FAQ's
Variable Frequency Drive Cables

Specifying the correct cable is an integral part of ensuring VFD drive performance. Below we have answered frequently asked questions associated with VFD installations as well suggestions for proper cable selection.

Q: **Why are variable frequency drive (VFD) systems subject to electromagnetic interference (EMI)?**

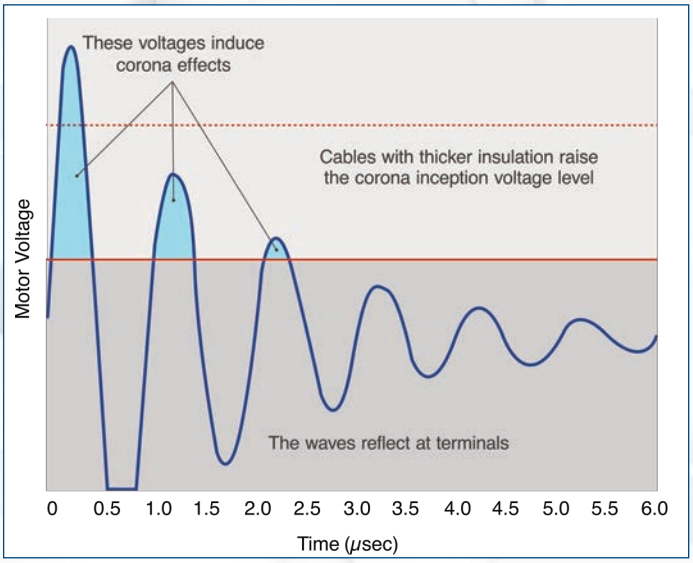
A: A VFD's output signal consists of a series of chopped DC pulses to induce motor motion. As those pulses travel through motor cables and into the motor, they can cause electrical interference that can damage surrounding components and degrade overall system performance. These high frequency DC pulses can also trigger false instantaneous-over-current (IOC) faults in VFDs of 5 horse power or less by charging the capacitance between the conductors and drawing more current from the drive. Cables with thicker insulation should be used since they will have lower dielectric values reducing this charging.

Q: **Are newer drives more susceptible to noise problems?**

A: Newer VFDs that use insulated gate bipolar transistors (IGBTs) have a faster DC pulse rise time, dv/dt. Faster pulse switching provides finer motor control but the DC pulses also have voltage overshoots which translate into noise. In addition to this noise, there are also reflective waves at the cable-to-motor junction which can create unwanted noise in the cables. Reflective waves are created because the motor's stator windings are an inductor. As such, a magnetic field must first build in order to generate current in the windings. The result is an impedance mismatch between the cable and the motor that causes a portion of the voltage waveform's leading edge to reflect back through the cable.

Q: **What about proper grounding?**

A: Without proper grounding, a VFD system can experience unwanted ground loops. Ground loops are unintended paths through an electrical interconnection system in which potentials, or voltages, measured with respect to ground at either end of the path differ. Using unshielded cables in metal conduit can cause ground loops and is, therefore, not recommended.



To combat ground loops, make sure both enclosure and motor are properly grounded and that the VFD cables are properly shielded, forming a Faraday cage. A Faraday cage, first invented by Michael Faraday in 1836, is an enclosure formed by conducting material that blocks]external static and non-static electric fields. It works by channeling electricity through the enclosure to ground and providing constant voltage on all sides of the enclosure so that no current flows through the space.

In addition, ground or earth wires can be subject to what is called the skin effect— this is the tendency of the current to flow near the outer surface of the conductor—at high frequencies. This effect becomes more pronounced with increasing frequency. It is recommended to ground the shield at the enclosure and motor with an EMC gland to prevent noise issues and create the Faraday cage.

SPECIAL CABLES SAB North America

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Q: **Should cable insulation be cross-linked polyethylene or PVC?**

A: Both PVC and XLPE are good electrical insulators. However, the NEC has changed its guidelines stating that PVC-based conductors are no longer permitted for use in VFD applications.

Cross-linked polyethylene (XLPE) is now the recommended insulation material for VFD cables, per NEC. With lower capacitance ratings than PVC, XLPE minimizes charging currents, provides better heat resistance and offers protection against corona discharge. Lower capacitance is a particularly important characteristic for longer-length cables since long runs can also create reflective waves. For these reasons, VFD manufacturers often suggest cable with core insulation thickness of 45 millimeters or greater of XLPE insulation.

Q: **What is the best way to connect the cable to the motor and drive?**

A: To prevent EMI in VFD systems, ground the shield with 360° contact at the enclosure entrance and at the motor. The shield acts as a ground path for electrical noise, so proper termination is essential. Create a pigtail with the braided shield and connect directly to the 2nd PE terminal on the drive and motor. This method is better than connecting a drain wire to the PE terminal because the braid has much more copper mass to carry the frequency noise to ground. SAB offers grounding connectors that provide 360° contact with the shield at the entry of the enclosure and motor.

Q: **How can I find a cable that meets the requirements of my motor manufacturer?**

A: When choosing cables for your VFD system, take application variables into account. Will the cables have be in a dry, damp, or wet environment? Are the cables suited for VFDs in that they have a thicker insulation? Also take a look at the recommendations of the motor manufacturers and the NEC. Finally, consult a SAB whose experts can recommend the proper cable for your system.

SAB North America offers a detailed selection table for both VFD cable and EMC grounding glands. Call your SAB Sales Specialist today for our latest copy at 866-722-2974.