Industrial Cable Solutions for Variable Frequency Drives

CVTC® VFD Low-Voltage Power, Type TC-ER, Unarmored
CCW® VFD Low- and Medium-Voltage Power, Type MC-HL, Armored
AIRGUARD® VFD Low-Voltage Power, Armored

When faced with significant challenges, you need high-performance solutions. Prysmian, your global provider of innovative products, offers a comprehensive range of industry-leading industrial cables. Our cables for Variable Frequency Drives (VFD) come in both unarmored and armored designs and are available in various power ratings, all engineered to deliver outstanding performance.

VFD Cable Advantages in Industrial Automation Applications

Modern manufacturing and processing environments increasingly depend on automation to enhance productivity. Consequently, there is a greater emphasis on minimizing downtime and improving safety. Utilizing VFD cables in industrial automation applications offers a reliable solution to tackle these challenges.

When Are VFD Cables Needed?

When installing a Variable Frequency Drive (VFD) system, it is important to use VFD cables between the inverter and the motor. Standard power cables are not designed to handle the high-frequency components produced by the inverter's output. The chart below illustrates some relevant market applications.

Why Are VFD Cables Needed?

Many issues common in VFD systems can be resolved, or their impact reduced, by simply using a properly terminated VFD cable. These issues include, but are not limited to:

- Intermittent issues with other factory control or communication systems
- Alarm system malfunctions
- Premature motor bearing failure
- Premature cable failure
- Drive failure and drive problems
- Shock hazards (to maintenance and other personnel)

How Does a VFD Cable Address These Issues?

VFD cables are designed with an effective overall electrical shield, symmetrically arranged conductors, and thermoset insulation that has a low dielectric constant.

Proper Shielding

VFD cables are designed with an overall electrical shield that can be made using armor, copper tape, or copper braid. Prysmian offers all three options, allowing you to choose the design that best fits your needs. The design of the shield is crucial; it must be engineered to effectively handle the high-frequency components of the inverter waveform while minimizing inductive loading.

This shielding and proper cable termination help reduce electromagnetic radiation emitted from the cable. Unshielded cables can act like antennas, radiating unwanted electrical signals as noise throughout your facility. Such radiation may cause problems with alarm systems, control and communication systems, and other drives. As factories become increasingly automated, these issues are becoming more common.

Additionally, shielding helps minimize electromagnetic induction, which occurs when a varying magnetic field creates a signal in nearby electrical circuits. It has been demonstrated that when unshielded inverter-motor cables are installed in a cable tray, potentially dangerous currents can be induced in cables that are not energized but are located near other live cables. Many believe that the protection of human safety alone justifies the use of VFD cables for motor-inverter connections.

Furthermore, shielding minimizes the risk of premature motor bearing failure by providing a low impedance path for common mode current to return to the inverter frame. Without this low-impedance path, current may flow through motor bearings, leading to bearing fluting.

Prysmian
4 Tesseneer Drive, Highland Heights, KY 41076
na.prysmian.com
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Proper Conductor Design

Common mode (CM) current frequently causes issues in drive systems, including false trips. One effective way to address CM current is by directing it back to the inverter frame through the shield. Some Variable Frequency Drive (VFD) cables go a step further by minimizing the generation of CM current. It is crucial to use cables designed with a symmetrical arrangement of phase conductors and ground conductors, as this symmetry helps cancel out CM current in the system. Typically, these designs consist of three phase conductors with three ground conductors positioned in between the phase conductors.

Proper Insulation

Never underestimate the importance of cable insulation in the performance of your Variable Frequency Drive (VFD) system. Choosing VFD cables with thermoset, cross-linked insulation, like those used in all VFD cable constructions by Prysmian, is a smart decision. It's important to note that using THHN cable as your inverter motor cable is not recommended.

The PVC insulation found on THHN cable is not suitable for VFD applications for two main reasons:

1. **Hydroscopic Nature:** THHN insulation can absorb moisture from the air, which can decrease its dielectric withstand to as low as 55% of its rated voltage.
2. **Cold Flow Issues:** This type of insulation may experience cold flow, leading to displacement when under pressure and reducing the thickness of the insulation wall.

Choosing the right insulation can have a significant impact on the reliability and performance of your VFD system.

It's important to recognize that while THHN cable is rated for 600 volts RMS and 850 volts peak, there is a significant risk of reflected waves (standing waves) in VFD cables potentially reaching 1300 volts over a distance as short as 35 feet. This 1300 volts can exert considerable stress on a cable that is rated for only 850 volts. Additionally, factors such as decreased insulation strength due to moisture and reduced wall thickness should not be overlooked, as they can lead to potential problems.

Moreover, PVC-insulated cables have high capacitance, which can cause current leakage through the insulation, leading to false trips. These cables also generate a higher charging current, which requires a drive with greater power and incurs additional costs. To address these issues, it is essential to choose a cable with thermoset insulation that is specifically rated to handle the peak standing wave voltage.

The Right Cable Solution for VFD Applications

VFD cable has three key features that help address common issues in various applications: shielding, robust insulation, and a symmetrical design. Although VFD cable tends to be more expensive than standard power cables, it is a smart investment in today's technology landscape. With the rise of automation, opting for VFD cable can provide long-term advantages and demonstrate a forward thinking approach.

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SPECIALLY ENGINEERED CABLE DESIGNS FOR VFD APPLICATIONS

Prysmian leverages its extensive expertise to offer high-quality and reliable VFD cable solutions suited for a variety of applications. These include factory automation, traditional power generation, refining and petrochemicals, marine operations, specialty chemicals, and wastewater treatment. Our product line features 1 kV and 2 kV CVTC® VFD cables (XLPE/PVC) in unarmored configurations, as well as CCW® VFD cables (Continuously Corrugated Welded) rated for 600 V to 8 kV in armored configurations. Additionally, we provide AIRGUARD® low-voltage power cables ranging from 600 V to 1 kV, which come equipped with polymeric AIRBAG™ armor.

Many of our designs include symmetrical grounding to minimize ground voltages and induced ground currents, which can cause motor-bearing fluting and lead to premature motor failure. We perform extensive and rigorous testing to ensure reliable power delivery from AC drive systems to AC motors. With our advanced processing capabilities and status as one of the industry's leading suppliers, our industrial-grade VFD designs effectively manage voltage spikes associated with rapid-switching Pulse Width Modulation (PWM) signals. They are also engineered to minimize radiated and induced Electromagnetic Interference (EMI) through optimized grounding and shielding options.

CVTC® VFD cables offer a high degree of customization, empowering you to address the specific requirements of various VFD applications. These cables, designed for use with AC motors controlled by pulse-width modulated inverters in VFD applications, ensure reliable performance and protection of VFD equipment. They significantly reduce the risk of EMI, which can lead to drive malfunction, and provide added protection in Class I, Division 2 hazardous industrial applications.

CCW® VFD cables provide a versatile solution for hazardous environments where cables must be resistant to gas, liquids, and vapors. These cables are designed to be terminated with explosion-proof glands for electrical equipment. CCW sets the standard in the refining industry, thanks to their robust design that meets the demands of performance-driven settings. They are commonly used in offshore production platforms, refineries, LNG facilities, and petrochemical processing plants. This product line is suitable for installation in Class I, II, and III, Divisions 1 and 2, as well as Class I, Zones 1 and 2 hazardous locations, as defined by NEC articles 501, 502, 503, and 505. CCW cables are ideal for both hazardous and non-hazardous locations, providing flexibility to adapt to various conditions.

AIRGUARD® VFD cables are specifically designed for heavy industrial applications, VFD environments, and offshore markets. They feature a robust polymeric armor known as AIRBAG™, which offers exceptional durability. Additionally, the cables are equipped with a chemical barrier protection package, ensuring their reliability in harsh and demanding conditions. These cables are rated for Class I Division I locations

INDUSTRY APPLICATIONS FOR VFD CABLES

Markets	VFD Offering			
	Unarmored CVTV® VFD	Armored CCW® VFD	Armored AIRGUARD® VFD	Applications
Marine		X	X	Fluid/flow control – process pumps/drilling and pumps (Note: TYPE P VFD cable for flex applications)
Power & Energy Management	X	X	X	Process & flow control, cooling towers
Pulp & Paper	X	X	X	Conveyors, process equipment
Automotive & Tire	X	X	X	Material handling, process equipment, conveyors
Global Machine & Equip	X	X	X	Packaging, material handling, equipment, cranes, conveyors
Oil, Gas & Petrochemical	X	X	X	Fluid/flow control – process pumps and cooling towers, terminals and pipelines
Specialty Chemical	X	X	X	Fluid/flow control, process pumps, rotary equipment
Water & Waste	X	X	X	Process/flow control pumps, rotary equipment

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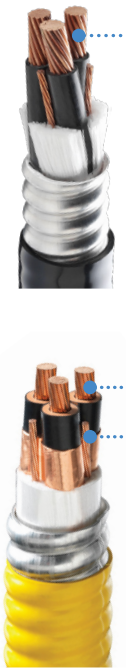
FEATURES AND BENEFITS of specially engineered cable designs for AC motors, which are controlled by pulse-width modulated inverters in variable frequency drive applications rated up to 1000 V, 2000 V, 5 kV, and 8 kV.

CVTC® VFD Low-Voltage Power Type TC-ER

- Compressed stranding to reduce overall cable diameter
- Symmetrically placed annealed bare copper grounding conductors in direct contact with shield
- Dual copper tape shields provide maximum shield coverage required for Variable Frequency Drive applications
- Designed to reduce the risk of Electromagnetic Interference (EMI), which can lead to malfunction
- Meets crush and impact requirements of Type MC cable
- Permitted for use in Class I, Division 2 industrial hazardous locations per NEC

CCW® VFD Low- & Medium-Voltage Power Type MC-HL



- Compact or compressed stranding to reduce conductor size
- XLPE insulation with high impulse voltage breakdown level resists degradation
- Symmetrically placed annealed bare copper grounding conductors in direct contact with shield
- Compact conductors provide reduced conductor size
- Pure EPR insulation system has outstanding corona resistance and high dielectric strength, providing electrical stability under stress
- Triple Extrusion applies strand shield, EPR insulation and insulation shield in one operation, eliminating exposure to contamination and providing maximum control and consistency

AIRGUARD® Low-Voltage Power

- Superior crush and impact resistance as compared to MC-HL cables when tested in accordance with UL-2225
- Reduced installation costs due to increased flexibility, ease of pulling, faster and safer cable preparation has proven to save 18% on installation labor over MC-HL
- AIR BAG™ layer provides superior protection from the ingress of harmful fluids, hydrocarbon and chemicals
- Rated for installation in cable try, for exposed runs (Type TC-ER), conduit, duct, direct burial, and aerial applications in Class I Division 2, Zone 2, and unclassified locations
- Permitted for use in Class I Division 1 and Zone 1 hazardous locations (Type TC-ER-HL) in accordance with NEC (2020) Sections 501.10(A)(2)(3) & 501.15(B)(i)

Additional Benefits of CCW® VFD Low- & Medium-Voltage Power Cable

Continuously Corrugated Welded Armor:

- Provides impervious barrier to moisture, gas and liquids.
- Provides EMI shielding performance.
- Factory assembled and tested for use as an economical, rugged and reliable alternative to cable in conduit wiring systems.

Armored constructions suitable for use in Class I, II, & III, Divisions 1 and 2; and Class I, Zones 1 and 2 hazardous locations per NEC Articles 501, 502, 503 and 505.

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