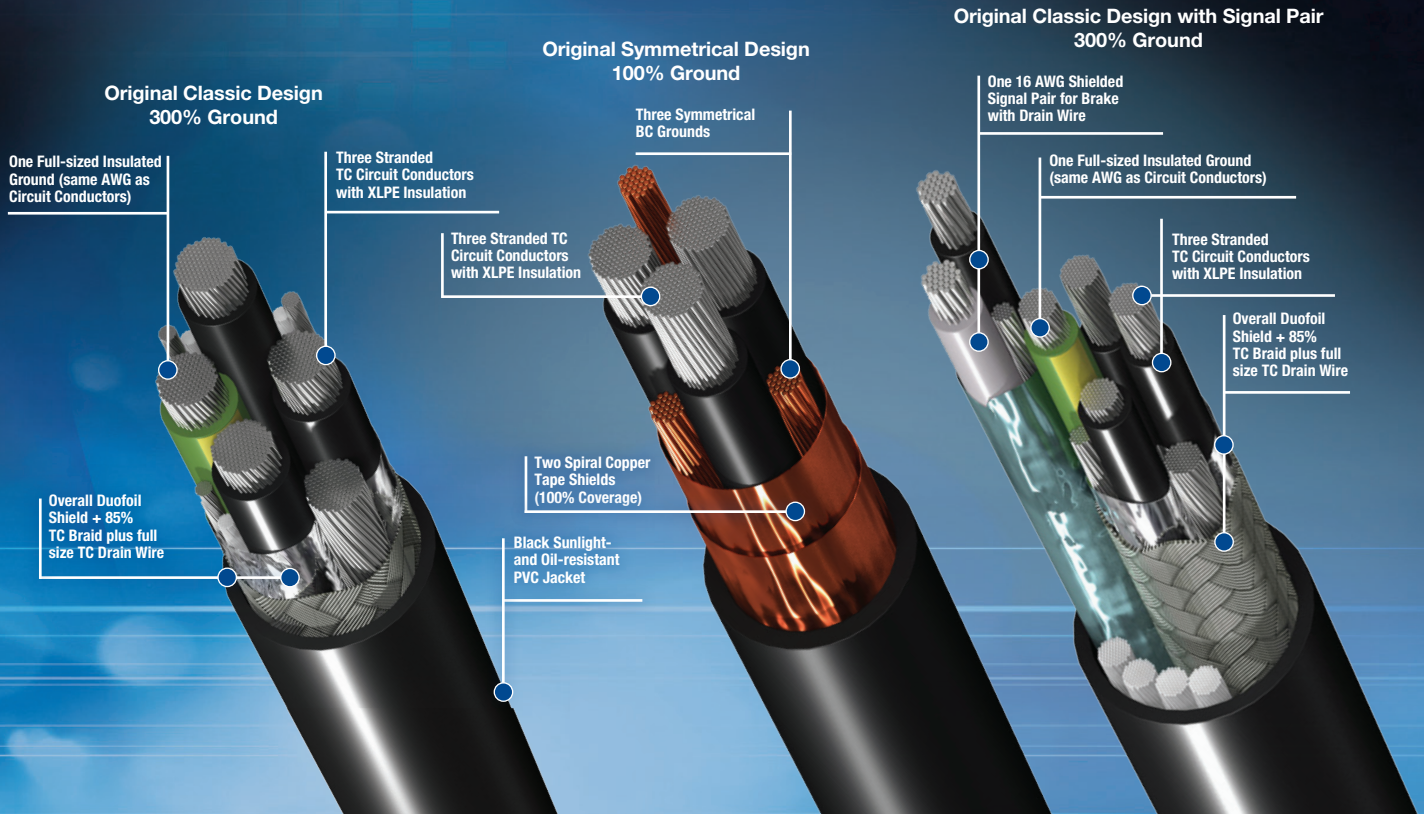


VFD Solutions for PowerFlex® Family



Power Cables For PowerFlex
4, 40, 400, 52x, 70, 700,
and 75x Series



**Be certain.
Belden.**

Power Cables

Why Use a Specially Designed VFD Cable?

Variable frequency AC motor drives generate significant electrical noise that can create issues with associated or near by equipment, affect operational reliability, and lead to system failures or downtime. Typical cabling solutions for this application have been unshielded tray cables, single-conductor lead wire installed in conduit or shielded tray. These solutions suffer from complex, costly installation and potential noise and reliability problems. Belden VFD Cables were designed and engineered to overcome these challenges.

The Main Challenges of VFD Applications

- Common mode current containment (CMC)
- Capacitive coupling and cable charging
- Reflective wave voltage
- Installation reliability and safety

VFD cables must handle not only the overall high power levels of the pulse-width modulated (PWM) VFD signals, but also the extremely high voltage which can occur when reflected waves develop on the conductors. This high voltage can cause

corona discharge between the conductors of conventional cables, causing damage not only to the cabling itself, but also to the motors, bearings, drives and related equipment. In turn, this damage can cause failure of the entire drive system, resulting in costly production downtime.

Limitations of Conventional VFD Cables

In addition to experiencing failures due to corona discharge and adverse environmental condition, conventional cabling is difficult and expensive to install. Armored cable and lead wire in conduit are cumbersome and heavy, plus require extremely large installation bending radii making installation both time-consuming and labor intensive. Yet they still do not solve noise and corona discharge problems, nor do they effectively address the high levels of noise generated by VFDs.

The Belden VFD Solution

Only Belden's series of VFD Cable provide the robust construction required to deliver superior electrical performance and reliability, even in the most demanding industrial environments.

Application Designed Grounding and Shielding

- Provides more grounding copper than other designs, ensuring the best containment of electrical noise

Thicker, Industrial-grade XLP Insulation

- Provides more stable electrical performance than PVC
- Lower capacitance resulting in :
 - Longer cable runs
 - Reduced peak motor terminal voltage for extended motor life
 - Reduced likelihood of corona discharge
 - Reduced magnitude of reflected waves
 - Increased efficiency of power transfer

High-strand Tinned Copper Circuit Conductors

- Superior high frequency transmission path for better CMC containment
- Higher flex life, better vibration resistance and easier installation
- Corrosion resistant for reliable termination

Industrial-Grade PVC or Optional HaloarrestXLink™ Low Smoke Zero Halogen (LSZH) Jackets

VFD Cable Types:

Original Classic Design – 300% Ground

Belden's Classic line of VFD cables, with foil/braid shields continues to be the highest-performing solution in the market and the cable recommended in most PowerFlex Installation Manuals. While other manufacturers offer the equivalent of one full-sized ground or less, Belden's oversized XLP insulation provides low capacitance. Belden's highly effective dual shielding and grounding system, featuring the **equivalent of three full-sized ground conductors**, provides the lowest impedance path to ground, improving common mode current containment. Included is a full-sized, insulated Green/Yellow ground wire, as well as a full-sized shield drain wire for ease of termination and installation. The 85% braid coverage and 100% overall Duofoil shield offers highly effective radiated and conducted noise protection.





**Original Classic with
Signal Pair – 300% Ground**

Belden's Classic line of VFD cables expands with the inclusion of one 16 AWG Shielded Signal Pair with drain wire for Brake Conductors.



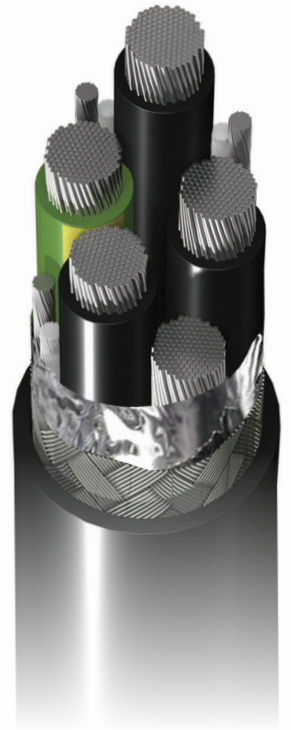
**Original Classic 2kV –
300% Ground**

Belden's Classic line of VFD cables further expands with new 2kV ratings. Maintaining the industry leading foil braided design, these cables are 2000V UL 1277 Type TC-ER per 2005 NEC Article 336.



**Symmetrical Design –
100% Ground**

Belden's Symmetrical ground design includes 100% coverage with dual copper tape shields that provide a low resistance path to ground, with improves common mode current containment. The spirally applied dual copper tapes provide improved flexibility and highly effective radiated and conducted noise protection. Three symmetrical bare ground wires provide a balanced ground system. This reduces AC motor shaft voltage, which in turn, reduces the likelihood of premature motor bearing or motor insulation failure.



**LSZH Marine Approved VFD –
100% Ground**

Belden introduces a Low Smoke, Zero Halogen Thermoset VFD Cable option. This cable provides the classic design with an innovative Haloarrest XLink ABS (American Bureau of Shipping) approved Jacket. Haloarrest XLink jackets offer non-toxic cable solutions particularly designed for demanding industrial markets including oil and gas, utility and power generation, transportation, petrochemical and mining. In addition, thermoset jackets do not melt at any level of heat or when exposed to flame, protecting workers and preventing damage to expensive machinery.





Selecting a VFD Cable:

While there are many factors that go into selecting the appropriate VFD cable for your application, the fundamental selection should be based on three key pieces of information:

- Motor HP
- Motor Voltage
- Motor Full Load Current (FLC) from NEC® section 430.250 FLC.

Using this you may select a cable gauge size and then correct for other factors.

Examples of additional factors include: ambient temperature, VFD cable and connector ratings, and the number of cables within the raceway.

(See correction and adjustment factors on page 5)

Basic VFD Cable Calculation Example

1. Determine amperage:
For a 3Ø, 460V, 50Hp Motor with a FLC rating of 65 Amps:
(See Table 430.250 below)
Per NEC the FLC x 125% is required to determine conductor ampacity.
 $65A \times 125\% = 81.25A$
2. Using NEC 310, find cable gauge that meets or exceeds amperage.
(See excerpt from NEC 310 on page 5)
3. Choose Belden part number
The correct Belden part number for a classic VFD cable in this example is 29506.

Assumptions

- Three current carrying conductors in raceway.
- Ambient temperature 30°C
- No need to use adjustment factors table

Note: The example shown is for a specific application under a specific set of conditions, and may not be applicable to any given situation. Always consult your Local Authority having jurisdiction for local and regional code compliance and interpretation questions.

NEC is a registered trademark of NFPA



Horsepower	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts	575 Volts
1/2	4.4	2.5	2.4	2.2	1.1	0.9
3/4	6.4	3.7	3.5	3.2	1.6	1.3
1	8.4	4.8	4.6	4.2	2.1	1.7
1½	12.0	6.9	6.6	6.0	3.0	2.4
2	13.6	7.8	7.5	6.8	3.4	2.7
3	-	11.0	10.6	9.6	4.8	3.9
5	-	17.5	16.7	15.2	7.6	6.1
7½	-	25.3	24.2	22	11	9
10	-	32.2	30.8	28	14	11
15	-	48.3	46.2	42	21	17
20	-	62.1	59.4	54	27	22
25	-	78.2	74.8	68	34	27
30	-	92	88	80	40	32
40	-	120	114	104	52	41
50	-	150	143	130	65	52
60	-	177	169	154	77	62
75	-	221	211	192	96	77
100	-	285	273	248	124	99
125	-	359	343	312	156	125
150	-	414	396	360	180	144
200	-	552	528	480	240	192
250	-	-	-	-	302	242
300	-	-	-	-	361	289
350	-	-	-	-	414	336
400	-	-	-	-	477	382
450	-	-	-	-	515	412
500	-	-	-	-	590	472

Based on Table 430.250 Full-Load Current, Three-Phase Alternating-Current Motors



Motor to VFD Power Cables

Based on NEC Table 310.15 (B) (16) 2014 for 75° Cable*



Conductor Rating (Amps)+	Conductor Gauge Size	Classic VFD Part No. UL/CSA (Recommended for PowerFlex Drives)	Classic w/Signal Pair Part No. UL	2kV VFD Part No. UL	Symmetrical VFD Part No. CSA	Thermoset LSZH VFD Marine Approvals UL
18	-	-	-	-	-	-
20	**14	29501	29511	29536	29550C	29501X
25	**12	29502	29512	29537	29551C	29502X
35	**10	29503	29513	29538	29552C	29503X
50	8	29504	-	29539	29553C	29504X
65	6	29505	-	29540	29554C	29505X
85	4	29506	-	29541	29555C	29506X
115	2	29507	-	29542	29556C	29507X
130	1	29528	-	29543	29557C	29528X
150	1/0	29529	-	29544	29558C	29529X
175	2/0	29530	-	29545	29559C	29530X
200	3/0	29531	-	29546	29560C	29531X
230	4/0	29532	-	29547	29561C	29532X
255	250 MCM	-	-	29533	29533	-
310	350 MCM	-	-	29534	29534	-
380	500 MCM	-	-	29535	29535	-

*All referenced Belden cables are rated 90° C, ampacity is limited by termination temperature of PowerFlex drives. At time of publishing, most PowerFlex VFDs were found to have connector ratings of 75°C. See NEC 310.15 (B) (16) 2014 for other temperature ratings.

**Note: Cable upsizing may be necessary to accommodate required breaker size. Reference to 240.4 for conductor overcurrent protection limitation
14 AWG can be on breaker no larger than 15 AMPS
12 AWG can be on breaker no larger than 20 AMPS
10 AWG can be on breaker no larger than 30 AMPS

+ Based on Ambient temperature of 30°C. For correction factors other than -30°C please see NEC Table 310.15(B)(2)(a) for correction factors. (See excerpts below) For raceways where the current carrying cables exceed three, see NEC table 310.15(B)(3)(a) for Amperage derating factors (i.e. 4 to 6 conductors 80%, 7 to 9 conductors 70%, etc.)

Correction Factors

Based on NEC Table 310.15(B)(2)(a) [Formerly Table 310(16)] - Ambient Temperature Correction Factors Based on 30°C (86°F)

For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities shown above by the appropriate factor shown below.

Ambient Temp. (°C)	Temperature Rating of Conductor			Ambient Temp. (°F)
	60°C	75°C	90°C	
10 or less	1.29	1.20	1.15	50 or less
11-15	1.22	1.15	1.12	51-59
16-20	1.15	1.11	1.08	60-68
21-25	1.08	1.05	1.04	69-77
26-30	1.00	1.00	1.00	78-86
31-35	0.91	0.94	0.96	87-95
36-40	0.82	0.88	0.91	96-104
41-45	0.71	0.82	0.87	105-113
46-50	0.58	0.75	0.82	114-122
51-55	0.41	0.67	0.76	123-131
56-60	-	0.58	0.71	132-140
61-65	-	0.47	0.66	141-149
66-70	-	0.33	0.58	150-158
71-75	-	-	0.5	159-167
76-80	-	-	0.41	168-176
81-85	-	-	0.29	177-185

Adjustment Factors

Based on NEC Table 310.15(B)(3)(a)

Where the number of current-carrying conductors in a raceway or cable exceeds three, the allowable ampacities shall be reduced as shown in the table below:

Number of Conductors ¹	Percent of Values in Table 310.15(B) (16) through Table 310.15(B)(19) as Adjusted for Ambient Temperature if Necessary
4 through 6	80
7 through 9	70
10 through 20	50
21 through 30	45
31 through 40	40
41 and above	35

¹Number of conductors is the total number of conductors in the raceway or cable adjusted in accordance with 310.15(B)(5) and (6).

Communication and Control Cables

Communication Adapters and Cables

Catalog Number	Description	Belden Comm. Cable
20-COMM-C	PowerFlex 7x ControlNet Copper to DPI Communication Adapter	3092A
20-COMM-Q	PowerFlex 7x ControlNet Fiber to DPI Communication Adapter	62.5 μm Duplex: B96915
20-COMM-D	PowerFlex 7x DeviceNet Communication Adapter	3084A
20-COMM-E	PowerFlex 7x EtherNet/IP to DPI Communication Adapter	Reel/Cut: 7958A
20-COMM-E	PowerFlex 7x EtherNet/IP to DPI Communication Adapter	Cordset: E5050xx 010A1
20-COMM-P	PowerFlex 7x Profibus Adapter	3079A
20-COMM-R	PowerFlex 7x Remote I/O Communication Adapter	9463
20-COMM-S	PowerFlex 7x RS-485 DF1 Communication Adapter	3107A
20-COMM-K	PowerFlex 7x CANOpen Communication Adapter	3107A
20-COMM-M	PowerFlex 7x Modbus/TCP Communication Adapter	8777

0-10V DC or / 4-20 mA Signal Cables

Catalog Number	Description	Notes:
8760	1 pair, 18 AWG Stranded Tinned Conductors, Polyolefin Insulation, overall Beldfoil® shield, Drain Wire and PVC Jacket	300V UL AWM 60°C
8770	3 conductor, 18 AWG Stranded Tinned conductors, Polyolefin Insulation, overall Beldfoil shield, Drain Wire and PVC Jacket	300V UL AWM 60°C

Encoder Cables

Catalog Number	Description	Notes
8790	18 AWG, 1 pair (Power Supply)	See Drives Manufacturer's recommended cable construction
9729	24 AWG, 2 pair	
9730, 89730	24 AWG, 3 pair	
9728	24 AWG, 4 pair	
9892	20 AWG, 4 pair	
9860	16 AWG, 1 pair (signal)	

