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Determining Short Circuit Currents when Applying VFD's

This note is designed to help explain the protection levels necessary when applying a VFD to your power system. It will explain a basic method for determining the actual short circuit current levels and typical protection devices to apply. Understanding your systems short circuit capability's are extremely important since most electrical distribution systems have enormous capacities for destruction when a short circuit occurs. One cycle of short circuit current can vaporize wiring, warp bus bars, blow fuses and possible human injury.

Short circuit currents in a particular electrical distribution system today can vary from 3000A to beyond 150,000A. Due to impedance in the distribution and transmission system feeding the utility's supply transformer, short circuit current is dependant on the impedance looking back into the utility's supply system. Since this determination is quite complex and dependent on your total facility distribution and supply power system, we will only look at the magnitude of fault currents available at the point where the drive is connected.

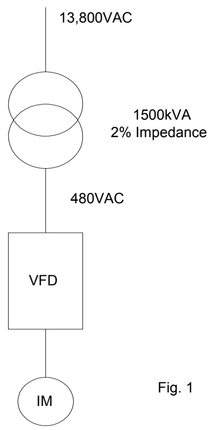

Fig. 1

How to calculate short circuit currents

1. Calculate the drives supply transformers full load current.
   I = KVA÷ (Voltage ×1.73)
   Fig.1 I = 1500000÷ (480×1.73) = 1,807A

2. Calculate the Short circuit currents from the transformer's impedance.
   $I_{sc} = I \times$ % Impedance (If impedance is in Ohms: $I_{sc} = V \div \Omega$
   Fig.1 I_{sc} = 1807 ÷ 0.02 = 90,350A

NOTE: This is a worst case scenario assuming the source impedance is zero. If your source impedance and transmission (wiring) impedance is known the I_{sc} value will be reduced.

In this case, if a short circuit occurred between the transformer and the VFD, you would have to select a device able to clear 90,350A of current. This would just about eliminate all devices except for high interrupt fusing. In most VFD installations, a disconnect means is required to meet local code. This would force you to not only supply fusing but a disconnect means, fuseable disconnect or C/B with fusing.

Lets assume that in Fig. 1, the connected VFD was a 10HP controller. The required transformer KVA would be 15KVA (V×I×1.73÷1000). Lets look at the short circuit currents with a 15KVA isolation transformer in the system.

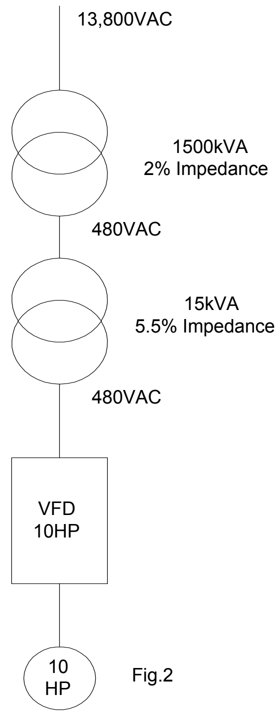

Fig.2

Calculate the drives supply transformers full load current.

I = KVA ÷ (Voltage × 1.73)

Fig.2 I = 15000 ÷ (480×1.73) = 18A

Calculate the Short circuit currents from the transformer's impedance.

$I_{sc\,=}$ I × %Impedance (If impedance is in Ohms: $I_{sc\,=}$ V ÷ Ω

Fig.2 I_{sc} = 18 ÷ 0.055 = 327A

In this case we see a dramatic reduction of the short circuit current when an isolation transformer is installed between the main supply transformer and the VFD. You now can install an "off the shelf" C/B for both a disconnect means and short circuit protection.

Conclusion:

Knowing the short circuit fault currents of the your power system before installation of a VFD will reduce the installation cost and down time. Having this knowledge will allow you to select the proper protection devices for your installation. You may also, if it is determined that the available short circuit fault currents are extremely large, can install alternative equipment to reduce these currents. Reducing these short circuit currents will allow you to install more readily available devices and will also reduce the cost of these devices.