

# Efficiency in Automation

Cable • Connectivity • Cabinet • Control

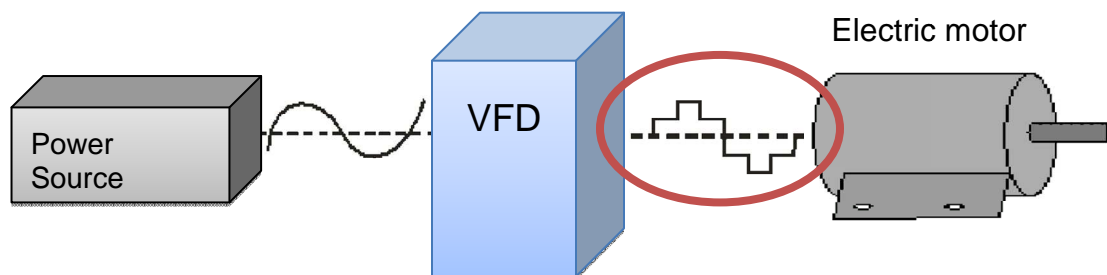


## Best insulation material for VFD cables

Many electrical contractors use PVC/Nylon (THHN) wiring in conduit or THHN power tray cables to connect Pulse Width Modulation (PWM) drives to the motor. However, PVC is not a good insulator for this application. The dielectric strength, the capacitance and impedance of PVC insulated wires, is simply not good enough to cope with the power distortions caused by the PWM. Often times the contractor does not know that there are better alternatives. The application would be better served by shielded VFD cable with thermoset XLPE insulation which offers superior electrical performance and improved safety to any VFD application compared to power tray cables with PVC/Nylon insulation.

Let's review why the electrical characteristics of the VFD cable are important by analyzing the basic function of the AC VFD utilizing PWM:

The purpose of an AC VFD is to gain control over the motor speed and torque. This control is achieved by varying the frequency at which the VFD sends power to the motor. Many AC VFDs use Pulse Width Modulation to accomplish this goal.



The VFD input receives a sinusoidal wave which is converted into pulses on the output that the motor perceives as a standard three phase sinusoidal curve. This process gives you control over the motor but causes high frequency electrical noise which is entering the cable. This is also creating voltage spikes much higher than nominal voltage and capacitive charges higher than expected and referred to as power distortions. These power distortions are being amplified especially in long cable runs from VFD to motor.

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PVC/Nylon insulation (also referred to as THHN or THWN) is not a suitable solution for the following three reasons:

1. It is thermoplastic material which allows deformation or might even melt at high temperatures caused by overload or short circuit.
2. It causes high cable charging current due to high capacitance resulting in more current to be required from the VFD to operate the motor
3. The dielectric strength of PVC is not strong enough to cope with the voltage spikes caused by the VFD. Some cable manufacturers include conductor stress relief layers before extruding the PVC in order to strengthen the PVC, but this does not solve the issue of high capacitance and therefore high cable charging current.

XLPE insulation offers better electrical performance and is safer than products using PVC insulation. XLPE is thermoset insulation resulting in improved overload and short circuit temperature ratings. A proper VFD cable should be listed by a national recognized testing laboratory as Flexible Motor supply cable or even as Flexible VFD Servo cable. XLPE insulation typically comes in two versions, RHW-2 or XHHW-2. The difference is mainly in the wall thickness. Both types offer very good characteristics for a VFD cable; the RHW-2 offers better electrical performance while the XHHW-2 results in cable with a smaller outer diameter.

Use this checklist to select the proper VFD cable:

- Give preference to thermoset materials over thermoplastic materials
- Avoid PVC/Nylon insulated cables with THHN or THWN designation on cable print legend
- Look for the designation RHW-2 or XHHW-2 in the cable print legend for XLPE insulation
- Use shielded cable and terminate the shield according to the VFD manufacturer's instructions
- The cable should be dual-listed "Flexible VFD Servo" and TC-ER for the intended use with VFDs and to be installed in cable trays per NEC 336.



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