

## **Application Guide for High Power resonant Capacitors** (Conduction Cooled Capacitors)

### **Capacitor selection**

The following formula is to be used to determine what capacitance value is required:

$$\text{KVA}_r = (V^2/X_c) = V^2 \times 2\pi f \times C \times 10^{-6}$$

Where

KVA<sub>r</sub>= Kilovolt-ampere reactance

V= Applied RMS voltage

X<sub>c</sub>= Capacitive reactance =1/(2πfC)

C= capacitance in μF

f= Operating frequency in kHz

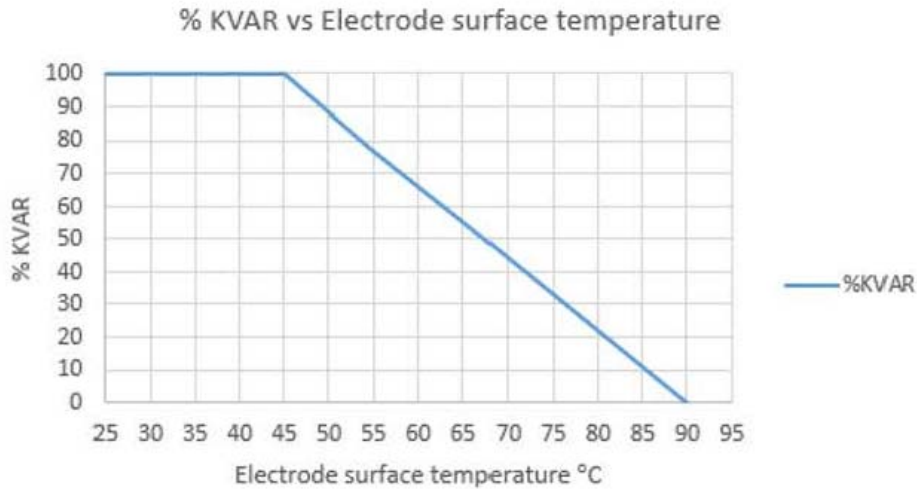
Select a capacitance that is equal to or greater than the calculated value.

### **Cooling Power Capacitors**

High power resonant capacitors are designed to handle large voltages and currents in a small compact package size. As a result of their small size these capacitors need to be cooled. Failure to cool the capacitors properly will result in the capacitors failing prematurely. Proper cooling of high power resonant capacitors is to be done by the use of water cooled heatsinks or bus bars.

At no time are high power resonant capacitors to have their external surfaces exceed 85°C. When possible the external surfaces of the capacitors should not exceed 45°C when used at full power.

At temperatures above 45°C the KVA<sub>r</sub> rating of the capacitors must be de-rated per the chart shown below. Failure to de-rate the capacitors properly can cause them to fail prematurely.



### Capacitor Mounting

In applications where the capacitor bank is in series with the induction coil, the losses of the induction coil are at least ten times higher than the capacitor bank. As a result of the higher losses in the induction coil the capacitor bank should be cooled first.

To ensure the capacitor is cooled properly the entire external surface area (both plates/ electrodes) of the capacitor must be placed in contact with a heat sink/ bus bar. Use of thermal conductive paste to ensure optimal heat conductance is highly recommended. Ideally the cooling water temperature should be <math><45^{\circ}\text{C}</math> at the capacitors.

When multiple capacitors are required care is to be taken to prevent any capacitor from being exposed to the field currents of the other capacitors which can generate inductive heating within the capacitors.

The inductance of the bus bars should be minimized. Bus bar inductances are proportional to their lengths and inversely proportional to the widths and the distance between the bus bars. See below for examples of proper mounting.

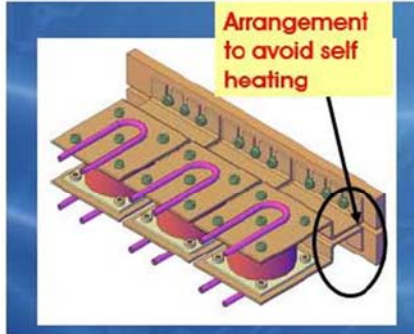


Image 1 (proper mounting)

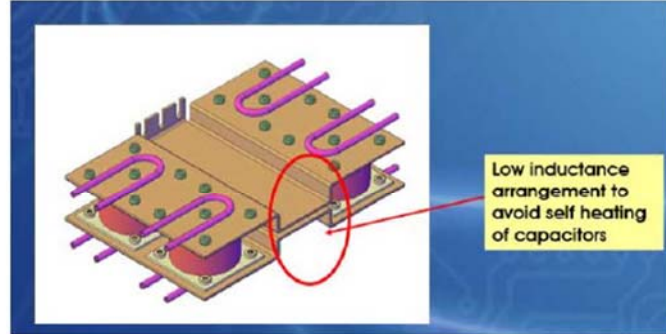


Image 2 (low inductance mounting)

### Capacitor Bank Power Losses

Power losses may occur between the capacitors, the connections and the output terminals in any system. The power losses within the capacitor should be limited to 10% of its KVAR rating. Power losses consist of:

- A. Capacitor losses. Losses from the capacitors are typically low, normally about 0.05% of the reactive power.
- B. Connection losses. When done properly the capacitor bank and its connections will have losses approximately equal to the capacitor losses (0.05% of the reactive power).
- C. Total capacitor power loss is equal to the sum of the capacitor losses and connection losses. Typical capacitance bank losses total about 0.1% of the reactive power.