Power Capacitor: RF Rating & Operating Conditions

The electrical performance is determined by the voltage, current and reactive power ratings. For the ideal case of a pure sinusoidal voltage waveform these parameters are related by the following equations:

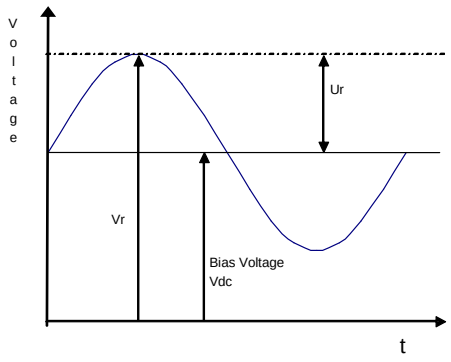
$$W_r = \frac{U_r^{\,2} fC}{318}$$

&

$$W_r = \frac{159 I_r^{\,2}}{fC}$$

Where W_r = Rated reactive power (kVA)
U_r = Rated a.c. voltage (kVpk)
I_r = Rated current (amps r.m.s.)
f = frequency (MHz)
C = Capacitance (pF)

V_r is the peak ac + dc voltage (Ur + dc) kVpk for which the capacitor is designed.

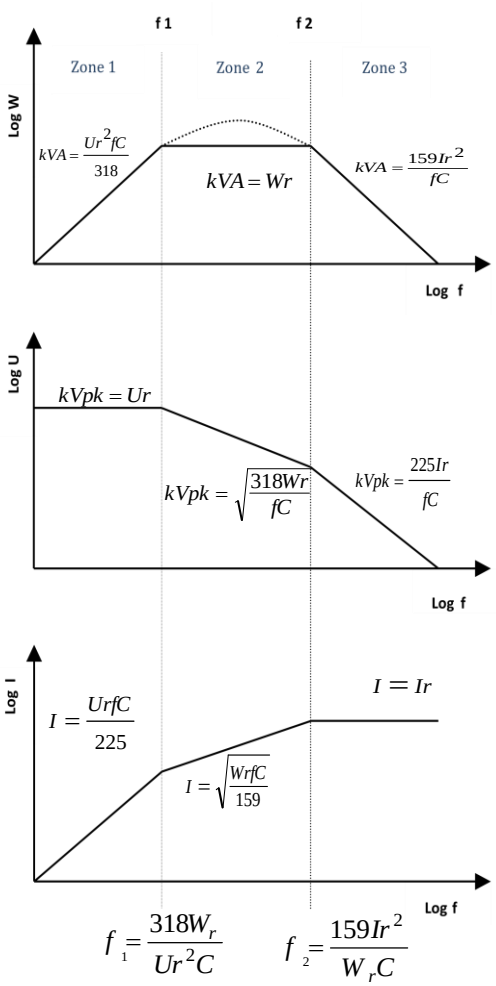


Rated current Ir is the r.m.s. current for which the capacitor is designed

Rated reactive power Wr is such that the capacitor temperature rise shall not exceed 45°C when operated, in still air, at an ambient temperature of 30°C (or as otherwise specified in the datasheet).

Frequency

When a capacitor is subjected to an RF load, heat is generated in the dielectric due to internal losses and in the electrode system due to resistance heating.
The performance is characterized by a typical frequency load curve as shown below:



$$f_1 = \frac{318 W_r}{Ur^2 C} \qquad f_2 = \frac{159 Ir^2}{W_r C}$$

At frequencies below f_1(Zone1) the capacitor can be operated at it's maximum ac rating U_r

At frequencies above f_2 (Zone3) the capacitor can be operated at it's maximum current rating I_r.

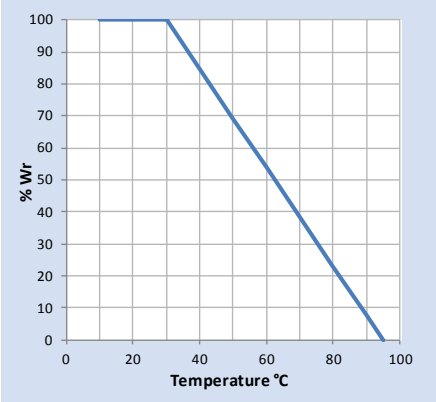
At frequencies between f_1 and f_2 (Zone2) the capacitor can be operated at it's maximum power rating W_r.

Operating Conditions

In certain circumstances such as intermittent operation the reactive power and current ratings can be exceeded but in no case should the maximum body temperature of the capacitor be exceeded, normally 95°C or as otherwise stated in the relevant data sheet.

For guidance shot term power and current ratings of 1.5 x are permissible. The voltages must not be exceeded.

If the capacitors are operated in an ambient temperature higher than 30°C then the reactive power loading must be reduced as shown in the graph below:



The user should ensure that the permissible operating conditions for the capacitor are not exceeded.

Care should be taken in the mechanical mounting to ensure that mechanical / thermal stresses are minimised. Vertical mounting is recommended.

The use of forced cooling methods allows higher reactive powers to be applied provided that the maximum body temperature of the capacitor is not exceeded. Methods of cooling commonly used are:

1. Forced Air
2. Water cooled connections
3. Oil immersion

Forced Air Cooling

Where Wr = Rated Reactive Power(kVAr)

$$W_r\ (\text{Force Cooled}) = \left(1 + \frac{2V}{3}\right) \times W_r\ (\text{naturally cooled})$$

V = air speed (ms^{-1})

Care should be taken when using forced air cooling to ensure that:

- Maximum body temperature is not exceeded
- Body temperature is even i.e. no 'hot spots' .

Maximum RF Current @ Frequencies > 20MHz

$$I_f = \left(\frac{f}{20}\right)^{-0.25} \times I_{20}$$

where

I_f = Current @ f MHz

I_{20} = Current @ 20MHz

f = frequency (MHz)

e.g. For f = 100 MHz and I_{20} = 25 Amps rms

$$If = \left(\frac{100}{20}\right)^{-0.25} \times 25$$

$$\boxed{If = 16.7 Amps}$$

RF Power Capacitor Storage Conditions

- Long term storage : +15°C to + 35°C and 25-75% relative humidity.
- Avoid accumulation of dust / water collection on sheds as this may lead to corona discharge / flashover.
- Avoid transportation of the units mounted as excessive vibration could lead to damage to the ceramic/metalwork joint.
- Avoid subjecting the units to undue shock e.g. dropping them, as this could lead to cracking of the ceramic and ultimate failure of the device.