LIFE TIME ESTIMATION OF CAPACITORS 電容器的壽命時間推算

The life of aluminum electrolytic capacitors is mainly dependent on environmental conditions (e.g. ambient temperature, humidity etc.) and electrical factors (e.g. operating temperature, ripple current etc.). Generally, the wear-out mechanism of aluminum electrolytic capacitors is based on evaporation of electrolyte through the rubber seal. Consequently, the factor of temperature (ambient temperature and internal heating due to ripple current) is the most critical to electrolytic capacitors life. The effect of voltage on capacitor life is negligible, especially for low voltage electrolytic capacitors. The lifetime of aluminum electrolytic capacitors can be expressed as following equations:

鋁電解電容器的壽命主要依賴於其適用的環境條件（如環境溫度，濕度等）和電負荷情況（如工作電壓，紋波電流等）。通常而言，鋁電解電容器的失效機理被認為是電解液通過膠塞逐漸揮發所導致。因此，溫度因素（環境溫度和由於紋波電流所引致的內熱）對電容器壽命的影響最大，而電壓對電容器壽命的影響可以忽略，尤其對低電壓鋁電解電容器更是如此。鋁電解電容器的壽命可用下列公式來估算：

$$L_e = L_o \bullet K_t \bullet K_r$$

Where: 其中：

L_e = Expected life at operating temperature T_e (h) 在工作溫度 T_e (h)下的預期壽命

L_o = Specified life at temperature operating temperature T_o (h) 在最大工作溫度 T_o (h)下的壽命

K_t = Ambient temperature acceleration term 環境溫度影響因子

K_r = Ripple current acceleration term 紋波電流影響因子

$$K_t = L_o \bullet A^{(T_o - T_e)/10}$$

Where: 其中：

T_o = Maximum rated operating temperature (°C) 最大額定工作電壓 (°C)

T_e = Actual ambient temperature (°C) 實際環境適用溫度 (°C)

A = Acceleration coefficient (for the range from 35°C to the maximum operating temperature, A≈2)
加速系數（對於從 35°C 到最高工作溫度的範圍，A≈2）

$$K_r = 2^{(-\Delta T/5)}$$

Where: 其中：

ΔT = An increase in core temperature by internal heating due to ripple current 由於紋波電流引起的內熱造成電容器芯子的升溫
(ΔT = core temperature – ambient temperature) （ΔT = 芯子溫度 – 環境溫度）

ΔT can be estimated as follows: ΔT 可用以下公式估算：

$$\Delta T = (I^2 \bullet R)/(\beta \bullet S)$$

Where: 其中：

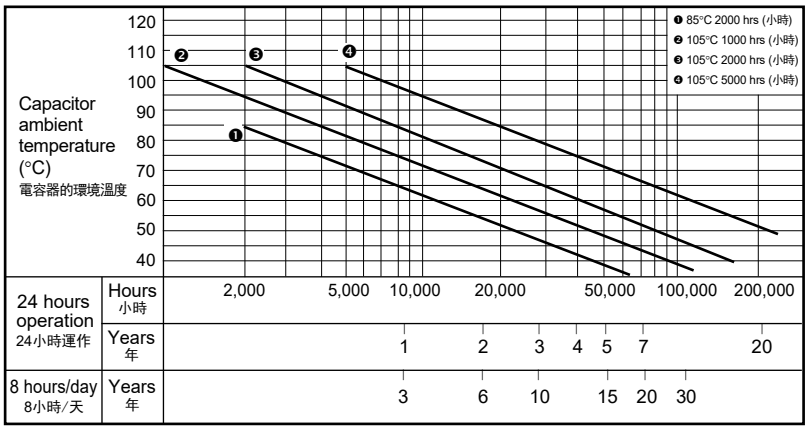
I = Ripple current of the capacitor (A rms) 通過電容器的紋波電流 (A rms)

R = Equivalent series resistance of the capacitor (Ω) 電容器的等效串聯電阻 (Ω)

β = Heat radiation coefficient of the aluminum can (W/°C•cm²) 鋁殼的熱輻射系數 (W/°C•cm²)

S = Surface area of the capacitor (cm²) 電容器的表面積 (cm²)

In neglecting ripple current effect, the expected life of the capacitors at lower temperature is shown in the following chart.
當忽略紋波電流影響時，電容器在較低溫下的預期壽命可參考以下圖表。



● Quick Reference Guide of the Expected Life 預期壽命快速參考圖

Example 1: When a 2000 hours/105°C guaranteed product is used continuously at 60°C, it can be expected to have a life of 5 years.
例 1：對於 105°C 2000 小時的產品，如果在 60°C 環境中連續使用，它的預期壽命約 5 年。

Example 2: 例 2：

Conductive Polymer Aluminum Solid Electrolytic Capacitors 導電性高分子固態鋁電解電容器	Aluminum Electrolytic Capacitors/Conductive Polymer Hybrid Aluminum Electrolytic Capacitors 鋁電解電容器/導電式高分子混合型鋁電解電容器
105°C ≥ 2,000 hours 小時	105°C ≥ 2,000 hours 小時
95°C ≥ 6,324 hours 小時	95°C ≥ 4,000 hours 小時
85°C ≥ 20,000 hours 小時	85°C ≥ 8,000 hours 小時
75°C ≥ 63,245 hours 小時	75°C ≥ 16,000 hours 小時

Please note that:
a) The maximum estimated life is 15 years.
b) Ripple current in application should be less than or equal to ripple current specified in this catalogue.

請留意：
a) 最大壽命時間約為 15 年。
b) 施加的紋波電流值應較本目錄冊所列的紋波值小或等同。