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From Experience

Protecting VFDs and Motors

Variable Frequency Drives (VFD) are the industry standard for speed control of motors. Because of the importance of VFDs and the motor circuits, many businesses look for ways to protect their investments. When considering protection options, it's important to first understand that the transmission of power can be divided into two areas:

- Line side power is where Alternating Currents (ACs) are supplied that may experience voltage distortion from spikes and surges.
- Load side power is where the ACs have been translated into a Direct Current (DC) pulse signal. This signal is a sharp, square wave power signal creating voltage distortion that could potentially cause damage to wire and motor insulation.

To protect motors and VFDs, reactors and filters are cost-effective options owners can use to increase life expectancy and reduce downtime:

- **Reactors**. In the simplest form, a reactor is an inductor consisting of a steel core and copper wound coils commonly with one core and coil pair per phase. A reactor is referred to as a line reactor or load reactor depending on whether it is installed on the line or load side of the VFD. In both cases, the reactor is responsible for stabilizing the current waveform to either the VFD or motor. While reactors will offer protection, keep in mind that they will result in a voltage drop to the motor or drive.
- **Filters**. Filters are like reactors in that they have inductive properties but also add in capacitance to offer a longer range of protection. The delta (Δ) Voltage/delta (Δ) time (dV/dT) filter is used to prevent overshoot transient voltage at the motor terminals. Another commonly used filter, sine wave filters, work to smooth out the pulse width modulating signal to mimic a regular AC signal as closely as possible.

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For those cases in which multiple motors are fed from the same location, a third layer of protection to consider are VFD cables. VFD cabling can help protect other motors and wiring from high voltage spikes, while also protecting the motor the VFD is connected to from other outside disturbances. (Note that in proper VFD cabling installations, the drain wire must be connected to ground at both the VFD and motor.)

While the recommended practice for line side protection of a VFD is to install line side reactors in all cases, it is also important to consider motor lead length for load side protection. The table below can be used as a general guideline for the solution best suited for a load side installation based on wire length. Whether choosing a reactor or filter for your application, keep in mind they should be installed as close to the VFD as possible while accounting for their physical footprint in installations.

Load Side Protective Device	Standard Motor/ Standard Cable	Standard Motor/ VFD Cable	Inter-Duty Motor/ Standard Cable	Inter-Duty Motor/ VFD Cable
No Filter	< 100 ft	< 150 ft	< 300 ft	< 300 ft
3% Reactor	100 - 300 ft	150 - 350 ft	150 - 350 ft	300 - 600 ft
dV/dT Filter	300 - 1,000 ft	350 - 1,000 ft	350 - 1,000 ft	650 - 1,000 ft
Sine Wave Filter	> 1,000 ft	> 1,000 ft	> 1,000 ft	> 1,000 ft

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