

Capacitor Protection

The primary responsibility of a capacitor fuse is to isolate a shorted capacitor before the capacitor can damage surrounding equipment or personnel. Typical capacitor failure occurs when the dielectric in the capacitor is no longer able to withstand the applied voltage. A low impedance current path results. The excessive heat generated builds pressure and can cause violent case rupture. A fuse will isolate the shorted capacitor before case rupture occurs.

Fuse Placement

The Code requires that an overcurrent device be placed in each ungrounded conductor of each capacitor bank (see Figure 1). The Code further requires that the rating or setting of the over-current device be as low as practicable. A separate overcurrent device is not required if the capacitor is connected on the load side of a motor-running overcurrent device.

Fusing per the Code provides reasonable protection if the capacitors are the metallized film self-healing type. If not, each capacitor should be individually fused as shown in Figure 2.

Fusing each individual capacitor is especially important in large banks of parallel capacitors. Should one capacitor fail, the parallel capacitors will discharge into the faulted capacitor and violent case rupture of the faulted capacitor can result. Individual capacitor fusing eliminates this problem.

If the capacitors are to be placed in banks comprised of both series and parallel combinations, the capacitor manufacturer must be consulted for fuse placement recommendations. The opening of improperly placed fuses can cause overvoltage and result in damage to other capacitors in the network.

Ampere Rating

How much overcurrent can a capacitor withstand? What effects do neighboring capacitors have on the inrush of a given capacitor? These and other questions influence fuse selection. Circuit analysis can be very complex. It is best to consult the capacitor manufacturer for specific recommendations.

For applications 600V or less in lieu of specific fusing recommendations from the capacitor manufacturer, we suggest a Mersen A60C Type 121 or an A6Y Type 2SG fuse sized at 165% to 200% of the capacitor's current rating (contact factory for technical data). If these fuses are not dimensionally acceptable, then a non-time delay Class J or Class RK1 fuse could be used and sized at 185% to 220% of the capacitor's current rating.

For applications over 600V to 5.5kV, we suggest Amp-Trap A100C to A550C capacitor fuses. These medium voltage fuses are available in a variety of voltage ratings and mounting configurations. Refer to pages E36 for specific data. Medium voltage capacitor fuses are sized at 165% to 200% of the capacitor current rating.

Capacitor fuses are selected for their ability to provide short circuit protection and to ride through capacitor inrush current. Inrush current is affected by the closing angle, capacitance, resistance and inductance of the circuit, and varies from one application to another. Inrush lasts for less than 1/4 cycle and is typically less than 25 times the capacitor's current rating.

Steady state capacitor current is proportional to the applied voltage and frequency. Since voltage and frequency are fixed in power factor correction applications, the capacitor is not expected to be subjected to an overload. Therefore, capacitor fuses are not selected to provide overload protectors for the capacitor.

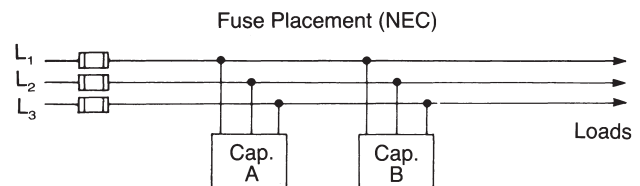


Figure 1

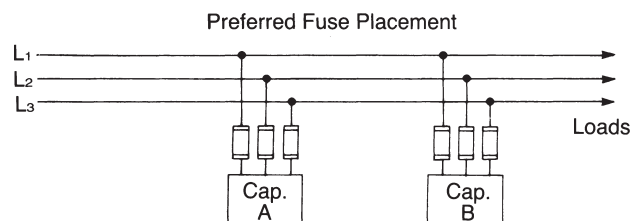


Figure 2

Capacitor Protection

kVAR vs. AMPS

The capacitor's current rating can be derived from its kVAR rating by using the following formula:

$$\frac{\text{kVAR} \times 1000}{\text{volts}} = \text{amps} \quad 1 \text{ kVAR} = 1000\text{VA (Reactive)}$$

Example#1: What fuse would you recommend for a three phase capacitor rated 100kVAR at 480 volts?

$$\frac{100,000 \text{ volt-amps}}{480 \text{ volts}} = 208 \text{ amps}$$

To determine line current, we must divide the 208 amps, which is the three phase current by $\sqrt{3}$

$$\frac{208}{\sqrt{3}} = 120 \text{ amps}$$

If an A60C Type 121 fuse is to be used, size the fuse at 165% to 200% of line current.

$$120 \text{ amps} \times 1.65 = 198 \text{ amps}$$

$$120 \text{ amps} \times 2.00 = 240 \text{ amps}$$

Suggestions: A60C200-121 or A60C200-121TI

If a Class J or a Class RK1 is to be used, size the fuse at 185% to 220% of line current.

$$120 \text{ amps} \times 1.85 = 222 \text{ amps}$$

$$120 \text{ amps} \times 2.20 = 264 \text{ amps}$$

Suggestions: A4J225 or A6K225R

Example#2: What fuse would you recommend for a three phase capacitor rated 2400kV, 100kVAR?

$$\text{Calculate Capacitor Current} = \frac{100,000 \text{ volt-amps}}{\sqrt{3} \times 2400\text{V}} = 24\text{A}$$

$$\text{fuse size } 24 \times 1.65 = 39\text{A}$$

$$24 \times 2.00 = 48\text{A}$$

We suggest a 40 or 50 amp fuse rated at least 2400V A250C50-XX, where XX is the type of mounting needed.