra flexible cables with high-voltage insulation for use as temporary connections. Usually has a red jacket.

K

- KAPTON**—DuPont's trademark for polyimide.
- kB**—Kilobyte. 1,024 bytes. Transmission speeds are measured in kB/second.
- kbps**—Thousands of bits per second (bps).
- kcmil**—One thousand circular mils, replaced "MCM" in the 1990 NEC. Sometimes shortened to "kcm."
- KEVLAR**—A high-strength DuPont polymer used as a cable messenger or strength member.
- K-FIBER**—A polyaramid-based material used for jacketing high-temperature cables.
- KILO**—Prefix meaning thousand.
- kV**—Kilovolt (1,000 volts).
- kVA**—Kilovolt ampere.
- kW**—Kilowatt. 1,000 watts of power.
- KYNAR**—Arkema Inc. trademark for polyvinylidene fluoride (PVDF).

L

- L**—Symbol for inductance.
- LACING AND HARNESSING**—A method of grouping wires by securing them in bundles of designated patterns.
- LACQUER**—A liquid resin or compound applied to textile braid to prevent fraying, moisture absorption, etc.

- LAMINATED TAPE**—A tape consisting of two or more layers of different materials bonded together.
- LAN**—Local area network. A user-owned, user-operated, high-volume data transmission facility connecting a number of communicating devices within a single building or campus of buildings.
- LASER DIODE**—A semiconductor diode that emits coherent light.
- LAUNCH ANGLE**—The angle between the radiation vector and the axis of an optical fiber.
- LAY**—Pertaining to wire and cable, the axial distance required for one cabled conductor or conductor strand to complete one revolution about the axis around that it is cabled.
- LAY DIRECTION**—The twist in the cable as indicated by the top strands while looking along the axis of the cable away from the observer. Described as "right hand" or "left hand."
- LAYER**—Consecutive turns of a coil lying in a single plane.
- L BAND**—The band of frequencies between 390 and 1,550 megahertz.
- LEACHING AND NONLEACHING**—In a leaching wire the plasticizer will migrate when exposed to heat. A nonleaching wire will retain its plasticizer under extreme temperature conditions and remain flexible after baking.
- LEAD**—A wire, with or without terminals, that connects two points in a circuit.
- LEAD CURED**—A cable that is cured or vulcanized in a metallic lead mold.
- LEAD-IN**—The conductor or conductors that connect the antenna proper to electronic equipment.
- LEAKAGE CURRENT**—An undesirable flow of current through or over the surface of an insulating material.
- LEAKAGE DISTANCE**—The shortest distance along an insulation surface between conductors.
- LED**—Light-emitting diode; device that accepts electrical signals and converts the energy to a light signal; with lasers, the main light source for optical-fiber transmission, used mainly with multimode fiber.
- LENGTH OF LAY**—The axial length of one turn of the helix of a wire or member. See LAY.
- LEVEL**—A measure of the difference between a quantity or value and an established reference.
- LF**—Low frequency. A band of frequencies extending from 30 to 300 kHz in the radio spectrum, designated by the Federal Communications Commission.
- LIFE CYCLE TESTING**—A test to determine the length of time before failure in a controlled, usually accelerated environment.
- LIGHTNING GROUND CABLE**—A specially stranded single conductor cable used to connect lightning rods (air terminals) to grounding rods.
- LIGHT SOURCE**—An object capable of emitting light. In fiber optics, the light source is normally a LED or a laser.
- LIMITS OF ERROR**—The maximum deviation (in degrees or percent) of the indicated temperature of a thermocouple from the actual temperature.
- LIMPNESS**—The ability of a cable to lay flat or conform to a surface.

Glossary

LINE BALANCE—The degree to which the conductors of a cable are alike in their electrical characteristics with respect to each other, to other conductors and to ground.

LINE DROP—A voltage loss occurring between any two points in a power transmission line. Such loss, or drop, is due to the resistance, or leakage of the line.

LINE EQUALIZER—A reactance (inductance and/or capacitance) connected in series with a transmission line to alter the frequency-response characteristics of the line.

LINE FAULT—A fault such as an open circuit, short circuit or ground in an electrical line or circuit.

LINE LEVEL—The level of a signal at a certain point on a transmission line. Usually expressed in decibels.

LINE LOSS—A total of the various energy losses occurring in a transmission line.

LINE VOLTAGE—The value of the potential existing on a supply or power line.

LITZ WIRE—Very fine, e.g. #44 AWG bare copper, each strand is enamel insulated. Used for low inductance coil windings.

LOAD—A device that consumes or converts the power delivered by another device.

LOAD CELL CABLE—Small multiconductor shielded cables for connecting load cells with instruments in electronic strain gauges. Also used for weighing and force measurement applications.

LOADED LINE—A transmission line that has lumped elements (inductance or capacitance) added at uniformly spaced intervals. Loading is used to provide a given set of characteristics to a transmission line.

LOC-TRAC—Alpha's registered trademark for a zipper tubing closure track that does not require any sealants to keep it closed, even during extreme flexing.

LOCAL AREA NETWORK (LAN)—A network that is located in a localized geographical area (e.g., an office, building, complex of buildings, or campus), and whose communications technology provides a high-bandwidth, low-cost medium to which many nodes can be connected.

LOGGING CABLE—Usually FEP/Tefzel self-supporting instrumentation cable. Generally dropped through borings in subsurface mining or well applications.

LONGITUDINAL SHIELD—A tape shield, flat or corrugated, applied longitudinally with the axis of the cable.

LONGITUDINAL SHRINKAGE—A term generally applied to shrink products denoting the axial length lost through heating in order to obtain the recovered diameter.

LONGITUDINAL WRAP—Tape applied longitudinally with the axis of the core being covered.

LONGWALL MACHINE—A mining machine used to undercut coal.

LOOP RESISTANCE—The total resistance of two conductors measured round trip from one end. Commonly used term in the thermocouple industry.

LOOP TEST—A long line test where a good line is connected to a faulty line to form a loop in which measurements will locate the fault.

LOSS—The portion of energy applied to a system that is dissipated and performs no useful work.

LOSS FACTOR—The power factor times the dielectric constant.

LOW BOND INSULATION—An insulation that exhibits a small bond strength to the conductors.

LOW FREQUENCY—A band of frequencies extending from 30 to 300 kHz in the radio spectrum, designated by the Federal Communications Commission.

LOW-LOSS DIELECTRIC—An insulating material that has a relatively low dielectric loss, such as polyethylene or Teflon. Dielectrics with $\tan \delta$ below 0.01 (approximately) are considered low-loss materials.

LOW-NOISE CABLE—A cable specially constructed to eliminate spurious electrical disturbances caused by capacitance changes or self-generated noise induced by either physical movement or adjacent circuitry.

LOW TENSION—Low voltage, as applied to ignition cable.

LOW VOLTAGE—(1) As defined in the National Electrical Code, a system rated nominal 24 volts or less, supplied from a transformer, converter, or battery. (2) A power system voltage rating of 1,000 volts or less.

LPF—Low pass filter. A filter that greatly attenuates signals of higher than a specified frequency, but passes with minimal attenuation all signals lower in frequency.

LS (LOW SMOKE)—An optional rating for UL Listed cable types that also pass low smoke requirements contained in UL Standards. A cable that meets the requirements can be marked "LS."

LSZH—Abbreviation for low smoke, zero halogen. Sometimes also written LSOH (0 = zero).

LUMEN—(lm) A SI unit of measurement for light output as perceived by the human eye. Defined as candela-steradians and abbreviated "lm."

LV—Low voltage.

M

mA—Milliampere (one-thousandth of an ampere).

MAGNET WIRE—Insulated wire used in the windings of motors, transformers and other electromagnetic devices.

MAGNETIC FIELD—The field created when current flows through a conductor.

MAP—Manufacturing automation protocol. The OSI profile championed by General Motors Corporation to provide interconnectivity between plant hosts, area managers and cell controllers over a broadband token-passing bus network.

MARKER TAPE—A tape laid parallel to the conductors under the sheath in a cable, imprinted with the manufacturer's name and the specification to which the cable is made.

MARKER THREAD—A colored thread laid parallel and adjacent to the strand in an insulated conductor that identifies the manufacturer and sometimes the specification to which the wire is made.

MASTIC—A meltable coating used on the inside of some shrink products that when heated flows to help create a waterproof seal.

MATV—Master Antenna Television System. A combination of components providing multiple television receiver operations from one antenna or group of antennas.

MAXIMUM CABLE DIAMETER—The largest cable diameter that a high-voltage cable termination is designed to accommodate.

MINIMUM CABLE DIAMETER—The smallest cable diameter that a high-voltage cable termination is designed to accommodate.

MAXIMUM DESIGN VOLTAGE—The maximum voltage at which a high-voltage cable termination is designed to operate continuously under normal conditions.

MC—(1) Main cross-connect. (2) A UL cable type (metal clad).

MECHANICAL WATER ABSORPTION—A check of how much water will be absorbed by material in warm water for seven days (mg/sq. in. surface).

MEDIUM FREQUENCY—The band of frequencies between 300 and 3,000 kilohertz.

MEDIUM HARD-DRAWN WIRE—As applied to copper wire, having tensile strength less than the minimum for hard-drawn wire, but greater than the maximum for soft wire.

MEDIUM VOLTAGE—A class of nominal power system voltage ratings between 2.4 and 46 kV.

MEGA—Prefix meaning million.

MEGAHERTZ (MHz)—One million cycles per second.

MEGGER—A special ohmmeter for measuring very high resistance. Primarily used for checking the insulation resistance of cables; however, it is also useful for equipment leakage tests.

MELT INDEX—The extrusion rate of a material through a specified orifice under specified conditions.

MEMBER—A group of wires stranded together that is in turn stranded into a multiple-membered conductor.

MESSANGER WIRE—A metallic supporting member either solid or stranded that may also perform the function of a conductor.

MFD—Microfarad (one-millionth of a farad). Obsolete abbreviation.

MFT—Abbreviation for 1,000 feet. M is one thousand in the Roman numeral system.

MG—Glass reinforced mica tape insulated cable with an overall sheath of woven glass yarn impregnated with a flame, heat and moisture resistant finish. 450°C, 600 V appliance wire.

MHO—The unit of conductivity. The reciprocal of an ohm.

MHz—Megahertz (one million cycles per second).

MI—A UL cable type. One or more conductors insulated with highly compressed refractory minerals and enclosed in a liquid-tight and gas-tight metallic tube sheathing.

MICA—A transparent silicate that separates into layers and has high insulation resistance, high dielectric strength and high heat resistance.

MICRO—Prefix meaning one-millionth.

MICROBENDING LOSS—A signal loss due to small geometrical irregularities along the core-cladding interface of optical fibers.

MICROFARAD—One-millionth of a farad (abbreviated μf).

MICROMICROFARAD—One-millionth of a microfarad (abbreviated $\mu\mu\text{f}$). Also, a picofarad (pf).

MICROPHONE CABLE—A very flexible, usually shielded cable used for audio signals.

MICROPHONICS—Noise caused by mechanical movement of a system component. In a single conductor microphone cable, for example, microphonics can be caused by the shield rubbing against the dielectric as the cable is flexed.

MICROWAVE—A short (usually less than 30 cm wavelength) electrical wave.

MID-SPLIT—A broadband cable system in which the cable bandwidth is divided between transmit and receive frequencies. The bandwidth used to send toward the headend (reverse direction) is approximately 5 MHz to 100 MHz and the bandwidth used to send away from the head-end (forward direction) is approximately 160 MHz to 300 MHz.

MIL—A unit of length equal to one-thousandth of an inch (.001 in. = 1 mil).

MIL-SPEC—Military specification.

MIL-DTL-17—A military specification covering many coaxial cables. Formerly MIL-C-17.

MIL-DTL-16878—A military specification covering various wires intended for internal wiring of electric and electronic equipment. Formerly MIL-C-16878.

MIL-W-22759—A military specification for fluorocarbon insulated copper and copper alloy wire. Replaced by SAE AS22759.

MILLI—Prefix meaning one-thousandth.

MIPS—Millions of instructions per second. One measure of processing power.

MODULATION—Systematic changing of properties, e.g., amplification, frequency, phase of an analog signal to encode and convey (typically digital) information.

MODULUS OF ELASTICITY—The ratio of stress (force) to strain (deformation) in a material that is elastically deformed.

MOISTURE ABSORPTION—The amount of moisture, in percentage, that a material will absorb under specified conditions.

MOISTURE RESISTANCE—The ability of a material to resist absorbing moisture from the air or when immersed in water.

MOLDED PLUG—A connector molded on either end of a cord or cable.

MONO FILAMENT—A single-strand filament as opposed to a braided or twisted filament.

MONOMER—The basic chemical unit used in building a polymer.

MOTOR LEAD WIRE—Wire that connects to the fragile magnet wire found in coils, transformers and stator or field windings.

MPF—Mine power feeder cables. Usually rated 5, 8, or 15 kV.

MSHA—Mine Safety and Health Administration. The Federal enforcement agency for employee safety in mines and mills. Formerly known as MESA, Bureau of mines. MSHA regulations appear in CFR (Code of Federal Regulations) Title 30, Chapter 1.

MTW—Machine tool wire, a UL cable type. Thermoplastic insulated, 90°C to 105°C, 600 V. UL 1063 is the governing standard.

MULTICAST—The ability to broadcast messages to one node or a select group of nodes.

MULTIMODE—Optical fiber that allows more than one mode (or ray) of light to propagate.

Glossary

MULTIPLE-CONDUCTOR CABLE—A combination of two or more conductors cabled together and insulated from one another and from sheath or armor where used.

MULTIPLE-CONDUCTOR CONCENTRIC CABLE—An insulated central conductor with one or more tubular stranded conductors laid over it concentrically and insulated from one another.

MULTIPLEX—The use of a common physical channel in order to make two or more logical channels, either by splitting of the frequency band (frequency-division multiplex) or by using this common channel at different points in time (time-division multiplex).

MULTIPLEXER—Equipment that permits simultaneous transmission of multiple signals over one physical circuit.

MULTIPOINT CIRCUIT—A single line connecting three or more stations.

MURRAY LOOP TEST—A method used to localize cable faults.

MUTUAL CAPACITANCE—Capacitance between two conductors in a cable.

MUX—Multiplex. To transmit two or more signals over a single channel.

mV—Millivolt (one-thousandth of a volt).

MV—Medium-voltage cables. Usually rated 5–35 kV.

mW—Milliwatt (one-thousandth of a watt).

MYLAR—DuPont's trademark for polyethylene terephthalate (polyester) film.

N

NBR—Butadiene-acrylonitrile copolymer rubber, a material with good oil and chemical resistance.

NBR/PVC—A blend of acrylonitrile-butadiene rubber and polyvinyl chloride (PVC). Used for jacketing.

NBS—National Bureau of Standards. Now called NIST (National Institute of Standards and Technology).

N CONNECTOR—A threaded connector for coax; N is named after Paul Neill.

NEC—National Electrical Code.

NEGATIVE SEQUENCE IMPEDANCE—The electrical impedance of a three-phase power cable with the phase rotation reversed as compared to normal operation. Has the same numerical value as the positive sequence impedance. "Negative sequence" refers to the phase relationship of the currents in the conductors.

NEMA—National Electrical Manufacturers Association.

NEOPRENE—A synthetic rubber with good resistance to oil, chemicals and flame. Also called polychloroprene.

NETWORK—A series of nodes connected by communications channels.

NEWTON—The derived SI unit for force; the force that will give one kilogram mass an acceleration of one meter per second. Equals 0.2248 pounds force.

NEXT—Near-end crosstalk. A measure of the unwanted signal coupling from a transmitter at the near-end into a neighboring (nonenergized) pair measured at the near-end.

NFPA—National Fire Protection Association. Publishes the NEC and other codes and standards.

NICKEL CLAD COPPER WIRE—A wire with a layer of nickel on a copper core where the area of the nickel is approximately 30 percent of the conductor area.

NIST—National Institute of Standards and Technology. Formerly the National Bureau of Standards.

NM-B—A UL cable type rated 600 volts and intended for use per Article 334 of the NEC. Nonmetallic sheathed cable. For dry use, 90°C conductor rating.

NMC-B—A UL cable type rated 600 volts and intended for use per Article 334 of the NEC. Nonmetallic sheathed cable. Wet or dry use, 90°C conductor rating.

NODE—A station or point in a network.

NOISE—In a cable or circuit any extraneous sounds or signal that tends to interfere with the sound or signal normally present in or passing through the system.

NOMEX—DuPont's trademark for a heat-resistant, flame-retardant nylon.

NOMINAL—Name or identifying value of a measurable property by which a conductor or component or property of a conductor is identified and to which tolerances are applied.

NOMINAL VOLTAGE (NATIONAL ELECTRICAL CODE)—A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (as 120/240, 480Y/277, 600 volts, etc.). The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

NOMOGRAPH—A chart or diagram with which equations can be solved graphically by placing a straight edge on two known values and reading the answer where the straight edge crosses the scale of the unknown value.

NONCONTAMINATING—A type of PVC jacket material whose plasticizer will not migrate into the dielectric of a coaxial cable and thus avoid contaminating and destroying the dielectric.

NONCONTAMINATING PVC—A polyvinyl chloride formulation that does not produce electrical contamination through plasticizer migration.

NONFLAMMABLE—The property of a material that is not capable of being easily ignited.

NONMIGRATING PVC—Polyvinyl chloride compound formulated to inhibit plasticizer migration.

NRZI—Nonreturn to zero inverted. A binary encoding technique in which a change in state represents a binary 0 and no change in state represents a binary 1.

N-SERIES CONNECTOR—A coaxial connector (RG-8/U) used in standard Ethernet networks.

NTSC—National Television System Committee. Defined the U.S. standard definition color TV standard.

NUMERICAL APERTURE—The acceptance angle of an optical fiber that determines the angle at which light can enter the fiber; expressed as a number that is equivalent to the sine of the angle.

NYLON—An abrasion-resistant thermoplastic with good chemical resistance. Polyamide.

O

- O.D.**—Outside diameter.
- OEM**—Original equipment manufacturer.
- OFHC**—Oxygen-free high-conductivity copper.
- OHM**—The electrical unit of resistance. The value of resistance through which a potential difference of one volt will maintain a current of one ampere.
- OHM'S LAW**—Stated $V = IR$, $I = V/R$, or $R = V/I$ where V is voltage, I is current in amperes and R is resistance in ohms.
- OIL AGING**—Cable aged in an accelerated manner by placement in an oil bath and heated to a preset temperature for a stated time.
- OPEN CELL**—Foamed or cellular material with broken cell walls. Air fills in the spaces in the material. Usually softer and less expensive than closed cell material.
- OPEN CIRCUIT**—A break in an electrical circuit so there can be no current flow.
- OPTICAL CONDUCTOR**—Materials that offer a low optical attenuation to transmission of light energy.
- OPTICAL CROSS-CONNECT**—A cross-connect unit used for circuit administration. It provides for the connection of individual optical fibers with optical fiber patch cords.
- OPTICAL ENCODER**—A device whose position is determined by a photoelectric device and converted to an electrical data output.
- OPTICAL FIBER**—Any filament or fiber, made of dielectric materials, that is used to transmit light signals; optical fiber usually consists of a core, which carries the signal and cladding, a substance with a higher refractive index than the core, which surrounds the core and serves to reflect the light signal. See also FIBER OPTICS.
- OPTICAL WAVEGUIDE**—A fiber used for optical communications. Analogous to a waveguide used for microwave communications.
- OSCILLATORY SURGE**—A surge that includes both positive and negative polarity values.
- OSCILLOSCOPE**—Test instrument for visually showing the changes in a varying voltage by means of a line made on a fluorescent screen using the deflection of a beam of cathode rays.
- OSHA**—Abbreviation for Occupational Safety and Health Act. Specifically the Williams-Steiger laws passed in 1970 covering all factors relating to safety in places of employment.
- OSMOSIS**—The diffusion of fluids through membranes.
- OTDR**—Optical time domain reflectometer. A device used for testing and characterization of fiber optic cables.
- OUTDOOR TERMINATION**—A cable termination intended for use where it is not protected from direct exposure to either solar radiation or precipitation.
- OUTGASSING**—Dissipation of gas from a material.
- OUTPUT**—The useful power or signal delivered by a circuit or device.
- OVERALL DIAMETER**—Finished diameter of a wire or cable.
- OVERCOAT CONDUCTOR**—A stranded conductor made from individual strands of tin-coated wire stranded together and then given an overall tin coat.

OVERLAP—The amount the trailing edge laps over the leading edge of a spiral tape wrap.

OXYGEN INDEX—A test to rate relative flammability of materials in a mixture of oxygen and nitrogen. More formally referred to as limiting oxygen index (LOI). Usually defined as the percentage of oxygen in air required to sustain combustion of the material.

OZONE—An extremely reactive form of oxygen, normally occurring around electrical discharges and present in the atmosphere in small but active quantities. In sufficient concentrations it can break down certain insulations.

P

PAIR—Two insulated wires of a single circuit associated together; also known as a “balanced” transmission line.

PARALLEL CIRCUIT—A circuit in which identical voltage is presented to all components and the current divides among the components according to the resistances or the impedances of the components.

PARALLEL STRIPE—A stripe applied longitudinally on a wire or cable parallel to the axis of the conductor.

PARALLEL TRANSMISSION—A type of data transfer in which all bits of a character, or multiple-bit data blocks, are sent simultaneously, either over separate communications lines or circuits, over a single channel using multiple frequencies, or over a multiple-conductor cable.

PARTIAL DISCHARGE (CORONA) EXTINCTION VOLTAGE—The voltage at which partial discharge (corona) is no longer detectable on instrumentation adjusted to a specific sensitivity, following the application of a specified higher voltage.

PATCH CABLE—A cable with plugs or terminals on each end of the conductors to connect circuits of equipment together. Commonly used in data centers to interconnect computer networking hardware.

PAYOFF—The process of feeding a cable or wire from a bobbin, reel or other package. The payoff is the source reel. Wire is fed from a payoff reel onto a take-up reel.

PBDE—Polybrominated diphenyl ether. A class of flame retardants sometimes used in wire and cable products. PBDEs are generally banned by European Union RoHS regulations.

PCB—Printed circuit board. Also referred to as PWB (printed wiring board) to distinguish this usage from the chemical usage (polychlorinated biphenyls—persistent organic pollutants that are banned in many countries).

PCP—Polychloroprene (neoprene).

PDN—Public data network. A packet-switched or circuit-switched network available for use by many customers. PDNs may offer value-added services at a reduced cost because of communications resource sharing and usually provide increased reliability due to built-in redundancy.

PE—Polyethylene. A widely used thermoplastic insulation and jacket compound.

PEAK—The maximum instantaneous value of a varying current or voltage, different from the rms value that is usually used to categorize AC voltages. Also called crest.

Glossary

PEEK—Poly ether ether ketone. A colorless organic thermoplastic used for its robustness.

PEEL STRENGTH—The force necessary to peel a flexible member from another member that may be either flexible or rigid.

PERCENT CONDUCTIVITY—The ratio of the resistivity of the International Annealed Copper Standard (IACS) at 20°C to the resistivity of a material at 20°C, expressed in percent. Results are calculated on a weight basis or volume basis and so specified.

PERCENT PLATING—Quantity of plating on a conductor expressed as a percentage by weight.

PERCENTAGE CONDUCTIVITY—Conductivity of a material expressed as a percentage of that of copper.

PFA—Perfluoroalkoxy. Teflon is DuPont's trademark for this material.

PHASE—The location of a position on a waveform of an alternating current, in relation to the start of a cycle. Measured in degrees, with 360 corresponding to one complete cycle.

PHASE SEQUENCE—The order in which successive members of a periodic wave set reach their positive maximum values: a) zero phase sequence—no phase shift; and b) plus/minus phase sequence—normal phase shift.

PHASE SHIFT—A change in the phase relationship between two alternating quantities. The phase angle between the input and output signals of a system.

PHOTOVOLTAIC WIRE (PV WIRE)—A UL cable type. 600 V, 1,000 V, 2,000 V, insulated, stranded single conductor wire used to connect photovoltaic electricity generating panels to each other and to collection, distribution and utilization equipment.

PICK—Distance between two adjacent crossover points of braid filaments. The measurement in picks per inch indicates the degree of coverage.

PICO—Prefix meaning one-millionth of one-millionth (10^{-12}).

PICOFARAD—One-millionth of one-millionth of a farad (10^{-12}). A micromicrofarad, or picofarad (abbreviation pF).

PIGTAIL WIRE—Fine stranded, extra flexible, rope lay lead wire attached to a shield for terminating purposes.

PILC CABLE—Paper insulated, lead covered. Old cable style present in many urban distribution networks. Most are scheduled for replacement due to lead content and age.

PIN ASSIGNMENT—A predetermined relationship between the terminals in a connector and the conductors in a cable that specifies the terminals to which each conductor is to be terminated.

PITCH—In flat cable, the nominal distance between the index edges of two adjacent conductors.

PITCH DIAMETER—Diameter of a circle passing through the center of the conductors in any layer of a multiconductor cable.

PLANETARY TWISTER—A cabling machine whose payoff spools are mounted in rotating cradles that hold the axis of the spool in a fixed direction as the spools are revolved so the wire will not kink as it is twisted.

PLASTICIZER—A chemical added to plastics to make them softer and more flexible.

PLATED HOLE—A hole with walls that have been plated with conductive material to provide an electrical connection between the conductive patterns on both sides of a printed circuit or an anchor for soldering an inserted wire.

PLC—Programmable logic controller. A type of industrial control system.

PLENUM—The air return path of a central air handling system, either ductwork or open space over a suspended ceiling.

PLENUM CABLE—Cable approved by a recognized agency such as UL for installation in plenums without the need for conduit due to a higher flame resistance rating.

PLTC—Power limited tray cable, rated 300 volts.

PLUG—The part of the two mating halves of a connector that is movable when not fastened to the other mating half.

PLY—The number of individual strands or filaments twisted together to form a single thread.

POINT-TO-POINT WIRING—An interconnecting technique wherein the connections between components are made by wires routed between connecting points.

POLARIZATION—(1) The orientation of a flat cable or a rectangular connector. (2) Orientation of the electric field in an electromagnetic wave. Common characteristic of antennas.

POLISHING—Act of smoothing ends of optical fibers to an "optically smooth" finish, generally using abrasives.

POLYAMIDE—The chemical name for nylon.

POLYARAMID—Generic name for Kevlar. Sometimes also referred to as aramid fiber.

POLYBUTADIENE—A type of synthetic rubber often blended with other synthetic rubbers to improve their properties.

POLYCHLOROPRENE—See NEOPRENE.

POLYESTER—Polyethylene terephthalate, used extensively as a moisture-resistant cable core wrap. Mylar is DuPont's trademark for polyester.

POLYETHYLENE—A thermoplastic material having excellent electrical properties.

POLYHALOCARBON—A general name for polymers containing halogen atoms. The halogens are fluorine, chlorine, bromine and iodine.

POLYIMIDE—A relatively high-temperature plastic developed for use as a dielectric or jacketing material. Kapton is DuPont's trademark for polyimide.

POLYMER—A substance made of many repeating chemical units or molecules. The term polymer is often used in place of plastic, rubber or elastomer.

POLYOLEFINS—A family of plastics including cross-linked polyethylene and various ethylene copolymers.

POLYPROPYLENE—A thermoplastic similar to polyethylene but stiffer and having a higher temperature softening point.

POLYURETHANE—Broad class of polymers noted for good abrasion and solvent resistance. Can be in solid or cellular form.

POLYVINYL CHLORIDE (PVC)—A general purpose thermoplastic used for wire and cable insulations and jackets.

POROSITY—Generally defined as the percentage of space occupied by voids in an insulation cross section.

PORT—A point of access into a computer, a network or other electronic device; the physical or electrical interface through which one gains access; the interface between a process and a communications or transmission facility.

P.O.S.—Abbreviation for point-of-sale (e.g., a cash register station).

POSITION CODING—Identification of conductors by their location, possible only when conductors are located in assigned positions with relation to each other throughout the entire length of a cable.

POSITIVE SEQUENCE IMPEDANCE—The electrical impedance of a three-phase power cable during normal operation. A cable parameter used by electrical system engineers to calculate voltage drop. “Positive sequence” refers to the phase relationship of the currents in the conductors.

POTTING—Sealing by filling with a substance to exclude moisture.

POWER—The amount of work per unit of time. Usually expressed in watts and equal to I^2R in electrical systems.

POWER CABLES—Cables of various sizes, constructions and insulations, single or multiconductor, designed to distribute primary power to various types of equipment.

POWER FACTOR (PF)—The cosine of the phase difference between current and applied voltage or the ratio of real power flow to the apparent power flow expressed as a ratio between zero and one. Resistive loads have a power factor of unity. Nonlinear loads have PFs less than one.

POWER LOSS—The difference between the total power delivered to a circuit, cable, or device and power delivered by that device to a load.

POWER RATIO—The ratio of the power appearing at the load to the input power. Expressed in dB, it is equal to $10 \log_{10} (P_2/P_1)$ where P_1 is input power and P_2 is the power at the load.

PPE—Polypropylene ethylene.

PREBOND—Stranded wire that has been fused, topcoat tinned or overcoat tinned.

PREMOLDED SPLICE—A joint made of premolded components assembled in the field.

PRIMARY—The transformer winding that receives the energy from a supply current.

PRIMARY INSULATION—The first layer of nonconductive material applied over a conductor, whose prime function is to act as electrical insulation.

PRINTING WIRING—A printed circuit intended to provide point-to-point electrical connections.

PRODUCTION TESTS—Tests made on components or subassemblies during production for the purpose of quality control.

PROPAGATION DELAY—The time it takes a signal, composed of electromagnetic energy to travel from one point to another over a transmission channel; usually most noticeable in communicating with satellites; normally, the speed-of-light delay.

PROPAGATION TIME—Time required for a wave or pulse to travel between two points on a transmission line.

PROPAGATION VELOCITY—The velocity of the propagation of a wave or pulse along a transmission path.

PROTECTIVE COVERING—A field-applied material to provide environmental protection over a splice or housing, or both.

PROXIMITY EFFECT—Nonuniform current distribution over the cross-section of a conductor caused by the variation of the current in a neighboring conductor.

PSAACRF—Power sum insertion loss to alien crosstalk ratio far-end. A computation of signal coupling from multiple pairs of disturbing channels, to a disturbed pair in another channel measured at the far-end and relative to the received signal level in the disturbed pair at the far-end. Also referred to as power sum alien equal-level far-end crosstalk (PSAELFEXT).

PSANEXT—Power sum alien near-end crosstalk. A computation of signal coupling from multiple near-end disturbing channel pairs into a disturbed pair of a neighboring channel or part thereof, measured at the near-end.

PSAFEXT—Power sum alien far-end crosstalk. A computation of signal coupling from multiple near-end disturbing channel pairs into a disturbed pair of a neighboring channel or part thereof, measured at the far-end.

PSNEXT—Power sum near-end crosstalk. A computation of the unwanted signal coupling from multiple transmitters at the near-end into a neighboring (non-energized) pair measured at the near-end.

PT—Thermostat cable with solid conductor, individual insulation, twisted together.

PTFE—Polytetrafluorobthylene. One type of Teflon. Sometimes abbreviated TFE.

PULLING EYE—A device attached to a conductor to pull cable into or from a duct.

PULSE—A current or voltage that changes abruptly from one value to another and back to the original value in a finite length of time.

PULSE CABLE—A type of coaxial cable constructed to transmit repeated high-voltage pulses without degradation.

PVC—Polyvinyl chloride. A common insulating and jacketing material used on cables.

PVC-I—A MIL-DTL-17 coax jacket type. A black polyvinyl chloride with excellent weathering and abrasion properties, but is a contaminating type and will cause cable attenuation to increase with age. Can be used for direct burial.

PVC-II—A MIL-DTL-17 coax jacket type. A gray polyvinyl chloride material which is semi-noncontaminating.

PVC-IIA—A MIL-DTL-17 coax jacket type. A black or gray polyvinyl chloride material that is noncontaminating. It has good weathering and abrasion-resistant properties and can be used for direct burial.

PVDF—Polyvinylidene difluoride. Arkema Inc.’s trademark for this material is Kynar.

PWB—Printed wiring board. Replacing PCB in common usage to avoid confusion with chemical PCBs.

PYROMETER—See THERMOCOUPLE.

Q

Q band—The band of frequencies between 36 and 46 gigahertz.

QPL—A Qualified Products List issued by the U.S. government.

QUAD—A series of four separately insulated conductors, generally twisted together in pairs.

Glossary

R

R—Symbol for electrical resistance.

RADIO FREQUENCY—The frequencies in the electromagnetic spectrum that are used for radio communications. A band of frequencies between 10 kilohertz and 100 gigahertz.

RANDOM WINDING—A winding in rotating equipment wherein wires do not lie in an even pattern.

REA (RURAL ELECTRIFICATION ADMINISTRATION)—A federally supported program to provide electrical service to rural areas. See RUS.

REACH (REGISTRATION, EVALUATION AND AUTHORIZATION OF CHEMICALS)—A European community regulation on the safe use of chemicals. Companies selling into the European market are required to provide compliance information to their downstream users. Compliance requires the investigation of the supply chain for the presence of certain chemicals called SVHCs (substances of very high concern). REACH began in 2008. Chemicals will be added for a period of several years.

REACTANCE—The opposition to an alternating electron flow by a capacitance or inductance. The amount of such opposition varies with the frequency of the current. The reactance of a capacitor decreases with an increase in frequency; the opposite occurs with an inductance.

RECOVERED DIAMETER—Diameter of shrinkable products after heating has caused it to return to its extruded diameter.

RED PLAGUE—A powdery, brown-red growth sometimes found on silver-coated copper conductors and shield braids.

REDRAW—The consecutive drawing of wire through a series of dies to reach a desired wire size.

REEL—A revolving flanged device made of plastic, wood or metal, used for winding flexible cable. Also called a spool.

REFERENCE EDGE—See INDEX EDGE.

REFERENCE JUNCTION—The junction of a thermocouple that is at a known reference temperature. Also known as the “cold” junction, it is usually located at the EMF measuring device.

REFLECTION—(1) The change in direction (or return) of waves or pulses striking a surface. For example, electromagnetic energy reflections can occur at an impedance mismatch in a transmission line, causing standing waves. (2) Change in direction of a light wave or ray in an optical fiber.

REFLECTION LOSS—The part of a signal that is lost to reflection of power at a line discontinuity.

REFLOW SOLDERING—The process of connecting two solder-coated conductive surfaces by remelting of the solder to cause fusion.

REFRACTION—The bending of light waves or rays as they go from one material to another due to the difference in velocities in the materials.

REINFORCED SHEATH—The outer covering of a cable that has a reinforcing material, usually a braided fiber, molded in place between layers.

RELIABILITY—The probability that a device will function without failure over a specified time period or amount of usage.

RESIN—A solid or semisolid organic substance, originally of plant origin but largely synthesized now. Resins are broadly classified as thermoplastic or thermoset according to whether they soften or harden with the application of heat.

RESISTANCE—In DC circuits, the opposition a material offers to current, measured in ohms. In AC circuits, resistance is the real component of impedance and may be higher than the value measured at DC.

RESISTIVE CONDUCTOR—A conductor with high electrical resistance.

RESISTIVITY—A material characteristic that opposes the flow of electrical energy through the material. It is affected by temper, temperature, contamination, alloying, etc. The unit of volume resistivity is the ohm-cm. The unit of surface resistivity is ohms/m².

RESISTOR—An electronic component designed to have a specific value of resistance.

RESISTOR COLOR CODE—A method of indicating resistance value and tolerance. The first color represents the first significant figure of the value. A second color represents the second significant figure and the third is the multiplier or the number of zeros that follow two significant figures. When there is a fourth color band, it indicates the tolerance.

RESONANCE—An AC circuit condition in which inductive and capacitive reactance interact to cause a minimum or maximum circuit impedance.

RETRACTILE CORD—A cord having a specially treated insulation or jacket so it will retract like a spring. Retractability may be added to all or part of a cord’s length.

RETURN LOSS—A measure of the degree of impedance mismatch between two impedances. It is the ratio, expressed in decibels, of the amplitude of a reflected wave echo to the amplitude of the main wave at the junction of a transmission line and a terminating impedance.

RETURN WIRE—A ground wire or the negative wire in a direct-current circuit.

REW—A 600 volt Canadian wire type covered by CSA standards. Made with thermoset insulation.

RFI—Radio frequency interference. The disruption of radio signal reception caused by any source that generates radio waves at the same frequency and along the same path as the desired wave. Similar to EMI.

RF MODEM—Radio frequency modem. A device used to convert digital data signals to analog signals (and from analog to digital) then modulate/demodulate them to/from their assigned frequencies.

RG/U—“RG” (radio guide) is the military designation for coaxial cable and “U” stands for “general utility.”

RHH—Rubber-insulated, heat-resistant wire, rated 90°C in dry and damp locations. A UL cable type.

RHW—Rubber-insulated building wire, heat and moisture-resistant, 75°C dry or wet. A UL cable type.

RHW-2—Rubber-insulated building wire, heat and moisture-resistant, 90°C dry or wet. A UL cable type.

RIBBON CABLE—A flat cable of individually insulated conductors lying parallel and held together by means of adhesive or an extruded polymer web.

RIDGE MARKER—One or more ridges running laterally along the outer surface of a plastic insulated wire for purposes of identification.

RIGID COAXIAL CABLE—Nonflexible coaxial cable, usually a metal tube armored coaxial cable. Sometimes called “hardline.”

RINGING OUT—Locating or identifying specific conductive paths by passing current through selected conductors.

RING TONGUE—A solderless terminal that connects wire to a stud.

RIP CORD—Two or more insulated conductors in a parallel configuration that may be separated to leave the insulation of each conductor intact.

RISE TIME—The time it takes the voltage to rise from 0.1 to 0.9 of its final value.

RIV—Radio influence voltage. The radio noise appearing on conductors of electric equipment or circuits.

rms—See ROOT MEAN SQUARE.

ROCKWELL HARDNESS—A measure of hardness determined by resistance to indentation by a small diamond or steel ball under pressure.

RoHS—Restriction of Hazardous Substances. A European Union regulation (Directive 2002/95/EC), which became effective in 2006 that requires the elimination of six hazardous substances from electrical and electronic products sold in the EU including lead, cadmium, mercury, hexavalent chromium, PBB and PBDE.

ROMEX—A type of nonmetallic sheathed (Type NM) cable. A trademark of the Southwire Company.

ROOT MEAN SQUARE (rms)—The effective value of an alternating current or voltages.

ROPE CONCENTRIC—A group of stranded conductors assembled in a concentric manner.

ROPE-LAY CONDUCTOR—See CONCENTRIC-LAY CONDUCTOR.

ROPE STRAND—A conductor composed of a center group of twisted strands surrounded by layers of twisted strands.

ROPE UNILAY—A group of stranded conductors assembled in a unilay manner.

ROTATING CABLE—A coil of cable whose inner end is attached to a member that rotates in relation to a member to which the outer end of the cable is fastened.

ROUND CONDUCTOR FLAT CABLE—A cable made with parallel round conductors in the same plane.

ROUND WIRE SHIELDS—Shields constructed from bare, tinned or silver-plated copper wire that include braided, spiral and reverse spiral.

ROUTINE TESTS—Tests made on each high-voltage cable or upon a representative number of devices, or parts, during production for the purposes of quality control.

RS-232—An ANSI/TIA recommended standard (RS); a common standard for connecting data processing devices. RS-232 defines the electrical characteristics of the signals in the cable that connect DTE (data terminal equipment) with DCE (data communications equipment); it specifies a 25-pin connector (the DB-25 connector is almost universally used in RS-232 applications). It is similar to ITU-T V.24/V.28.

RS-232-C SERIAL I/O PORT—A standard connection interface for computer peripheral equipment.

RS-422—An ANSI/TIA standard for cable lengths that exceed the RS-232 50-foot limit. Although introduced as a companion standard with RS-449, RS-422 is most frequently implemented on unused pins of DB-25 (RS-232) connectors. Similar to ITU-T V.11.

RS-423—An ANSI/TIA standard for cable lengths that exceed the RS-232 50-foot limit. Although introduced as a companion standard with RS-422, RS-423 is not widely used. Similar to ITU-T V.10.

RTD—Resistance temperature sensing device. Converts temperature to an electrical signal.

RTS—Request-to-send. An RS-232 modem interface signal (sent from the DTE to the modem on pin 4) that indicates that the DTE has data to transmit.

RUBBER, ETHYLENE PROPYLENE (EPR)—A synthetic rubber insulation having excellent electrical properties.

RUBBER INSULATION—A general term used to describe wire insulations made of elastomers such as natural or synthetic rubbers, neoprene, CSPE, EPR, CPE and others.

RUS—Rural Utilities Service. A federal agency formerly known as the REA.

S

S—A UL cable type. Hard service flexible cord with thermoset insulation and jacket. Also see SO and SJ.

SAE—Society of Automotive Engineers. Automotive standards body.

S BAND—A band of frequencies between 1,550 and 5,200 megahertz.

SBR—A copolymer of styrene and butadiene. Also GRS or Buna-S.

SCHERING BRIDGE—See BRIDGE.

SDN—A small diameter multiconductor control cable with neoprene jacket and nylon sheath over polyethylene insulation.

SECONDARY INSULATION—A nonconductive material that protects the conductor against abrasion and provides a second barrier.

SEGMENTAL CONDUCTOR—A stranded conductor consisting of three or more stranded conducting elements, each element having approximately the shape of the sector of a circle, assembled to give a substantially circular cross section.

SELF-EXTINGUISHING—Characteristic of a material whose flame is extinguished after the igniting flame source is removed.

SEMICONDUCTOR—In wire industry terminology, a material possessing electrical conduction properties that fall somewhere between conductors and insulators. Usually made by adding carbon particles to an insulator and used to provide a graduated transition between conductor and insulation in high-voltage cable. Not the same as semiconductor materials, such as silicon, germanium, etc., used for making transistors and diodes.

SEMICONDUCTING JACKET—A jacket having a sufficiently low-electrical resistance so its outer surface can be kept at substantially ground potential.

SEMIRIGID CABLE—Generally refers to Type MI or Type ALS that can be bent or shaped into a required configuration from coils or reels.

Glossary

SEMIRIGID PVC—A hard semiflexible polyvinylchloride compound with low plasticizer content.

SEMISOLID—An insulation cross-section having a partially open space between the conductor and the insulation perimeter.

SENSITIVE CONDUCTOR—A conductor terminated to a circuit that is adversely affected by spurious signals.

SEPARABLE INSULATED CONNECTOR—An insulated device to facilitate cable connections and separations.

SEPARATOR—Pertaining to wire and cable, a layer of insulating material such as textile, paper, Mylar, etc., which is placed between a conductor and its dielectric, between a cable jacket and the components it covers, or between various components of a multiple-conductor cable. It can be used to improve stripping qualities and/or flexibility, or can offer additional mechanical or electrical protection to the components it separates.

SE-R—Style R residential service entrance cable.

SERIAL INTERFACE—An interface that requires serial transmission, or the transfer of information in which the bits composing a character are sent sequentially. Implies only a single transmission channel.

SERIES CIRCUIT—A circuit in which the components are arranged end to end to form a single path for current.

SERVE—A filament or group of filaments such as fibers or wires, wound around a central core.

SERVED WIRE ARMOR—Spiral wrap of soft galvanized steel wires wrapped around a cable to afford mechanical protection and increase the cable-pulling tension characteristic.

SERVING—A wrapping applied over the core of a cable or over a wire.

SE—A UL cable type. Service entrance cable, 600 volts.

SEW, SEWF—A CSA cable type. Silicone rubber-insulated equipment wire.

SF—A CSA cable type. Silicone rubber insulated fixture wire, solid or seven-strand conductor, 200°C.

SFF—A CSA cable type. Same as SF, except flexible stranding 150°C.

SG—A CSA cable type. Same as SW except with ground wires.

SGO—A CSA cable type. Same as SWO except with ground wires.

SHD—Portable mine power cable, three or four individually shielded conductors, with grounding conductors, 5 kV through 25 kV.

SHEATH—The outer covering or jacket over the insulated conductors to provide mechanical protection for the conductors.

SHIELD—A sheet, screen or braid of metal, usually copper, aluminum or other conducting material placed around or between electric circuits or cables or their components, to contain any unwanted radiation, or to keep out any unwanted interference.

SHIELD COVERAGE—See SHIELD PERCENTAGE.

SHIELDED INSULATED SPLICE—An insulated splice in which a conducting material is employed over the full length of the insulation for electric stress control.

SHIELDED LINE—A transmission line whose elements confine radio waves to an essentially finite space inside a tubular conducting surface called the sheath, thus preventing the line from radiating radio waves.

SHIELD EFFECTIVENESS—The relative ability of a shield to screen out undesirable radiation. Frequently confused incorrectly with the term shield percentage, they are not the same.

SHIELDING, POWER CABLE—A conducting layer applied to increase safety, control dielectric stresses and prevent partial discharges.

SHIELD PERCENTAGE—The physical area of a circuit or cable actually covered by shielding material, expressed as a percentage.

SHORT—A low-resistance path that results in excessive current flow and often in damage.

SHOVEL CABLE—Normally an SHD-GC type that supplies high-voltage (2 kV to 25 kV) power to mobile equipment.

SHRINKING RATIO—The ratio between the expanded diameter and recovered diameter of shrinkable products.

SHRINK TEMPERATURE—The temperature that effects complete recovery of a heat shrinkable product from the expanded state.

SHRINK TUBING—Tubing that has been extruded, cross-linked and mechanically expanded, which when reheated or released will return to its original diameter.

SHUNT—A very low-resistance component used to divert a portion of the electric current.

SHUNT WIRE—A conductor joining two parts of an electric circuit to divert part of the current.

SI—An international system of standardized units of measurement.

SIC (SPECIFIC INDUCTIVE CAPACITANCE)—See DIELECTRIC CONSTANT.

SIGNAL—Any visible or audio indication that can convey information. Also, the information conveyed through a communications system.

SIGNAL CABLE—A cable designed to carry current of usually less than one ampere per conductor.

SIGNAL-TO-NOISE RATIO—A ratio of the amplitude in a desired signal to the amplitude of noise, usually expressed in dB.

SILICONE—A material made from silicon and oxygen. Can be in thermosetting elastomer or liquid form. The thermosetting elastomer form is noted for high heat resistance.

SINGLE CABLE—A one-cable system in broadband LANs in which a portion of the bandwidth is allocated for send signals and a portion for receive signals, with a guard band in between to provide isolation from interference.

SINGLE-MODE—Optical fiber in which only one mode of light can propagate.

SINTERING—Fusion of an extruded paste or a spirally applied tape wrap insulation or jacket by the use of high heat to a homogenous continuum. Usually employed for fluorocarbon, nonextrudable materials.

SIS—Switchboard wiring made with cross-linked polyethylene insulation.

SJ—A UL or CSA cable type. Junior hard service, rubber-insulated pendant or portable cord. Same construction as type S, but 300 V.

- SJO**—Same as SJ, but with oil-resistant jacket.
- SJ00**—Same as SJO but with oil-resistant insulation as well as an oil-resistant jacket.
- SJT**—A UL or CSA cable type. Junior hard service thermoplastic or rubber insulated conductors with overall thermoplastic jacket. 300 V.
- SJTO**—Same as SJT but oil-resistant thermoplastic outer jacket.
- SJTOO**—Same as SJTO but with oil-resistant insulation.
- SKIN EFFECT**—The tendency of alternating current, as its frequency increases, to travel only on the surface of a conductor.
- S METER**—An instrument to measure signal strength.
- S/N**—See SIGNAL-TO-NOISE RATIO.
- SNM**—Shielded nonmetallic sheathed cable.
- SO**—A UL or CSA cable type. Hard service cord, same construction as type S except oil-resistant thermoset jacket, 600 V.
- SOFT WIRE**—Wire that has been drawn or rolled to final size and then heated (annealed) to remove the effects of cold working.
- SOLEF**—Solvay's trademark for its PVDF polymer.
- SOLID CONDUCTOR**—A conductor consisting of a single wire.
- SOO**—Same as SO but with oil-resistant insulation.
- SOOW**—A UL or CSA cable type. Portable cord and control cable. 600 V. Same as SOO but UL Listed or CSA Certified for outdoor use.
- SOURCE COUPLING LOSS**—Loss of light intensity as the light from a source passes into an optical fiber.
- SPACER CABLE**—A type of overhead power distribution cable. Spacing is accomplished by ceramic or plastic hangers suspended from a support messenger.
- SPAN**—In flat conductors, distance between the reference edge of the first and the last conductor. In round conductors, distance between centers of the first and last conductors.
- SPC**—Statistical process control.
- SPECIFIC INDUCTIVE CAPACITY (SIC)**—Dielectric constant of an insulating material.
- SPIRAL SHIELD**—A metallic shield of fine stranded wires applied spirally rather than braided.
- SPIRAL STRIPE**—A color coding stripe applied helically to the surface of an insulated wire or cable.
- SPIRAL WRAP**—The helical wrap of a tape or thread over a core.
- SPLICE**—A connection of two or more conductors or cables to provide good mechanical strength as well as good electrical conductivity.
- SPLITTER**—A passive device used in a cable system to divide the power of a single input into two or more outputs of lesser power. Can also be used as a combiner when two or more inputs are combined into a single output.
- SP-1**—A UL cable type. All thermoset, parallel-jacketed, two-conductor light duty cord for pendant or portable use in damp locations, 300 V.
- SP-2**—Same as SP-1, but heavier construction, with or without a third conductor for grounding purposes, 300 V.
- SP-3**—Same as SP-2, but heavier construction for refrigerators or room air conditioners, 300 V.
- SPT**—A UL type of thermoplastic-insulated, two- or three-conductor parallel cord. Frequently called “zip cord” or “lamp cord.”
- SQUIRREL CAGE MOTOR**—An induction motor having the primary winding (usually the stator) connected to the power and a current is induced in the secondary cage winding (usually the rotor).
- SR**—Silicone rubber cable 600 V, 125°C.
- SRG**—A cable with ozone-resistant silicone rubber insulation with an overall jacket of braided glass yarn impregnated with flame-, heat- and moisture-resistant finish. 150/200°C 600 V appliance and motor lead wire.
- SRGK**—A cable with ozone-resistant silicone rubber insulation with braided glass yarn conductor jacket. Cable core of insulated conductors shielded or unshielded and an overall jacket of braided K-fiber impregnated with flame-, heat- and moisture-resistant finish. 150/200°C 600 V multiconductor cable.
- SRK**—A cable with ozone-resistant silicone rubber insulation with an overall jacket of braided K-fiber impregnated with flame-, heat- and moisture-resistant finish. 200°C 600 V fixture wire and power cable.
- ST**—A UL cable type. Hard service cord, jacketed, same as type S except thermoplastic construction. 600 V, 60°C to 105°C.
- ST1**—Smoke Test #1. An optional rating for UL Listed cable types that also pass the Limited Smoke requirements contained in UL Standards. A cable that meets the requirement can be marked “ST1.”
- STABILITY FACTOR**—The difference between the percentage power factor at 80 volts/mil and at 40 volts/mil measured on wire immersed in water at 75°C for a specified time.
- STANDARD**—A set of rules or protocols that describe how a device should be manufactured so it will be reliable and interoperable (compatible) with others of the same type from different manufacturers.
- STANDING WAVE**—The stationary pattern of waves produced by two waves of the same frequency traveling in opposite directions on the same transmission line. The existence of voltage and current maximum and minimum along a transmission line is a result of reflected energy from an impedance mismatch.
- STANDING WAVE RATIO (SWR)**—In a transmission line, waveguide or analogous system, a figure of merit used to express the efficiency of the system in transmitting power.
- STATIC CHARGE**—An electrical charge that is bound to an object. An unmoving electrical charge.
- STAY CORD**—A component of a cable, usually a high-tensile textile, used to anchor the cable ends at their points of termination and to keep any pull on the cable from being transferred to the electrical connections.
- STEP INDEX FIBER**—A multimode optical fiber consisting of a core of uniform refractive index, surrounded by cladding of slightly lower refractive index.

Glossary

STIFFNESS—As applied to copper, the property of a conductor that causes it to resist permanent deformation by bending.

STO—A North American flexible cord type. Same as ST but with an oil-resistant thermoplastic outer jacket, 600 V, 60°C.

STOO—Same as STO but with oil-resistant insulation.

STOOW—Same as STOO but suitable for use in wet locations.

STOP JOINT—A splice that is designed to prevent any transfer of dielectric fluid between the cables being joined.

STP—Shielded twisted pair. Two wires, wound around each other to help cancel out any induced noise in balanced circuits. Multiple pairs of wires are contained in one sheath and each wire pair is shielded.

STRAIGHT JOINT—A cable splice used for connecting two lengths of cable, each of which consists of one or more conductors.

STRAIN GAUGE—A device for determining the amount of strain (change in dimension) when a stress is applied.

STRAIN HARDENING—An increase in hardness and strength caused by plastic deformation at temperatures lower than the recrystallization range.

STRAND—One of the wires of any stranded conductor.

STRANDED CONDUCTOR—A conductor composed of a group of wires, usually twisted, or of any combination of such groups of wires.

STRAND LAY—The distance of advance of one strand of a spirally stranded conductor, in one turn, measured longitudinally. Also referred to as lay length.

STRESS-RELIEF CABLE—Cable used to relieve stresses in the process of welding pipe joints by inducing heat in pipe sections to be welded, flexible copper strand.

STRESS-RELIEF CONE (TERMINATION)—A device used to relieve the electrical stress at a shielded cable termination; generally used above 2,400 volts.

STRIP—To remove insulation from a wire or cable.

STRUCTURAL RETURN LOSS—Backward reflected energies from uneven parts of the cable structure.

SUBSTRATE—Insulating material layer on a printed wiring board.

SUGGESTED WORKING VOLTAGE—AC voltage that can be applied between adjacent conductors.

SUPERCONDUCTORS—Materials whose resistance and magnetic permeability are virtually zero at very low temperatures.

SUPPRESSOR—A device used to reduce or eliminate unwanted voltages in electric or electronic circuits. For example, a resistance conductor in, or a resistor in series with, a spark plug cable to suppress interference that would otherwise affect radio reception in and near the vehicle.

SURFACE RESISTIVITY—The resistance of a material between two opposite sides of a unit square of its surface. It is usually expressed in ohms.

SURGE—A temporary and relatively large increase in the voltage or current in an electric circuit or cable. Also called transient. Commonly caused by environmental conditions (lightning) or sudden load changes. Protective devices are employed to prevent damage from surges.

SV—A North American cable type. Vacuum cleaner cord, two or three conductor, rubber insulated. Overall rubber jacket. For light duty in damp locations, 300 V 60°C.

SVO—A North American cable type. Same as SV except oil-resistant thermoset jacket, 300 V 60°C or 90°C.

SVT—A North American cable type. Same as SV except thermoplastic jacket. 300 V, 60°C or 90°C.

SVTO—A North American cable type. Same as SVT, except with oil-resistant thermoplastic jacket, 60°C.

SW—A CSA cable type. Rubber jacketed power supply cable (8 AWG to 2 AWG) 600 V.

SWR—Standing wave ratio. The ratio of incoming to reflected energy in a cable system. See also VSWR.

SWEEP TEST—A test to check attenuation at a range of frequencies.

T

TAKE-UP—The process of accumulating wire or cable onto a reel, bobbin or some other type of pack. Also, the device for pulling wire or cable through a piece of equipment or machine.

TANK TEST—A dielectric strength test in which the test sample is submerged in water and voltage is applied between the conductor and the water acting as ground.

TAP—(1) Baseband. The component of a connector that attaches a transceiver to a cable. (2) Broadband. Also called a directional tap or multitap. A passive device used to remove a portion of the signal power from the distribution line and deliver it onto the drop line.

TAPED INSULATION—Insulation of helically wound tapes applied over a conductor or over an assembled group of insulated conductors.

TAPED SPLICE—A joint with hand-applied tape insulation.

TAPE WRAP—A spirally applied tape over an insulated or uninsulated wire.

TC—A UL cable type. See Tray Cable, NEC Article 336.

TCLP—Toxicity characteristic leaching procedure. A test created by the EPA to determine whether an item can be safely discarded in an ordinary (nonhazardous) landfill.

T CONNECTOR—A cable adapter that attaches a PC with a network interface module to the network.

TEAR STRENGTH—The force required to initiate or continue a tear in a material under specified conditions.

TEFLON—Trademark of the DuPont Co. for FEP, PTFE and PFA polymers.

TEMPERATURE RATING—The maximum temperature at which an insulating material may be used in continuous operation without loss of its basic properties.

TENSILE STRENGTH—The maximum load per unit of original cross-sectional area that a conductor attains when tested in tension to rupture.

TERMINALS—Metal wire termination devices designed to handle one or more conductors, and to be attached to a board, bus or block with mechanical fasteners.

TERMINATOR—A resistive device used to terminate the end of cable or an unused tap into its characteristic impedance. The terminator prevents interference-causing signal reflections.

TEST LEAD—A flexible, insulated lead wire used for making tests, connecting instruments to a circuit temporarily, or for making temporary electrical connections.

TEW—CSA appliance wire type. Solid or stranded single conductor, plastic insulated, 105°C, 600 V.

TEXTILE BRAID—Any braid made from threads of cotton, silk or synthetic fibers.

TF—A UL cable type. Fixture wire, thermoplastic-covered solid or seven strands, 60°C.

TFE—One of three types of Teflon. Also known as PTFE (polytetrafluoroethylene).

TFF—Same as TF but flexible stranding, 60°C.

TFFN—Same as TFF but with nylon outer jacket.

TFN—Same as TF but with nylon outer jacket.

TG—Flexible nickel or nickel-clad copper conductor, Teflon tape, glass braid, 200°C.

TGGT—PTFE Teflon tape insulation with an insulation covering of wrapped glass yarn and an overall sheath of braided glass yarn impregnated with a moisture, heat, flame and fraying resistant compound. 600 V, 250°C appliance wire.

TGS—Solid or flexible copper, nickel-clad iron or copper, or nickel conductor. Teflon tape, silicone glass braid, 600 V 250°C.

THERMAL AGING—Exposure to a thermal condition or programmed series of conditions for predescribed periods of time.

THERMOCOUPLE—A device consisting of two dissimilar metals in physical contact, which when heated will develop an EMF output.

THERMOCOUPLE ELEMENT—A thermocouple designed to be used as part of an assembly, but without associated parts such as terminal block, connecting head or protecting tube.

THERMOCOUPLE EXTENSION CABLE—A cable comprised of one or more twisted thermocouple extension wires under a common sheath.

THERMOCOUPLE EXTENSION WIRE—A pair of wires of dissimilar alloys having EMF temperature characteristics complementing the thermocouple with which it is intended to be used, such that when properly connected allows the EMF to be accurately transmitted to the reference junction.

THERMOCOUPLE LEAD WIRE—An insulated pair of wires used from the thermocouple to a junction box.

THERMOPLASTIC—A material that softens when heated and becomes firm on cooling.

THERMOSET—A material that has been hardened or set by the application of heat or radiation, and which, once set, cannot be resoftened by heating. The application of heat or radiation is called “curing.”

THHN—A UL cable type. 600 V, 90°C nylon-jacketed building wire for use in dry and damp locations.

THREE-PHASE CURRENT—Current delivered through three wires, with each wire serving as a return for the other two.

THREE-PHASE THREE-WIRE SYSTEM—An alternating current supply system comprising three conductors over which three-phase power is sent.

THREE-QUARTER-HARD WIRE—As applied to aluminum, wire that has been processed to produce a strength approximately midway between that of half-hard wire and that of hard-drawn wire.

THREE-WIRE SYSTEM—A DC or single-phase AC system comprising three conductors, one of which is maintained at a potential midway between the potential of the other two.

THW—A UL cable type. Thermoplastic vinyl-insulated building wire. Flame-retardant, moisture and heat resistant. 75°C rated in dry and wet locations.

THW-2—A UL cable type. Thermoplastic vinyl-insulated building wire. Flame-retardant, moisture and heat resistant. 90°C rated in dry and wet locations.

THWN—A UL cable type. Same as THW but with nylon jacket overall. Rated 75°C in wet and dry locations.

THWN-2—A UL cable type. Same as THW but with nylon jacket overall. Rated 90°C in wet and dry locations.

TIA—Telecommunications Industries Association.

TINNED WIRE—See COATED WIRE, OVERCOAT CONDUCTOR and TOPCOATED.

TIN OVERCOAT (TOC)—Tinned copper wire, stranded, then coated with tin.

TINSEL WIRE—A low-voltage stranded wire, with each strand a very thin conductor ribbon spirally wrapped around a textile yarn.

TKGT—PTFE Teflon tape insulation with an insulating covering of felted K-fiber yarn and an overall sheath of braided glass yarn impregnated with a moisture-, heat-, flame- and fraying-resistant compound. 250°C 600 V apparatus and motor lead wire.

TL-9000—A quality system for the telecommunications industry based on ISO 9000.

TNC—A threaded connector for miniature coax; TNC is said to be an abbreviation for threaded-Neill-Concelman. Contrast with BNC, a similar nonthreaded bayonet connector.

TOPCOATED—Bare (untinned) copper wire, stranded then coated with pure tin.

TPE—Thermoplastic elastomer.

TRACER—A means of identifying an individual conductor (e.g., for polarity, etc.).

TRANSCEIVER—A device required in baseband networks which takes the digital signal from a computer or terminal and imposes it on the baseband medium.

TRANSCEIVER CABLE—Cable connecting the transceiver to the network interface controller allowing nodes to be placed away from the baseband medium.

TRANSFER IMPEDANCE TEST—A laboratory test that measures the effectiveness of a cable shield to keep EMI in (or out) of the cable. Usually conducted per NEMA WC61. Sometimes also referred to as a “surface transfer impedance” test.

TRANSITION SPLICE—A cable splice that connects two different types of cable.

TRANSMISSION—The dispatching of a signal, message, or other form of intelligence by wire, radio, telegraphy, telephony, facsimile, or other means.

TRANSMISSION CABLE—Two or more transmission lines. See TRANSMISSION LINE.

TRANSMISSION LINE—A signal-carrying circuit with controlled electrical characteristics used to transmit high-frequency or narrow-pulse signals.

Glossary

TRANSMISSION LOSS—The decrease or loss in power during transmission of energy from one point to another. Usually expressed in decibels.

TRANSPOSITION—Interchanging the relative positions of wires to neutralize the effects of induction to or from other circuits or to minimize interference pickup by the lead-in during reception.

TRAY—A cable tray system is an assembly of units or sections and ancillary fittings, made of noncombustible materials used to support cables. Cable tray systems include ladders, troughs, channels, solid bottom trays and similar structures.

TRAY CABLE—A factory-assembled multiconductor or multipair control cable approved under the National Electrical Code for installation in trays.

TREEING—Microscopic tree-like channels in medium-voltage cable insulation that can lead to cable failure.

TRIAxIAL—A three-conductor cable with one conductor in the center, a second circular conductor concentric with and insulated from the first, and a third circular conductor insulated from and concentric with the second, and an impervious sheath overall.

TRIBOELECTRIC NOISE—Noise generated in a shielded cable due to variations in capacitance between shielding and conductor as the cable is flexed.

TROLLEY WIRE—A round or shaped solid, bare, hard conductor ordinarily used to supply current to motors through traveling current collectors.

TRUNK CABLE—A main cable used for distribution of signals over long distances throughout a cable system.

TRUE CONCENTRIC—A cable conductor in which each successive strand layer has a reversed direction of lay from the preceding layer.

TR-XLP—Tree retardant cross-linked polyethylene.

TUBING—A tube of extruded unsupported plastic material.

TURNKEY SYSTEM—Refers to any system that is completely assembled and tested by one party for another that only requires the purchaser to turn the key on to be fully operational.

TV CAMERA CABLE—Multiconductor (often composite) cable to carry power for camera, lights, maneuvering motors, intercom signals to operators, video, etc. Usually heavy-duty jacketed.

TW—A UL wire type. Thermoplastic vinyl-jacketed building wire, moisture resistant and rated 60°C.

TWINAXIAL CABLE—A shielded coaxial cable with two central insulated conductors.

TWIN COAXIAL—A coaxial cable configuration containing two separate, complete coaxial cables laid parallel or twisted around each other in one unit.

TWIN-LEAD—A transmission line having two parallel conductors separated by insulating material. Line impedance is determined by the diameter and spacing of the conductors.

TWINNER—A device for twisting together two conductors.

TWINNING—Synonymous with pairing.

TWISTED PAIR—A pair of insulated copper conductors that are twisted around each other, mainly to cancel the effects of electrical noise; typical of telephone and LAN wiring.

U

U-BEND TEST—A cable test in which the insulation is tested for resistance to corona and ozone.

UF—A UL Underground Feeder cable type. Thermoplastic underground feeder or branch circuit cable.

UHF—Ultrahigh frequency, the band extending from 300 to 3,000 MHz as designated by the Federal Communications Commission.

UL—Underwriters Laboratories, Inc. A U.S. independent testing laboratory that also publishes standards for most products in the NEC.

UL LISTED—A product that has been tested and found to comply with applicable standards. Listing also involves regular follow-up to ensure continued compliance.

UL STYLE—A subset of UL Type AWM (appliance wiring material) consisting of thousands of different styles. Many UL styles are single-conductor hook-up wire. A unique four or five digit number, e.g., UL 1015, identifies each style. Styles identify an additional subset of features from the referenced standards in order to allow customers to quickly identify the type of wire needed.

ULTRASONIC CLEANING—Immersion cleaning aided by ultrasonic waves that cause microagitation.

ULTRASONIC DETECTOR—A device that detects ultrasonic noise such as that produced by corona or leaking gas.

ULTRAVIOLET—Radiant energy within the wavelength range 10 to 380 nanometers. It is invisible and can be filtered out by glass.

UNBALANCED LINE—A transmission line in which voltages on the two conductors are unequal with respect to ground (e.g., coaxial cable).

UNBALANCED-TO-GROUND—Describing a two-wire circuit, where the impedance-to-ground on one wire is measurably different from that on the other, compare with BALANCED LINE.

UNIDIRECTIONAL CONDUCTOR—See CONCENTRIC-LAY CONDUCTOR.

UNIDIRECTIONAL STRANDING—A term denoting that in a stranded conductor all layers have the same direction of lay.

UNILAY—More than one layer of helically-laid wires with the direction of lay and length of lay the same for all layers. See CONCENTRIC-LAY CONDUCTOR.

USE—A UL cable type. Underground service entrance cable, XLP or rubber-insulated, CSPE or XLP jacketed.

UTP—Unshielded twisted pair. Two wires, usually twisted around each other to help cancel out induced noise in adjacent circuits. An unshielded twisted-pair cable usually contains four pairs in a single cable jacket.

V

V—Volts. The SI unit of electrical potential difference. One volt is the difference in potential between two points of a conducting wire carrying a constant current of one ampere when the power dissipated between these two points is equal to one watt. It represents the energy available per unit charge within an electrical system (joules /coulombs).

VA—Volt-ampere. A designation of power in terms of volts and amperes. See APPARENT POWER.

VAR—A unit of reactive power that means volt-amperes, reactive.

VAR METER—An instrument used by power companies to measure the kVAR consumption. Utilities charge more for loads that consume large amount of reactive power.

V BAND—A band of frequencies between 46 and 56 gigahertz.

VC—Varnished-cambric insulation.

VCSSEL—Vertical-cavity surface-emitting laser is a type of semiconductor laser diode operating in the 850-nm wavelength window that is commonly used in Ethernet-based networks.

VDE—Association of German Electrical Engineers.

VELOCITY OF PROPAGATION—The transmission speed of an electrical signal down a length of cable compared to its speed in free space. Usually expressed as a percentage.

VFD CABLE—Variable frequency drive cable. A power cable specially designed for use with VFDs. Usually has three-phase conductors, three symmetrically positioned grounding conductors and an overall RF shield. Also called adjustable speed drive (ASD) cable.

VG—Varnished-glass or nylon braid, 600 V or 3,000 V, 130°C.

VHF—Very high frequency. The band extending from 30 to 300 MHz as designated by the Federal Communications Commission.

VIDEO PAIR CABLE—A transmission cable containing low-loss pairs with an impedance of 125 ohms. Used for TV pickups, closed-circuit TV, telephone carrier circuits, etc.

VISCOSITY—Internal friction or resistance to flow of a liquid: the constant ratio of shearing stress to rate of shear.

VLF—Very low frequencies. The band extending from 10 to 30 kHz, as designated by the Federal Communications Commission.

VOICE FREQUENCY (VF)—Describes an analog signal within the range of transmitted speech, typically supported by an analog telecommunications circuit.

VOLT—A unit of electrical “pressure.” One volt is the amount of electrical potential that will cause one ampere of current to flow through one ohm of resistance. Volt is a SI unit, the base units are joules (energy) per coulomb (charge) (J/C).

VOLTAGE—Electrical potential or electromotive force expressed in volts.

VOLTAGE BREAKDOWN—A test to determine the maximum voltage insulated wire can withstand before failure.

VOLTAGE, CORONA EXTINCTION—The minimum voltage that sustains corona (partial discharge), determined by applying a corona producing voltage, then decreasing the voltage until corona is extinct.

VOLTAGE DIVIDER—A network consisting of impedance elements connected in series to which a voltage is applied and from which one or more voltages can be obtained across any portion of the network.

VOLTAGE DROP—The voltage developed across a conductor by the current and the resistance or impedance of the conductor. Also refers to the voltage used in a system to overcome the wiring resistance. Long runs of cable sized closely to the operating ampacity can suffer significant voltage drop that affects the load. Less than 5 percent is recommended by the NEC, around or less than 2 percent is ideal. Using larger conductor (less resistance) if possible will solve voltage drop problems.

VOLTAGE, INDUCED—A voltage produced in a conductor by a change in magnetic flux from an outside source.

VOLTAGE RATING—The highest voltage that may be continuously applied to a wire or cable in conformance with standards or specifications.

VOLTAGE STANDING WAVE RATIO (VSWR)—The ratio of the maximum effective voltage to the minimum effective voltage measured along the length of a mismatched radio frequency transmission line.

VOLTAGE TO GROUND—The voltage between an energized conductor and earth.

VOLUME RESISTIVITY—The resistance in ohms of a body of unit length and unit cross-sectional area.

VSWR—See VOLTAGE STANDING WAVE RATIO.

VULCANIZATION—A chemical reaction in which the physical properties of a polymer are changed by reacting it with cross-linking agents.

VW-1—Vertical wire flame test. Formerly designated as FR1. A UL fire rating for single conductor cables. The test is described in UL Standard 1581.

W

W—(1) Symbol for watt or wattage. (2) A UL cable type. Heavy-duty portable power cable, one to six conductors. 600 V, without grounds.

WALL THICKNESS—The thickness of an applied insulation or jacket. Generally wall thickness increases for higher voltages.

WATER ABSORPTION—A test to determine the amount of water absorbed by a material after a given immersion period.

WATER-BLOCKED CABLE—A multiconductor cable having interstices filled with a water-blocking compound to prevent water flow or wicking.

WATER-COOLED LEADS—Furnace cables. High-energy cables. Usually welding cable strands cabled with a hose core for carrying coolant used in heavy-duty welding equipment, electric furnace applications, plating and various chemical processes.

WATER TREEING—A type of insulation deterioration that can occur after long-term immersion in water with an electrical stress applied.

Glossary

WATERFALL—The point at which cables installed horizontally in a tray transition to a vertical section of tray.

WATT—A unit of electrical power (energy consumed per unit time). One watt is equivalent to the power represented by one ampere of current under a pressure of one volt in a DC circuit.

WAVEFORM—A graphical representation of a varying quantity. Usually, time is represented on the horizontal axis and the current or voltage value is represented on the vertical axis.

WAVE FRONT—(1) That portion of an impulse (in time or distance) between the 10 percent point and the point at which the impulse reaches 90 percent of crest value. (2) The rising part of an impulse wave.

WAVELENGTH—The distance between the nodes of a wave. The ratio of the velocity of the wave to the frequency of the wave.

WAVESHAPE REPRESENTATION—The designation of current or voltage by a combination of two numbers. For other than rectangular impulses: (a) virtual duration of the wave front in microseconds; and (b) time in microseconds from virtual zero to the instant at which one-half of the crest value is reached on the tail. For rectangular impulses: (a) minimum value of current or voltage; and (b) duration in microseconds.

WEEE—Waste Electrical and Electronic Equipment. A European Union regulation (Directive 2002/96/EC) which holds the manufacturer responsible for proper recycling or disposal when it reaches end-of-life. See also RoHS and REACH.

WEIGHT RESISTIVITY—The resistance in ohms at a specified temperature of a copper wire of uniform cross section and of unit weight and unit length.

WELDING—Joining the ends of two wires, rods or groups of wires: (a) by fusing, using the application of heat or pressure or both, by means of a flame torch, electric arc, or electric current; or (b) by cold pressure.

WHEATSTONE BRIDGE—A device used to measure DC resistance. See BRIDGE.

WICKING—The longitudinal flow of a liquid in a wire or cable due to capillary action.

WIRE—A rod or filament of drawn or rolled metal whose length is great in comparison with the major axis of its cross section.

WIRE BRAID—Flexible wire constructed of small size strands in tubular form. Used for shielding or connections where constant flexing is required.

WIRE GAUGE (AWG)—The American Wire Gauge, originally called Brown & Sharpe Gauge. A system of numerical wire sizes starting with the lowest numbers for the largest sizes. Gauge sizes are each 20.6 percent apart based on the cross-sectional area.

WIRE NUT—A closed-end splice that is screwed on instead of crimped.

WIRE-WRAPPED CONNECTION—A solderless connection made by wrapping bare wire around a square or rectangular terminal with a power or hand tool.

WIRE WRAPPING TOOLS—Portable electric tools and automatic stationary machines used to make solderless wrapped connections of wires to terminals.

WITHSTAND TEST VOLTAGE—The voltage that the device must withstand without flashover, disruptive discharge, puncture or other electric failure when voltage is applied under specified conditions.

WP—Weatherproof construction for overhead wires.

WORKSTATION—(1) Input/output equipment at which an operator works; (2) A station at which a user can send data to, or receive data from, a computer or other workstation for the purpose of performing a job.

WRAPPER—An insulating barrier applied as a sheet of tape wrapped around a coil periphery.

X

X—Symbol for reactance.

X BAND—A band of frequencies between 5,200 and 10,000 megahertz.

XHHW—A UL cable type. Cross-linked polyethylene insulated small diameter building wire rated 75°C wet and 90°C dry.

XHHW-2—A UL cable type. Cross-linked polyethylene insulated small diameter building wire rated 90°C wet and dry.

XLP—Cross-linked polyethylene. Also written XLPE.

Y

YIELD STRENGTH—The point at which a substance changes from elastic to viscous.

Z

Z—Symbol for impedance.

ZERO SEQUENCE IMPEDANCE—The electrical impedance of a three-phase power cable under fault (short-circuit) conditions. It is typically 2.5 to 3 times the positive sequence impedance.

ZETABON—Dow's trade name for an acrylic acid copolymer coated aluminum tape.

ZIPPER TUBING—Alpha's trade name for harnessing/jacketing material containing a zipper-track type closure. The zipper arrangement allows installation with no need to disconnect installed wire. See LOC-TRAC.

ZYTEL—DuPont's trademark for nylon resins.