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Basic Formulas!

Basic Formulas

The following pages of formulas, some derivations and discussions are intended to assist in designing and applying capacitor banks properly. Also, refer to Capacitor Bank Inrush Calculations for additional information.

1. Ohm's Law

RI = V or V = IZ	(1) (2)
Then Z = $\frac{V}{I}$	(3)
and I = $\frac{V}{Z}$	(4)
P=I * V	(5)
$\frac{V}{Z}$ From (4)	
This becomes $\left(\frac{V}{Z}\right) * V = \frac{V^2}{Z}$	(6)
Let P = VAR	
Then Z = $\frac{V^2}{Z}$	(7)
or Z = $\frac{V^2}{VAR}$	(8)
Or Z = $\frac{KV^2}{KVAR} * 1000$	(9)
Letting Z = XC Or XL	(10)
We have XC (Or XL) = $\frac{KV^2}{MVAR}$	(11)

This will allow you to determine the reactance of a capacitor or reactor when voltage and KVAR is given.

Example:

A three-phase 600KVAR capacitor bank at 12,470 will yield

$$Xc = \frac{KV^2}{MVAR} = \frac{12.47^2}{.600} = 259.168 \text{ Ohms}$$

A three-phase shunt reactor of 150KVAR, at 13.8KV will yield

$$Xc = \frac{KV^2}{MVAR} = \frac{13.8^2}{.150} = 1269.6 \text{ Ohms}$$

2. Capacitance

$X_C = \frac{1}{(2\Pi FC)}$	(12)
But, as stated VAR = $\frac{V^2}{Z}$ (6)	
$\therefore$ VAR = $\frac{V^2}{\left(\frac{1}{2\Pi FC}\right)}$	(13)
Or = $\frac{V^2}{X_C}$	(14)
Then VAR = $(V^2 * 2\pi F * C * 10^{-6})$	(15)
KVAR = $\frac{(V^2 * 2\pi F * C * 10^{-6})}{1000}$	(16)

Example:

From above 600KVAR at 12.47KV equals 259.168 Ohms and from (12)

$$X_C = \frac{1}{(2\Pi FC)}. \text{ Then } C = \frac{1}{2 * \pi * f * 259.168}$$

Let f = 60 Hertz $(2\pi f = 376.99)$

Then C = 0.000010235 farads or 10.235 microfarads.

From (16) KVAR = $\frac{12{,}470^2 * 376.99 * 10.235 * 10^{-6}}{1000}$

KVAR = 600

3. Inductance

$X_L = 2\pi fL$	(17)
VAR = $\frac{V^2}{Z}$ from (6) = $\frac{V^2}{(2\Pi FL)}$	(18)
KVAR = $\frac{V^2}{(2\Pi FL * 1000)}$	(19)

From above 150KVAR at 13.8KV equals 1269.6 Ohms and from (17)

$X_L = 2\pi fL$. Let f = 60 Hertz $(2\pi f = 376.99)$

Then L = $\frac{X_L}{2 * \pi * f_L}$ = $\frac{1269.6}{376.99}$ = 3.36773 Henries

Or 3367.73 millihenries.

From (19) KVAR = $\frac{13800^2}{2 * \pi * f * 3.36773 * 1000}$ = $\frac{13800^2}{376.99 * 3367.73}$

KVAR = 150

	LEGEND
R	Resistance
I	Amps
V	Volts
Z	Impedance
P	Power (in Watts and/or Vars)
VAR	Reactive Power
K	Kilo (10^3)
X_C	Capacitive Reactance
X_L	Inductive Reactance
M	Mega (10>6)

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