kVArCORRECT
POWER FACTOR SPECIALISTS

Resonance & Power Factor Systems

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Resonance

In physics, **resonance** is the tendency of a system to vibrate with increasing amplitudes at some frequencies of excitation. These are known as the system's **resonant** frequencies (or **resonance** frequencies).

Further to the above formal definition, all things have a natural resonant frequency. The best and most well-known example of this is the breaking of windows when a Soprano singer hits a particular note, shattering the glass. What is happening here is the singer sounds a pure, strong note very near to the glass's natural frequency, and the pane of glass oscillates in sympathy. The oscillations become increasingly larger in amplitude until the break occurs. This excitation happens because the frequency ranges overlap – a Soprano would generally sing in the range of 250-1050Hz, whereas dependent on its size and thickness, a pane of glass would sit around 850-1000Hz.

Electricity and Resonance

This phenomenon also occurs in the electricity supply. Loads such as capacitors and transformers have a natural resonant frequency that is determined by the laws of electricity. These loads behave normally until something comes along and excites them. This 'something' is usually a variable speed drive that is producing harmonics, normally the 5^{th} (250Hz), 7^{th} (350Hz), 11^{th} (550Hz) and 13^{th} (650Hz). If the load system has a natural resonant frequency close to any of these harmonic distortions, then resonance is likely to occur with the consequence of fuses blowing, wires being overloaded, and in extreme cases, explosions.

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The main thing that contributes to load resonance is the combination of the supply transformer's inductance in parallel with some capacitance in the network. Of course, power factor control systems include capacitors. When designing an installation, it is necessary to calculate the natural resonance of the transformer and the capacitors in the power factor system (kVArCorrect can easily do this).

How to Overcome these Challenges

If the resonant frequency is well above or below the frequencies generated by the offending variable speed drive, then there will be no excitement to start the resonance. If the resonant frequency is close to any of the harmonics generated by the drives, then the capacitor power factor system will need to be de-tuned to move its resonant frequency to a different frequency where no excitement occurs. In order to change the resonant frequency of transformers and capacitors, either the transformer needs to be changed (usually replaced with a bigger transformer) or changes made to the capacitor bank. It is far simpler and cheaper to de-tune the capacitor bank, and again, kVArCorrect can take care of this.

With reference to another paper written by the author (Harmonics and Power Factor Systems), it is known that capacitors may overheat with exposure to harmonic currents. The solution is to install harmonic blocking reactors so that any harmonics present on the network are not fed completely to the capacitor banks. These same reactors have a second feature and that is that they move the resonant frequency of the system to 189Hz. This is deliberately chosen because it is far enough away from the harmonics produced by the variable speed drives and therefore, resonance will **not** occur.

In current times, most capacitor based power factor correction systems will have harmonic blocking reactors installed as a matter of course and so resonance is most unlikely. If there are no reactors installed, resonance is still fairly unlikely and can be confirmed or not by calculations. Resonance is only a problem if the system has not been investigated and plans made accordingly. This is true, despite the best story lines delivered by the SVG and APF sales person who insists that capacitors are dangerous things to have on modern sites. A good question would be to ask if they could calculate the system's natural resonant frequency!

About the Author

The opinions expressed here are the researched views of Allan Ramson, General Manager, kVArCorrect Ltd. All claims have been substantiated by testing and observations from the Australasian market between 2007 and 2018. Having been associated with the design, manufacture and supply of many thousands of power factor capacitors and over 500 power factor systems, kVArCorrect are confident that they can assist with any power quality enquiry.

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