Application and Switching Solutions

Switching Shunt Capacitors

Shunt capacitors are often switched daily. One of the issues that an engineer must face when installing shunt capacitors is the impact on the system when they are switched on and off. Because a capacitor bank cannot instantaneously change voltage, energizing a capacitor bank results in an immediate drop in system voltage toward zero, followed by a fast voltage recovery (overshoot). The peak voltage magnitude depends on the system voltage at the moment of energization. This voltage can reach 2.0 times the normal system peak voltage for grounded banks and as high as 4.1 times the normal system voltage for ungrounded banks. (Fig. 1) The resulting voltage levels are typically not harmful to utility systems but because of their relatively low frequency the transients are able to pass through step-down transformers to customer loads. *The resulting secondary overvoltages can cause nuisance tripping of adjustable-speed drives, computer network problems, as well as customer equipment damage or failure.*

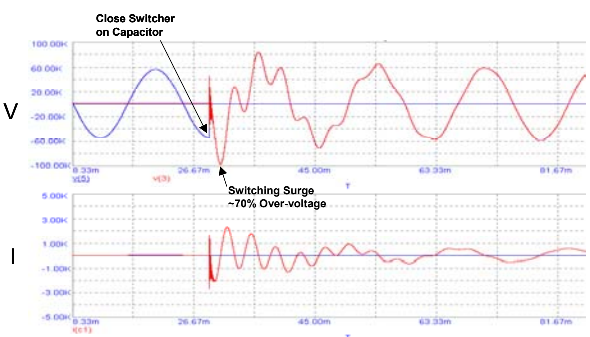


Fig. 1 Switching with no Transient Suppression

Common Methods Used To Control Transients

The two most popular switching devices used by utilities to control switching transients have been:

1. Controlled or synchronous closing devices

Circuit Breakers

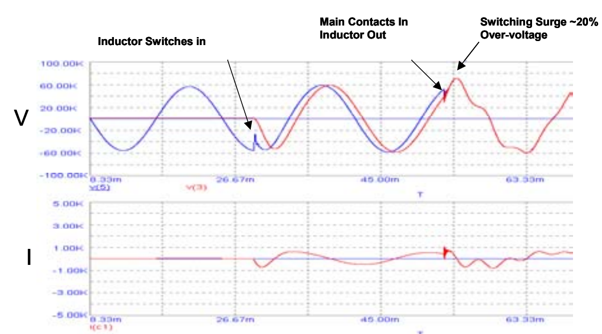
Vacuum Switches

(Synchronous Close cont.)
A synchronous close device requires closing of all three phases at a voltage zero. Complex algorithms are required to anticipate the voltage zero point. *The success of a synchronous close scheme hinges on the repeatability of the device closing mechanism under all system and environmental conditions.* Synchronous close devices for ungrounded banks operate differently that those used on grounded banks.

2. Circuit switchers with pre-insertion inductors

Inductors (with resistance) are inserted into the capacitor closing circuit for 7-12 cycles during the closing of the disconnect blade (Fig. 2). Insertion is accomplished through a sliding contact between the blade and the inductor on each pole of the switch. This operation introduces impedance that limits the initial inrush current and reduces voltage transients. The impedance (inductor) is shorted out (bypassed) a few cycles after the initial insertion transient damps out. *The insertion method utilized limits the ability of this solution to handle closing in on faults.*

Fig. 2 Pre-Insertion Inductor with Resistance



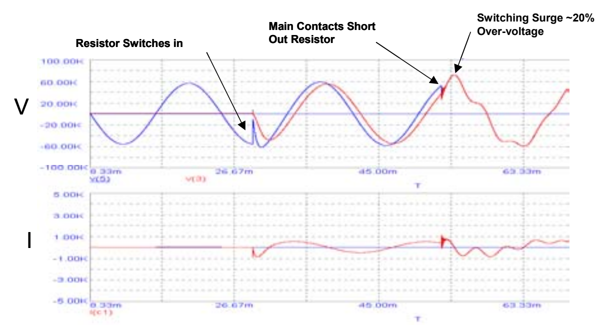
Both solutions involved taking a standard product and modifying it for the capacitor switching application.

***CapSwitcher®*, the New Solution From Southern States, LLC**

Southern States recently started shipping the first device designed specifically for capacitor switching. To control the switching transients, the ***CapSwitcher®*** utilizes pre-insertion resistors. The same operating mechanism is utilized to close the resistors into the circuit as is used for closing and opening the main contacts. This reduces the number of parts and as a result reduces cost and improves reliability.

As you can see in Fig. 3, the transients are minimized providing similar results to the use of pre-insertion inductors with the added benefit of having a fault close rating and longer life.

Fig. 3 Pre-Insertion Resistor



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