ILLINOIS CAPACITOR, INC.
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Aluminum Electrolytic Capacitors

Life expectancy

Aluminum electrolytic capacitors slowly degrade over time and once the capacitor has degraded beyond a specified amount, the capacitor is considered to have failed. Most capacitors are considered a failure when the capacitance has changed by 20 to 25% of its initial value.

Aluminum electrolytic Capacitors load life's ratings are generally expressed between 1000 and 10000 hours at their rated voltage, maximum temperature rating and with maximum ripple current applied to the capacitor. This means that the capacitance of the capacitor will not change by more than the amount indicated under the load life rating when the capacitor is operated at the stated conditions. Although the life expectancies appear be a short amount of time the following can increase them.

When the capacitor is operated at temperatures other than the maximum rated temperature for the capacitor the expected life of the capacitor will increase. The rate of increase in operating life is for the life to double for every 10°C decrease in temperature (Arrhenius's law).

For SMD, Snapin, Screw terminal and radial leaded capacitors with WVDC<100VDC the life expectancy is expressed mathematically as:

WVDC$\leq$100VDC - $L_2=L_1*2^x*2^y$ for SMD, Snapin, and radial leaded capacitor with L$\leq$7mm

WVDC$\geq$100VDC - $L_2=L_1*(Vr/Vo)^n*2^x*2^y$ Snapin, Screw terminal and radial leaded capacitors

Where L_2= life expected at application conditions
L_1= Load life rating of the capacitor
Vr= Rated voltage of the capacitor
Vo= applied voltage
X=(Tm-Ta)/10
Y= ΔTr/5 for SMD, Snapin, Screw terminal and radial leaded capacitors
ΔTr/8 for Snapin and radial leaded capacitors
Tm= maximum rated temperature of the capacitors
Ta= ambient temperature
Tr= temperature rise due to ripple current
n= 4.4 for D>10mm, L>20mm or snap in capacitors
2 for D$\leq$10mm, L$\leq$20mm radial lead only

Reducing the amount of voltage applied to the capacitor can also increase the expected life of the capacitor. The expected life can be increased by the ratio of applied voltage to rated voltage for the capacitor where the applied voltage is 80% or lower of the rated voltage. When the applied voltage is less

than 80% of the rated voltage the applied voltage is to be limited to 80% of the rated voltage of the capacitor. Voltage multipliers are to only be used when the ambient temperature is within 40°C of the rated temperature of the capacitor.

By de-rating, the life expectancies beyond 15 years can be achieved. When life expectancies exceed 15 years the expected life of the capacitor should be limited to 15 years mainly due to the sealing materials deteriorating over time.

The life of the capacitor can be reduced if the amount of ripple current becomes excessive causing the capacitor heat up from its ESR. Care should be taken to limit the temperature rise (Tr) due to the ripple current and ESR to a maximum of 10°C above the ambient temperature the capacitor is operating in.

It is evident that a 10°C temperature rise due to the ESR will reduce the expected life by half.

Other factors that can reduce the expected life of a capacitor are:

- High leakage current.
- Frequent charge and discharge cycles.
- Excessive reverse voltage.
- Application of voltages greater than the rated voltage of the capacitor.
- AC voltage exceeding the limits of the capacitor.
- Operation at temperatures exceeding the maximum temperature rating for the capacitor.