

Technical Information

Conductor and Insulation Materials

The technical information provided in this section has been expanded to include additional graphs and supplementary data as an aid in specifying the hook-up and lead wire best suited to the needs of a particular application. If you require additional technical information, contact Belden Technical Support at **1-800-BELDEN-1**.

The tables on the following pages are offered as a guide to assist users in selecting the correct lead wire for their application.

Conductors

Uni-Strand®

Uni-Strand tinned copper conductor. In this type of construction, the bare copper wires are stranded, then tinned to coat the strands and also to fill in the interstices between strands. This allows for easier wire stripping with no re-twisting operation.

Insulation Materials

PVC

Vinyl plastic insulation is fast stripping, resists oil, solvents, and ozone. The colors are bright and remain distinct after processing. Applications include motors, transformers, fluorescent ballasts and fixtures, switchboards, panels, controls, rectifiers and electronic circuits. Meets VW-1 Vertical Wire Flame Test in many cases.

Teflon®

Teflon is a fluorinated thermoplastic with outstanding thermal, physical, and electrical properties. Teflon is generally restricted to applications requiring its special characteristics because its basic resin and processing costs are relatively high.

Belden Teflon wire products are highly recommended for miniature cable applications because of their superior thermal and electrical properties. Teflon is especially suitable for internal wiring-soldering applications where insulation melt back is a specific problem. Belden wiring products insulated with Teflon are outstanding in their resistance to oil, oxidation, heat, sunlight and flame; and also in their ability to remain flexible at low temperatures. They have excellent resistance to ozone, water, alcohol, gasoline, acids, alkalis, aromatic hydrocarbons and solvents.

Hypalon and Teflon are DuPont trademarks.

EPDM

EPDM (ethylene-propylene diene elastomer) is a chemically cross-linked elastomer with excellent flexibility at high and low temperatures (+150°C to -60°C). It has good insulation and dielectric strength, as well as excellent abrasion resistance and mechanical properties. EPDM also has better cut-through resistance than Silicone rubber, which it replaces in some applications.

EPDM is compatible with most varnishes. After the dip and bake cycle, however, the varnish tends to adhere to the insulation because EPDM, unlike some rubber insulations, does not exude oils or waxes. As the lead wires are pulled apart for termination or flexed, the varnish cracks, sometimes tearing the insulation.

To help this problem, a stearic solution is applied to the lead wire during the manufacturing process. However, many varnishes may still bond to the insulation unless other special coatings are applied. (Other slip coats are available at additional cost.) **Because most cleaning processes will remove these coatings from the EPDM lead wire, cleaning EPDM lead wire before using in the process is not recommended.**

Due to the above, it is recommended that the compatibility between the individual lead wire size, the bake/varnish process and varnish used always be checked; and if possible, do not allow any varnish to extend beyond a point where the lead wire will be flexed or bent.

XL-Dur®

XL-Dur is a lead wire insulation utilizing thermoset, chemically cross-linked polyethylene. Because of its excellent physical and electrical properties, XL-Dur is highly desirable for a wide variety of applications.

Hypalon®

This insulation is chlorosulfonated polyethylene. Hypalon insulation has excellent heat resistance, color stability and electrical properties.

Neoprene

Neoprene insulation has good heat aging characteristics and is an excellent low-cost motor lead wire. It may be considered for use in hazardous locations and is being used in explosion-proof motors recognized by UL.

Silicone Rubber

Braidless Silicone lead wire features easy and clean stripping without the problems associated with glass braid lead wire. It has excellent physical and mechanical strength properties.

Recommended for high-temperature applications in motors, lighting fixtures, clothes dryers, stoves, therapeutic, and electronic devices. It is recommended that varnish compatibility be checked before production. Some rigid varnishes may cause cracking when the wire is severely bent.

Silicone Rubber — Glass Braid

The Silicone insulation strips clean and easy. The glass braid provides additional abrasion resistance and is treated to prevent fraying.

Recommended for high-temperature applications in motors, lighting fixtures, clothes dryers, stoves, therapeutic and electronic devices.

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Insulation Characteristics and Color Codes

Table 1: Insulation Characteristics

Insulation	Temperature Rating	UL Voltage Rating (Volts)	Oil Resistance	Ozone Resistance	Abrasion	Flame Resistance
Neoprene	90°C	300/600	Good	Good	Good	Good
PVC	80°C	300	Good-Excellent	Good-Excellent	Good	Excellent
	105°C	600	Good-Excellent	Good-Excellent	Good	Excellent
Hypalon®	105°C	300/600	Good	Excellent	Good	Good
XL-Dur®	105°C	300	Good	Good	Excellent	Fair-Good
Cross-Linked Polyethylene	125°C	600	Good	Good	Excellent	Fair-Good
	150°C	600	Good	Good	Excellent	Fair-Good
EPDM	125°C	600	Fair-Poor	Good	Good	Fair
	150°C	600	Fair-Poor	Good	Good	Fair
Silicone Rubber	150°C	300	Fair	Good	Poor	Good
	200°C	600	Fair	Good	Poor	Good
Silicone Rubber Glass Braid	150°C	600	Fair	Excellent	Excellent	Good
	200°C	600	Fair	Excellent	Excellent	Good
Teflon®	150°C	300	Excellent	Excellent	Excellent	Excellent
	200°C	300	Excellent	Excellent	Excellent	Excellent
	260°C	300	Excellent	Excellent	Excellent	Excellent

Table 2: Lead Wire Color Code Chart

Color No.	Color Combination	Color No.	Color Combination	Color No.	Color Combination
1	Brown	13	Dark Blue	25	White/Black/Yellow
2	Red	14	White/Black	26	White/Black/Blue
3	Orange	15	White/Red	27	White/Black/Brown
4	Yellow	16	White/Green	28	White/Black/Orange
5	Green	17	White/Yellow	29	White/Black/Gray
6	Light Blue	18	White/Blue	30	White/Black/Purple
7	Purple	19	White/Brown	189	Green/Yellow
8	Gray	20	White/Orange	620	Green/min. 30% Yellow
9	White	21	White/Gray	876	Nickel Gray
10	Black	22	White/Purple	B02	Purple
11	Tan	23	White/Black/Red		
12	Pink	24	White/Black/Green		

Non-Stock Colors: Non-stock colors and stripes of catalog items are available in minimum quantities. Price and delivery information is available upon request. Orders must be in multiples of standard packages.

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Current Carrying Capacity

Table 3: Lead Wire Current Carrying Capacity

AWG	90°C Neoprene, SIS	105°C Vinyl, Hypalon®	125°C XL-Dur, Hermetic	150°C EPDM, XL-Dur, Silicone	200°C Silicone
22	10	11	12	14	16
20	13	14	15	18	21
18	18	20	22	24	28
16	24	26	28	31	35
14	35	39	42	46	54
12	40	51	55	60	68
10	55	67	72	80	90
8	80	90	97	106	124
6	105	121	131	155	165
4	140	160	172	109	220
3	165	180	194	214	252
2	190	215	232	255	293
1	220	247	266	293	344
1/0	260	286	309	339	399
2/0	300	329	355	390	467
3/0	350	380	410	451	546
4/0	405	446	481	529	629

Values (amperes) shown in this table are maximum for a single conductor in free air with an assumed ambient room temperature of 30°C (86°F).

**Table 4:
Current Carrying Capacity of 2 or 3 Conductors**

AWG	90°C Neoprene, SIS	105°C Vinyl, Hypalon	125°C XL-Dur, Hermetic	150°C EPDM, XL-Dur, Silicone	200°C Silicone
22	6	7	8	9	10
20	8	9	10	13	15
18	14	15	16	17	20
16	18	19	20	22	25
14	25	29	31	34	36
12	30	36	39	43	45
10	40	46	50	55	60
8	55	64	69	76	83
6	75	81	87	96	110
4	95	109	118	120	125
3	110	129	139	143	152
2	130	143	154	160	171
1	150	168	181	186	197
1/0	170	193	208	215	229
2/0	195	229	247	251	260
3/0	225	263	284	288	297
4/0	260	301	325	332	346

Current carrying capacity of not more than three (3) conductors in a raceway, conduit or cable. The values (amperes) shown in this table are maximum at an assumed ambient room temperature of 30°C (86°F).

Hypalon is a trademark of DuPont.

How to Use

The choice of an appropriate conductor, with respect to current carrying capacity, usually depends on one or more factors which vary according to application. These factors include the temperature in which the lead wire operates, temperature rise of equipment, limitations of insulation, voltage drop, and location of wires as in free air or enclosed, such as formed by a compartment, tubing, or a bundle of wires.

For these reasons it is not practical to provide a general chart showing the current carrying capacity of Lead Wire for all conditions. Accordingly, the values shown in Table 3 are MAXIMUM for a single conductor in free air, based on ambient temperature of 30°C. For actual use temperatures above an ambient temperature of 30°C, reduce the maximum ampacity by use of correction factor in Table 5 to correct the values in Table 3 and Table 4.

Table 5: Correction Factors for Tables 3 & 4

Ambient Temperature (°C)	Insulation Temperature Rating				
	90°C	105°C	125°C	150°C	200°C
31 – 35	.96	1.00	1.00	1.00	1.00
36 – 40	.91	1.00	1.00	1.00	1.00
41 – 45	.87	.93	.94	.95	.97
46 – 50	.82	.93	.94	.95	.97
51 – 55	.76	.85	.87	.90	.94
56 – 60	.71	.85	.87	.90	.94
61 – 70	.58	.76	.80	.85	.90
71 – 80	.41	.65	.73	.80	.87
81 – 90	—	.53	.64	.74	.83
91 – 100	—	.38	.54	.67	.79
101 – 120	—	—	.24	.52	.71
121 – 140	—	—	—	.30	.61
141 – 160	—	—	—	—	.50
161 – 180	—	—	—	—	.35

For ambient temperatures over 30°C, multiply the ampacities shown in Table 3 or Table 4 by the appropriate correction factor to determine the maximum allowable load current.

Correction Factors for Table 4

Number of Conductors	Reduction Percentage
4 thru 6	80%
7 thru 9	70%
10 thru 20	50%
21 thru 30	45%
31 thru 40	40%
41 and above	35%

If more than three (3) conductors are in a raceway, conduit or cable, the values given in Table 4 must be reduced using the above percentages.

(Example: The ampacity for 7 through 9 conductors = 70% of the value(s) shown in Table 4.)

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Temperature Ranges and Classifications Conductor Configurations

Table 6: Nominal Temperature Operating Ranges (°C)

-100°	-80°	-60°	-40°	-20°	0	20°	40°	60°	80°	100°	120°	140°	160°	180°	200°	220°	240°		
				-30°	Neoprene					90°C									
				-30°	Hypalon®					105°C									
			-60°	EPDM					150°C										
			-75°	Silicone Braidless					200°C										
			-75°	Silicone Braided					200°C										
				-55°	Cross-Linked Polyethylene					150°C									
				-35°	PVC					105°C									
-100°	Teflon®															260°C			

Table 7: Temperature Classification

Insulation System Class	Minimum Acceptable Lead Wire Temperature Rating	
	C°	F°
130(B)	90	194
155(F)	125	257
180(H)	150	302
220(R)	200	392

Systems of Insulating Materials — UL Standard 1446

This is a guide intended for UL approved insulation systems connected to branch circuits of 600V or less. Approval required by Underwriters Laboratories when using lead wire with a temperature rating more than 5°C under the system temperature rating.

Table 8: Conductor Configurations

Typical Application	American Wire Gage							
	12	14	16	18	20	22	24	26
Fixed Services	19x25	solid	solid	solid	solid	solid	solid	solid
Hook-Up Wire		or	or	or	or	or	or	or
Cable in Raceway		19x27	19x29	7x26	7x28	7x30	7x32	7x34
				or	or			
				16x30	10x30			
Moderate Flexing	65x30	19x27	19x29	16x30	7x28,	7x30	7x34	7x34
Frequently Disturbed		or	or	or	10x30,	or	or	
For Maintenance		41x30	26x30	41x34	19x32,	19x34	10x34	
					or			
					26x34			
Severe Flexing	165x34	104x34	65x34	41x34	26x34	19x34	19x36	7x34
Microphone			or	or	or	or	or	or
Test Prods			104x36	65x36	42x36	26x36	45x40	10x36
Most Severe Duty	259x36	168x36	105x36	63x36	105x40			
Mercury Switches	(7x37	(7x24	(7x15	(7x9	(3x35	(Consider Braid or Tinsel)		
	Rope Lay)*	Rope Lay)*	Rope Lay)*	Rope Lay)*	Rope Lay)*			

Note: For a given AWG wire size (based on equal cross-sectional area of conductor), limpness and flex life are increased by use of a large number of fine strands. The finer stranding does result in higher costs.

*Rope Lay is several stranded groups cabled together. For example: #12 AWG, 259x36 is 7 cords each consisting of 37 strands of #36 AWG

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Packaging

Drums

Conductor is available in three drum pack sizes:

- The #15 Beldpak® is 15" high and 23" in diameter.
- The #31 Beldpak is 30½" high and 23" in diameter.
- The #42 Beldpak (pictured) is 42" high and 23" in diameter.



Price and delivery information is available upon request.

OD of Wire		#15 Beldpak		#31 Beldpak		#42 Beldpak	
Inch	mm	1000'	km	1000'	km	1000'	km
.070	1.78	35	10.7	70	21.3	85	25.9
.080	2.03	27	8.2	55	16.8	70	21.3
.090	2.29	21	6.4	43	13.1	55	16.8
.100	2.54	17	5.2	35	10.7	48	14.6
.110	2.79	12	3.7	25	7.6	40	12.2
.120	3.05	10	3.0	20	6.1	34	10.4
.130	3.30	9	2.7	18	5.5	30	9.1
.140	3.56	8	2.4	15	4.6	20	6.1
.150	3.81	7	2.1	14	4.3	18	5.5
.160	4.06	6	1.8	12	3.7	16	4.9
.170	4.32	5	1.5	10	3.0	14	4.3

Reels

Reel dimensions will vary by size, determined by AWG of wire.



OD of Wire		Quantity		Crate Reels*	Head Diameter		Barrel Diameter		Height Transverse	
Inch	mm	1000'	km		Inch	mm	Inch	mm	Inch	mm
.080	2.03	10.0	3.05	1748	15¾	400	8	203	8	203
.090	2.29	8.0	2.44	1748	15¾	400	8	203	8	203
.100	2.54	6.5	1.98	1748	15¾	400	8	203	8	203
.110	2.79	5.0	1.52	1748	15¾	400	8	203	8	203
.120	3.05	6.0	1.83	1747	15¾	400	8	203	10½	267
.130	3.30	5.0	1.52	1747	15¾	400	8	203	10½	267
.140	3.56	6.0	1.83	1746	17¾	451	8	203	10½	267
.150	3.81	5.0	1.52	1746	17¾	451	8	203	10½	267
.160	4.06	4.5	1.37	1746	17¾	451	8	203	10½	267
.170	4.32	7.0	2.13	1744	22	559	10	254	14¼	362
.180	4.57	6.0	1.83	1744	22	559	10	254	14¼	362
.190	4.83	5.5	1.68	1744	22	559	10	254	14¼	362
.200	5.08	5.0	1.52	1744	22	559	10	254	14¼	362
.250	6.35	5.0	1.52	1743	26	660	10	254	14¼	362
.300	7.62	3.5	1.07	1743	26	660	10	254	14¼	362
.350	8.89	2.5	.76	1743	26	660	10	254	14¼	362
.400	10.16	2.0	.61	1743	26	660	10	254	14¼	362
.450	11.43	1.5	.46	1743	26	660	10	254	14¼	362
.500	12.70	1.2	.37	1743	26	660	10	254	14¼	362
.550	13.97	1.0	.31	1743	26	660	10	254	14¼	362
.600	15.24	1.2	.37	1733	30	762	10	254	14¼	362

*Crate Reel numbers are Belden's internal numbers. They are representative only to the extent of the dimensions shown. Weight of the wire may require another reel with dimensions identical to those shown.

Special Orders

Orders for special packages must be placed for footage mentioned or for multiples for these quantities per color.