# Line Reactors and Line Transients

## Application Summary

Transient voltages on the power distribution equipment supplying an Adjustable Frequency Drive (AFD) can either cause damage to the AFD or nuisance tripping. Symptoms of transient voltages are input circuit breaker tripping, blown input fuses, damaged Metal-Oxide-Varistors (MOV's), shorted (or open) input bridge diodes, shorted buss capacitors, "High DC Bus" type protective trips, and DC Bus over temperature trips.

Transient voltages may be caused by events such as lightning strikes, transferring to and from generator operation, power factor correction capacitor switching, electrical distribution system switching transients, and electrical distribution system casualties.

Semiconductors may be damaged when their voltage ratings are exceeded by the transient voltage. On AFD's which use MOV's, the MOV's may be damaged if the transient peak energy exceeds the energy rating of the MOV's. The other issue associated with transient voltages is transient currents, which are limited only by the impedance in the electrical circuit feeding the AFD. AFD's installed on distribution systems with higher short circuit ampere values (SCA) will be more susceptible to voltage transient problems than on other systems with lower SCA's, and will benefit more from additional impedance in the form of a line reactor.

Adding a line reactor to the input of the AFD adds inductive reactance, which will oppose the instantaneous change in current induced from the transient instantaneous change in voltage. As a result, a line reactor will reduce both the transient voltages and transient currents at the AFD input terminals.

The additional impedance of the line reactor will also reduce the total harmonic distortion that an AFD will contribute to the rest of the system, and total power factor will be improved as well. A harmonic analysis of the AFD and the particular system may be used to anticipate the extent of the improvement of harmonic distortion levels for various values of additional line impedances (typically 1% or 1.5%, 3%, and 5%).

The recommended value of input impedance, which includes the impedance of the electrical distribution system, is 1% to 5%. The electrical distribution system impedance to the AFD may be estimated by the following formula:

$$\frac{AFD\ Nameplate\ Amps}{Short\ Circuit\ Amps\ (SCA)}\ x\ \ 100\ \ =\ \ Source\ Impedance\ (\%)$$

If the source impedance is less than 1.0% then additional impedance should be added to obtain the recommended 1% to 5%, with 1% being the lower level of benefit and 5% being the improved level of benefit. In corrective applications of line reactors, 3% is generally recommended to correct nuisance tripping situations, and 5% is recommended to correct situations which have resulted in damage to the AFD or clearing of AFD input fuses. Impedance levels above 5% may result in enough voltage drop to preclude full speed motor operation, since the output voltage is limited to a percentage of the input voltage.

## Additional Help

In the US or Canada: please contact the Technical Resource Center at 1-877-ETN-CARE or 1-877-326-2273 option 2, option 6.

All other supporting documentation is located on the Eaton web site at www.eaton.com/Drives

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