Life Time Estimation

To estimate the Life Time of an Electrolytic Capacitor, the following formulas can be utilized. The Life Time depends mainly on the ambient temperature, the ripple current and the operating voltage applied. Other parameters may also affect the Life Time. Moreover, L_0 can be interpreted in many different ways, which has a fundamental influence on the numerical result. Life Time estimations are approximations by nature.

Please let **JIANGHAI EUROPE** confirm any result before using it. The formulas given here do not constitute part of a contract nor of a specification. The formulas do not account for additional aging effects of certain electrolytic systems or other chemical effects. Please contact us should you need Life Time estimates for Solid Electrolyte Polymer Capacitors. Also the dimensions of the components may have an effect. Forced cooling or other additional cooling-methods have a strong impact on the Life Time and are not covered by the formulas.

For the estimation and interpretation of Life Time, a close collaboration with **JIANGHAI EUROPE** is strongly advised.

Structural formula:

$$L_X = L_0 \cdot K_T \cdot K_R \cdot K_V$$

Where:

L_X	Total Life Time
L_0	Life Time under Rated Ripple Current at Upper Category Temperature (see catalogue)
K_T	Temperature Factor
K_R	Ripple Current Factor
K_V	Voltage Factor

1. K_T **Temperature Factor**: Aluminum Electrolytic Capacitors follow roughly the 10K rule of Arrhenius. It is possible to estimate the Life Time by rule of thumb: When the operating temperature is reduced by 10K, the Life Time will double. The formula for K_T in detail is:

$$K_T = 2^{\frac{T_0 - T_X}{10K}}$$

Where: T_0 Rated Temperature

T_X Actual Operating Temperature

2. K_R **Ripple Current Factor**: The influence of ripple current on Life Time can be estimated according to the following formula:

$$K_R = K_i^{A \cdot \frac{\Delta T_0}{10K}}$$

With: $$A = 1 - \left(\frac{I}{I_0}\right)^2$$

Where: I Actual Rated Ripple Current

I_0 Ripple Current at Upper Category Temperature (databook value)

ΔT_0 Core Temperature Rise of the capacitor (typically 5K for T_0= 105°C and 10K for T_0= 85°C)

K_i Coefficient, defined as

$T_0 = 105°C \quad I > I_0 \rightarrow K_i = 4$

$I \leq I_0 \rightarrow K_i = 2$

$T_0 = 85°C \rightarrow K_i = 2$

3. K_V **Voltage Factor**: For Radial Electrolytic Capacitors, this part of the formula has no impact ($K_V = 1$). But for some bigger capacitors like Snap-In and Screw-Terminal types, the operating voltage will affect their Life Time. It is expressed as follows:

$$K_V = \left(\frac{U_R}{U_X}\right)^n$$

Where: U_R Rated Voltage

U_X Actual Operating Voltage

n Coefficient, defined as:

$$1 \leq \frac{U_R}{U_X} \leq 1{,}25 \rightarrow n = 5$$

$$1{,}25 < \frac{U_R}{U_X} \leq 2 \rightarrow n = 3$$

$$2 < \frac{U_R}{U_X} \rightarrow n = 1$$

4. **Frequency Correction Factors**: If the actual Ripple Currents I are not given at the same frequency like I_0, weighing factors need to be applied.

$$I = \sqrt{\left(\frac{I_{f1}}{F_{f1}}\right)^2 + \left(\frac{I_{f2}}{F_{f2}}\right)^2 + \cdots + \left(\frac{I_{fn}}{F_{fn}}\right)^2}$$

I Actual Rated Ripple Current at different frequencies

$I_{f1} \ldots I_{fn}$ Ripple Current at different frequencies

$F_{f1} \ldots F_{fn}$ Frequency Correction Factors for different frequencies

5. JIANGHAI Electrolytic Capacitor Life Time Estimation Formula

$$L_X = L_0 \cdot K_T \cdot K_R \cdot K_V$$

$$= L_0 \cdot 2^{\frac{T_0 - T_x}{10K}} \cdot K_i^{\left[1-\left(\frac{I}{I_o}\right)^2\right] \cdot \frac{\Delta T_0}{10K}} \cdot \left(\frac{U_R}{U_X}\right)^n$$

$T_0 = 105°C \quad I > I_0 \rightarrow K_i = 4$

$I \leq I_0 \rightarrow K_i = 2$

$T_0 = 85°C \quad \rightarrow K_i = 2$

$$1 \leq \frac{U_R}{U_X} \leq 1{,}25 \rightarrow n = 5$$

$$1{,}25 < \frac{U_R}{U_X} \leq 2 \rightarrow n = 3$$

$$2 < \frac{U_R}{U_X} \rightarrow n = 1$$