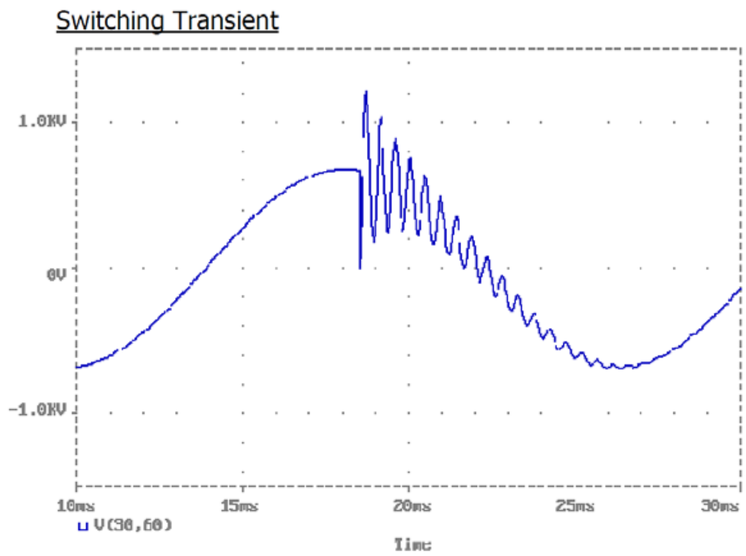
Adjustable Frequency Drives and Power Factor Correction Capacitors

Application Summary

Capacitor banks provide distribution and transmission circuits with power factor correction, reduced KVA demand and billing and improved voltage regulation. They can be switched in and out based on load conditions. While this practice is intended to provide quality power, with the increase use of electronic power equipment it may actually be blamed for poor quality power.

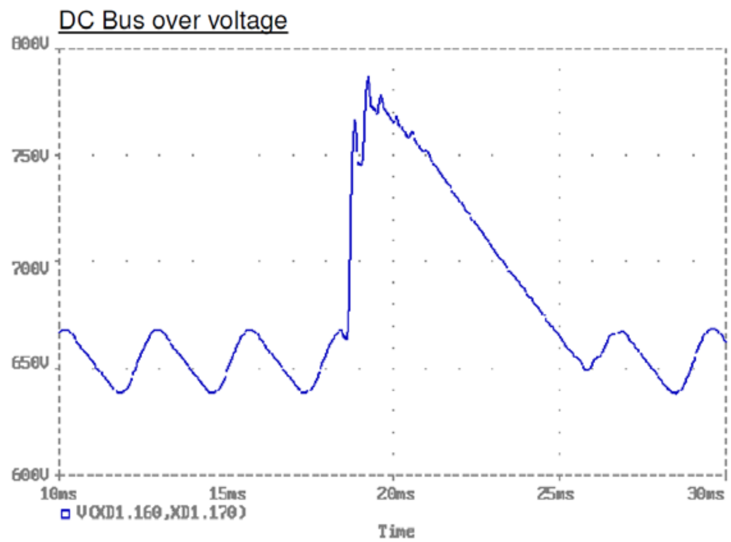
Capacitor Bank Switching Transients

A momentary short circuit is created each time a capacitor bank is switched on as energy is absorbed from the line to charge the capacitor. This results in a sudden drop in voltage followed by voltage ringing. The magnitude and frequency of the ringing is a function of the power distribution network. The over voltage can range from 1.2-1.6 time the nominal peak voltage with ringing frequencies between 400-600 Hz.



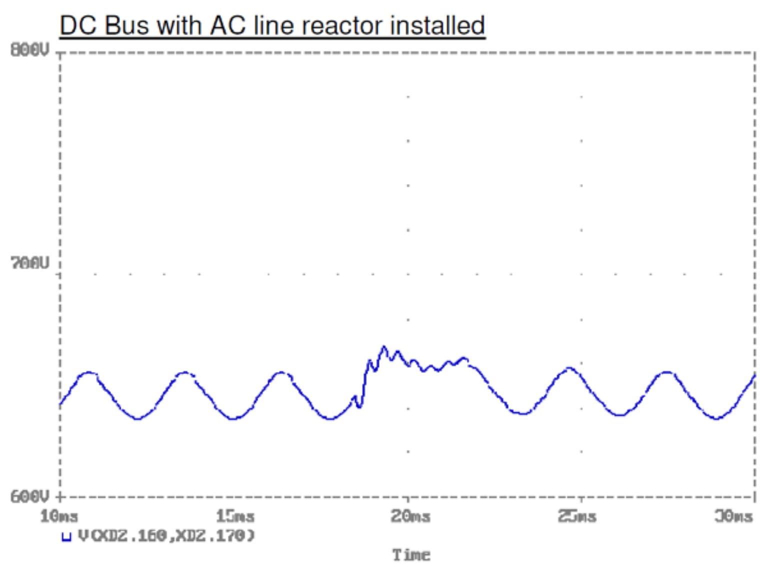
DC Bus Response to Switching Transients

The AFD's DC bus capacitors attempt to charge to the peak of the transient line voltage, resulting in an over voltage fault or possibly damage to the input diode front-end. Over voltage trips at the same time of day are symptomatic of this condition. This may happen early in the morning when capacitors are switched in response to increased load demand. Alternately, over voltage trips may result from starting large motor loads and power factor correction capacitors within the facility. The smaller the AFD and lighter the load, the more susceptible they are to over voltage tripping due to capacitor switching transients.



Influence of AC Line Reactors

AC Line Reactors are the AFD's first line of defense against capacitor switching transients as they provide some voltage drop as well as a limit to surge current. The required reactance depends on the source impedance, transient magnitude and trip level of the drive. A 3% reactor based on the drive's kVA rating normally does the job. However, when the over voltage transient is greater than 1.6 times nominal voltage, a 5% reactor may be required. When an AFD is powered but not running, then even a line reactor may not solve the problem. This is because the AFD does not draw any line current and the excess energy from the surge event cannot be transferred to the connected motor load.



Surge-protective Device and Switching Transients

Surge-protective devices are not a good solution to the capacitor-switching transients. These devices have a higher clamping voltage than the switching transients. If surge-protective devices are selected with a low clamping voltage, they are likely to become the point of failure due to insufficient energy-handling capability.

Resonance of Harmonic Currents

Capacitor banks in distribution systems with 6 pulse AFDs may result in undesirable resonant currents. Capacitors can amplify harmonics if a parallel resonance condition exists between the capacitor bank and the harmonic frequencies generated by the AFDs. The result would be excessive capacitor currents, capacitor fuse blowing, and excessive voltage distortion on the system bus. It is important to note that the capacitors themselves do not create harmonics, but can serve to amplify them if system conditions are right.

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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