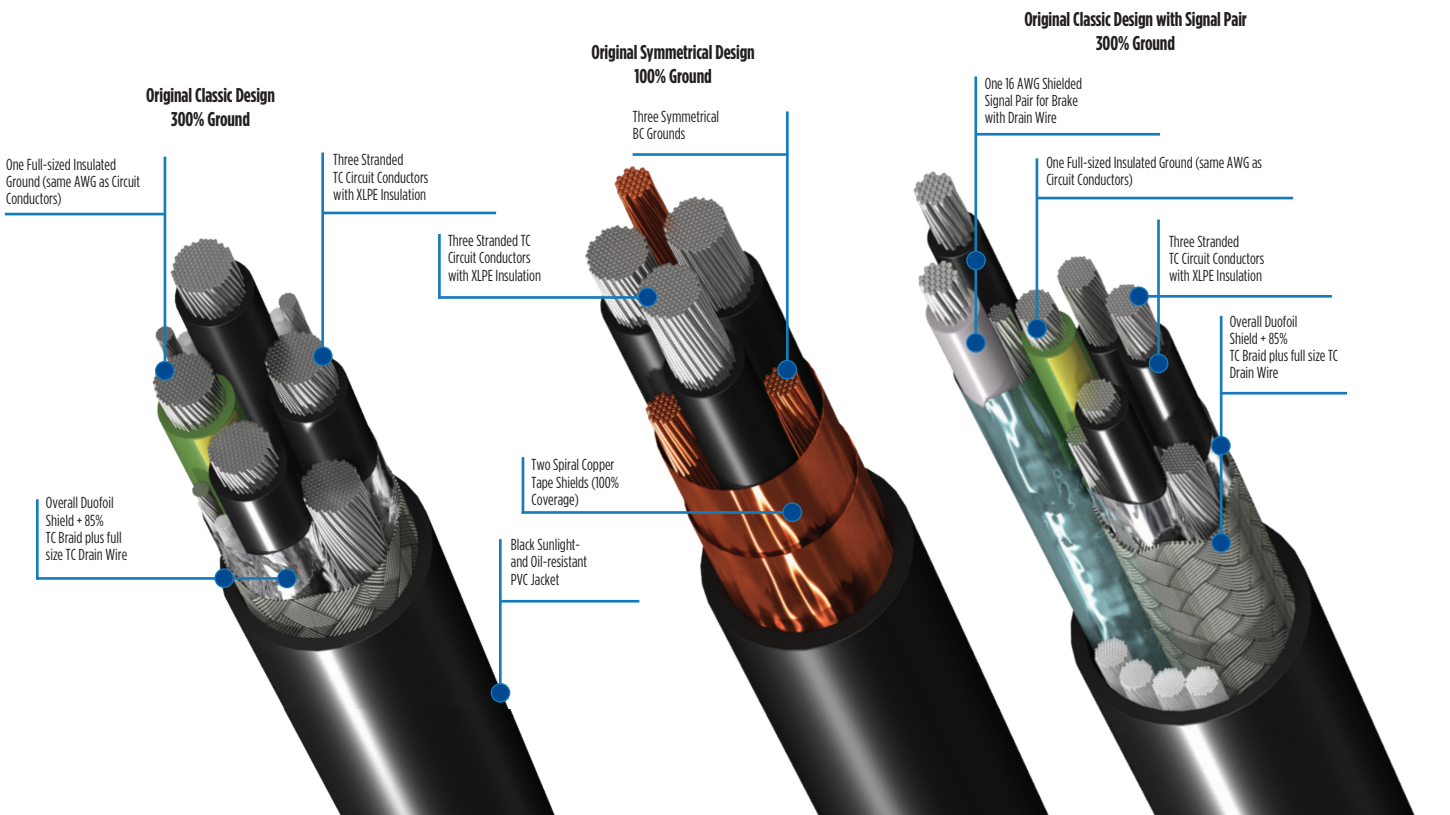


VFD Solutions for PowerFlex® Family

Power Cables For PowerFlex

4, 40, 400, 52x, 70, 700, and 75x Series

BROCHURE 



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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

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. Belden's oversized VFD grade XLPE insulation provides lower capacitance compared to other VFD cables using only XHHW-2 insulation thickness. This protects motors and bearings while delivering more energy to the motor with lower cable charging losses. While other manufacturers offer the equivalent of one full-sized ground or less, 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.

NFPA 79 - Why Compliance Matters

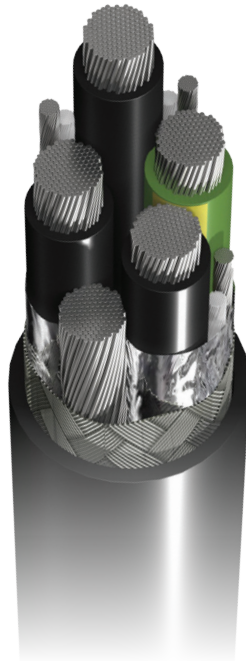
NFPA 79 is the standard for Machinery Safety. It is widely adopted and helps ensure safe practices are followed in many areas including wiring safety. NFPA 79 recognizes that some wire types and stranding, such as THHN type or Class B stranding are not suitable for variable Frequency service. NFPA 79 requires a minimum XHHW-2 Insulation rating, and a Flexible Motor supply rating(Flexible strand). Flexible stranding is much better suited to efficiently conduct the high frequency outputs of a VFD and results in lower cable losses. Requiring XHHW-2 insulation is important to enduring the voltage spikes and high thermal loads associated with VFD outputs, where THHN style insulations will fail over time and have high losses.





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 braid 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.



Belden Basics VFD — 600/1000V or 2KV

Belden offers Dual Copper Tape Symmetrical Ground Contractor Grade VFD products with 1000V XHHW-2KV RHW insulation designed to offer robust and reliable cable solutions for those applications where reliability is critical but the applications are not noise sensitive.



Selecting a VFD Cable:

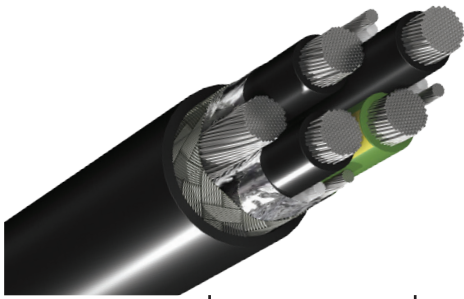
While there are many factors that go into selecting the appropriate VFD cable for your application, the fundamental selection should be based on three key pieces of information:

- 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 X)



| 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

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 x 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

Motor to VFD Power Cables

Based on NEC Table 310.16 (2020) for 75° Cable*



| Conductor Rating (Amps)+ | Conductor Gauge Size | Classic VFD Part No. UL/CSA (Recommended for PowerFlex Drives) | Continuous Flex VFD Cables | 2kV VFD Part No. UL | Symmetrical VFD Part No. CSA | Belden Basics VFD 1000V/2KV |
|--------------------------|----------------------|--|----------------------------|---------------------|------------------------------|-----------------------------|
| NFPA Compliance | ✓ | ✓ | ✓ | ✓ | - | - |
| 20 | **14 | 29501 | 29501F | 29536 | 29550C | 29521C/29721C |
| 25 | **12 | 29502 | 29502F | 29537 | 29551C | 29522C/29722C |
| 35 | **10 | 29503 | 29503F | 29538 | 29552C | 29523C/29723C |
| 50 | 8 | 29504 | 29504F | 29539 | 29553C | 29524C/29724C |
| 65 | 6 | 29505 | 29505F | 29540 | 29554C | 29525C/29725C |
| 85 | 4 | 29506 | 29506F | 29541 | 29555C | 29526C/29726C |
| 115 | 2 | 29507 | 29507F | 29542 | 29556C | 29527C/29727C |
| 130 | 1 | 29528 | 29528F | 29543 | 29557C | 29528C/29728C |
| 150 | 1/0 | 29529 | 29529F | 29544 | 29558C | 29529C/29729C |
| 175 | 2/0 | 29530 | 29530F | 29545 | 29559C | 29530C/29730C |
| 200 | 3/0 | 29531 | 29531F | 29546 | 29560C | 29531C/29731C |
| 230 | 4/0 | 29532 | 29532F | 29547 | 29561C | 29532C/29732C |
| 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 Now 310.16 (2020) 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)(1) [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 | - | - | 0.50 | 159-167 |
| 76-80 | - | - | 0.41 | 168-176 |
| 81-85 | - | - | 0.29 | 177-185 |

Adjustment Factors

Based on NEC Table 310.15(C)(1) 2020

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 race-way 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 DFI 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) | |

About Belden

Belden Inc., a global leader in high quality, end-to-end signal transmission solutions, delivers a comprehensive product portfolio designed to meet the mission-critical network infrastructure needs of industrial, enterprise and broadcast markets. With innovative solutions targeted at reliable and secure transmission of rapidly growing amounts of data, audio and video needed for today's applications, Belden is at the center of the global transformation to a connected world. Founded in 1902, the company is headquartered in St. Louis, USA, and has manufacturing capabilities in North and South America, Europe and Asia.



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