



# **Power Capacitor:**

## **RF Rating & Operating Conditions**

# 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:

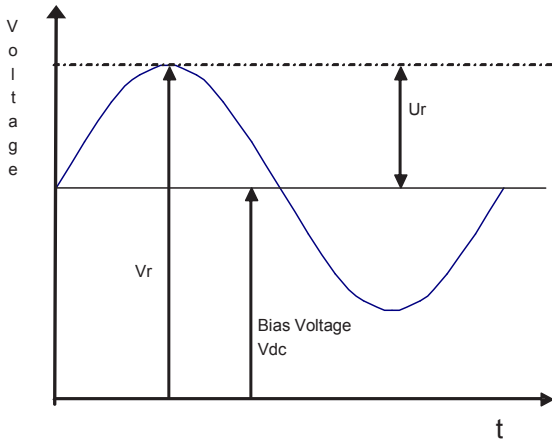
$$W_r = \frac{U_r^2 fC}{318}$$

&

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

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 ( $U_r + \text{dc}$ ) kVpk for which the capacitor is designed.

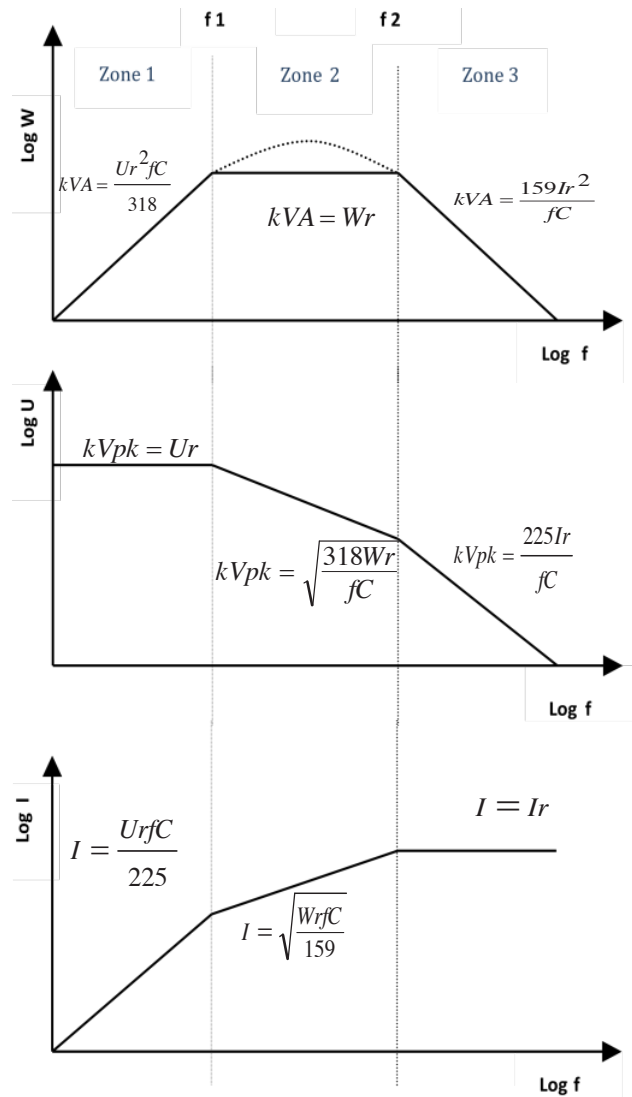


Rated current  $I_r$  is the r.m.s. current for which the capacitor is designed

Rated reactive power  $W_r$  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:



$$f_1 = \frac{318W_r}{U_r^2 C} \quad f_2 = \frac{159I_r^2}{W_r C}$$

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  $I_r$ .

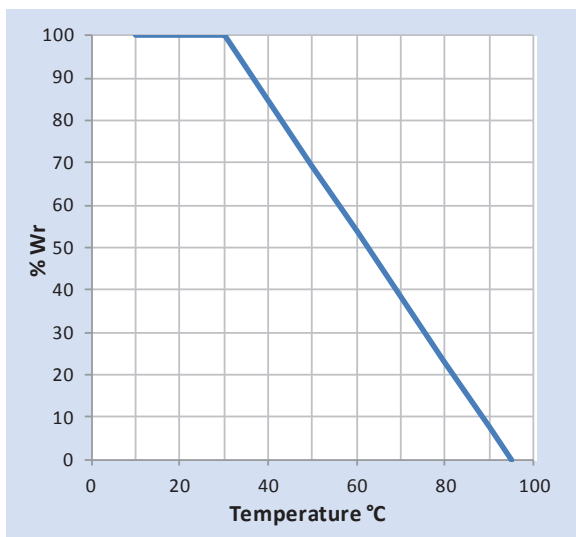
At frequencies between  $f_1$  and  $f_2$  (Zone2) the capacitor can be operated at it's maximum power rating  $W_r$ .

**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 short 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  $W_r$  = Rated Reactive Power(kVA<sub>r</sub>)

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

$V$  = air speed (ms<sup>-1</sup>)

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

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

$I_f = 16.7 \text{ Amps}$

**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.



The measured values mentioned before were determined for test samples and are applicable as standard values. The values were determined on the basis of DIN-/DIN-VDE standards and if these were not available, on the basis of CeramTec standards. The values indicated must not be transferred to arbitrary formats, components or parts featuring different surface qualities. They do not constitute a guarantee for certain properties. We expressly reserve the right to make technical changes.

**CeramTec UK Limited**  
Vauxhall Industrial Estate  
Ruabon  
Wrexham  
LL14 6HY  
United Kingdom  
Phone +44 (0) 1978 810 456  
[electroceramics@ceramtec.co.uk](mailto:electroceramics@ceramtec.co.uk)  
[www.ceramtec.com](http://www.ceramtec.com)