Capacitors in Series – Balancing Resistors

When aluminium electrolytic capacitors are connected as a bank of capacitors where there are multiple parallel branches of series capacitors, the need for balancing resistors is diminished due to the averaging effect of the number of capacitors where individual leakage current values become less critical. However, in the case of just two capacitors connected in series it is advisable to use balancing resistors in order to control the voltage sharing across each device due to imbalances in individual capacitor leakage currents. Figure 13 shows two capacitors in series along with balancing resistors.

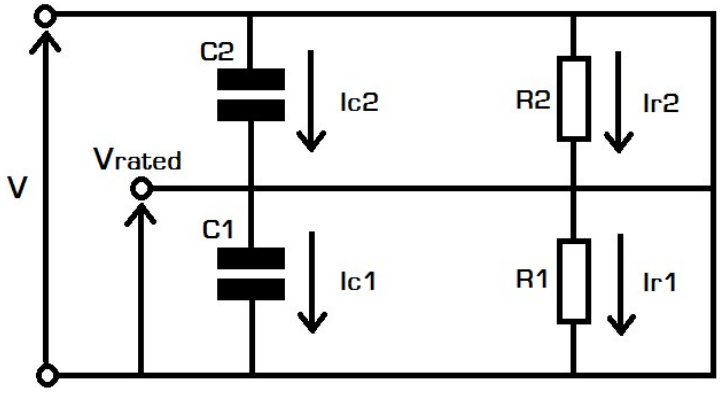

Figure 13

Trying to calculate individual leakage current values is impractical in a production environment and so an estimation based on experience can be made in order to calculate the differences in leakage currents between two capacitors in series. In figure 12 the individual leakage currents are Ic1 and Ic2.
The estimation for the leakage current difference between Ic1 and Ic2 is:
Difference, mA = (0.0015*C*V) / 2000

where C is the value of the individual capacitors in µF and V is the voltage across both capacitors in series.
Next, to calculate the value for balancing resistors, the equation is:
R Ω = ((2*Vrated) – V) / I difference
where Vrated is the individual capacitor rated voltage and V is the voltage across both capacitors in series.
Next to calculate the power rating of the resistors, we firstly require the current through the balancing resistor and then the power. The current through the balancing resistor is:
I, mA = (V/2)/R
where V is the voltage across both capacitors in series and R is the value of a balancing resistor.

The power, P, W = I^2R.

Example: V = 940v, Vrated = 500v, C = 1800uF
I difference = 2.538mA
R = 23.64k Ω
I = 19.881mA = 0.019881A
P = 9.34W