Lifetime Estimation of Conductive Polymer Hybrid Aluminum Electrolytic Capacitors

Subject series : HXC/HXD/HXJ/HXK/HXE/HXF/HSC/HSD/HSE

Please consult us about lifetime equations for HXF series.

Conductive polymer hybrid aluminum electrolytic capacitors, in common with other aluminum electrolytic capacitors, are electronic components with a finite lifespan. The lifetime of these capacitors is influenced by ambient temperatures, environmental conditions such as humidity, and operating conditions such as the level of ripple current and surge voltage, all of which can reduce capacitance and increase ESR as a result.

1. Lifetime Estimation

Estimation of lifetime can be expressed by the following equations (1) to (3), which take the effects of ambient temperatures and self-heat rise resulting from ripple current into account.

Subject series : HXC/HXD/HXJ/HXK/HSC/HSD

$$Lx = Lr \times Bt^{\frac{Kt(To-Tx)}{10}} \times Bt^{\frac{\Delta To-\Delta T}{10}} \quad \cdots\cdots(1)$$

Subject series : HXE/HXF/HSE

125 ℃<Tx≦135 ℃

$$Lx = Lr \times Bt^{\frac{To-Tx}{10}} \times Bt^{\frac{\Delta To-\Delta T}{10}} \quad \cdots\cdots(2)$$

Tx≦125 ℃

$$Lx = Lr \times Bt^{\frac{Kt(125-Tx)}{10}} \times Bt^{\frac{\Delta To-\Delta T}{10}} \quad \cdots\cdots(3)$$

Lx : Estimation of actual lifetime (hour)
Lr : Stated lifetime under the rated ripple current superimposition at the upper limit of the category temperature (hours)
Bt : Temperature acceleration factor ……(Table-1)
Kt : Correction factor of ambient temperature acceleration factor……(Table-2)
To : Maximum category temperature (℃)
Tx : Actual ambient temperature of the capacitor (℃)
Use 40℃ if the actual ambient temperature is below it.
ΔTo : Rise of internal temperature due to the rated ripple current (℃) ……(Table-3)
ΔT : Rise of internal temperature due to actual ripple current (℃)

Table-1 Bt : Temperature acceleration factor

Subject series		φ5, 6.3	φ8, 10
HXC/HXD/HXJ/HXK/HSC/HSD		1.7	2
HXE/HXF/HSE	Tx ≦ 125 ℃	1.7	2
	125 ℃ < Tx ≦ 135 ℃	1.7	1.7

Table-2 Kt : Correction factor of ambient temperature acceleration factor

Actual ambient temperature of the capacitor	Tx ≦ 65 ℃	65 ℃ < Tx ≦ 105 ℃	105 ℃ < Tx ≦ 125 ℃
Bt=1.7	1.06	1.03	1
Bt=2	1		

Table-3 ΔTo : Rise in internal temperature due to the rated ripple current (℃)

Subject series	HXC		HSC	HXD/HSD/HXK	HXJ			
Case size	φ6.3×5.8 to φ10×10L	φ10×12.5L	—	—	φ6.3x5.8L	φ6.3x7.7L	φ8×10L, Φ10×10L	φ10×12.5L
ΔTo	5℃	6℃	5℃	15℃	5℃	8℃	10℃	11℃

Subject series	HXE		HXF	HSE
Case size	φ6.3×5.8L to φ10×10L, φ10×16.5L	φ10×12.5L	φ8×10L, φ10×10L, φ10×12.5L, φ10×16.5L	—
ΔTo	15℃ (Tx≦125 ℃) 5℃ (125 ℃<Tx≦135 ℃)	16℃ (Tx≦125 ℃) 6℃ (125 ℃<Tx≦135 ℃)	20℃ (Tx≦125℃) 10℃ (125℃<Tx≦135℃)	15℃ (Tx≦125 ℃) 5℃ (125 ℃<Tx≦135 ℃)

An approximate value of ripple current-caused ΔT can be calculated using Equation (4)

$$\Delta T = \Delta To \times \left(\frac{Ix}{Io}\right)^2 \quad \cdots\cdots(4)$$

ΔTo : Rise in internal temperature due to the rated ripple current ……(Table-3)
Ix : Operating ripple current (Arms) actually flowing in the capacitor
Io : Rated ripple current (Arms), frequency compensated, at the upper limit of the category temperature range

To determine more accurate values of ΔT, they can be actually measured using a thermocouple.

2. Rated Ripple Current Frequency Multipliers

Self-heat rise is generated by the ripple current even though the conductive polymer hybrid aluminum electrolytic capacitors have low ESR compared to liquid based electrolyte aluminum electrolytic capacitor. The ESR value differs depending on the frequency, thus the degree of self-heat rise differs depending on the ripple current frequency. Therefore, if the actual ripple current frequency differs from the specifications stated in the standard ratings, use the value obtained by multiplying the rated ripple current multiplier to convert the rated current.

Conductive polymer hybrid aluminum electrolytic capacitors have super low ESR characteristic in high-frequency range. On the whole, ESR in low-frequency range relatively rises. Therefore, they can use only small ripple current in low-frequency range.
Please ensure that excessive ripple current is not applied to the capacitors in all frequency range.

3. Restriction of estimated lifetime calculation

The result calculated by the estimated lifetime formula, it is not guaranteed lifetime by Nippon Chemi-Con Corporation.
When designer calculate the lifetime of apparatus, please include an ample margin in consideration to the estimated lifetime of a capacitor.
When calculated lifetime result are over 15 years by using the estimated lifetime formula, please consider 15 years to be a maximum in considering that the sealing rubber characteristics vary during the lifetime.
If 15 years or more may be required as an expected lifetime, please consult us.