Life Estimation Formula

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Life Estimation Formula for the Capacitors

* Load life specified with DC + ripple current

Radial Type :KMQ,KMG,KZM,KZH,KZE,KY,LXZ,LXY,LXV,KXJ,KXG,KMX,SMH,KMH,PAG,FL,KZJ,KZG,KMY -series
Snap-ins Type :KMR,SMQ,KMQ,SMM,KMS,KMM,SMH,KMH,SLM,KLM,LXM,LXS,LXQ,LXG-series

$$Lx = Lo \times 2^{(To - Tx)/10} \times 2^{(\Delta To - \Delta Tx)/5}$$

Where:
- Lx = Lifetime (hours) of the capacitor to be estimated
- Lo = Base (Assured) lifetime (hours) of the capacitor
- To = Maximum rated operating temperature (°C)
- Tx = Actual ambient temperature (°C) of the capacitor within device (This is not the environment temperature of the device, but the environment temperature of the capacitor that has been placed within the device.)
- ΔTo = Rise (°C) in core temperature of the capacitor due to rated (permissible) maximum ripple current.

ΔTo	Radial Type	Snap-ins Type
5	KMQ,KMG,KZM,KZH,KZE,KY , KXJ,KXG,KMX, KMH, PAG,FL,KZJ,KZG,KMY-series	KMR, KMQ, KMS,KMM, KMH, KLM-series
10	SMH-series	SMQ, SMM, SMH, SLM-series
3	LXZ,LXY,LXV, KMF-series	LXM,LXS,LXQ,LXG-series

- ΔTx = Actual rise (°C) in the core temperature of the capacitor due to actual ripple current at device operating conditions.
  To calculate the ΔTx from the surface temperature of the capacitors, refer to the appendix 1.
  Also, to simply estimate the ΔTx from the actual rms ripple current, use the following equation:
  ΔTx = ΔTo x [**(actual rms ripple)** / **(rated rms ripple)**]^2
  The actual and rated maximum rms ripple current shall be equaled in frequency by using frequency multipliers prescribed for each product series in the catalog.
- Vo = Rated voltage (V) of the capacitor
- Vx = Actual operating voltage (V) which is applied to the capacitor at the device.
  When the actual operating voltage (Vx) is less than 80% of the rated voltage (Vo), the actual operating voltage (Vx) in the formula (1) shall be considered as 80% of the Vo.

Note) For the estimated life time (Lx), the maximum lifetime is 15 years(131,400H).

Life Estimation Formula for the Capacitors

* Load life specified DC

Radial Type : SRM, SRE, SRA, SRG, KRE, KMA, KRG, SMQ, SMG, SME -series
Chip Type : MVS, MV, MVA, MVK, MVE, MKA, MZA, MVY, MLA, MVJ, MVL, MZD, MLD, MKB, MHB, MVH -series

$$Lx = Lo \times 2^{(To - Tx)/10} \times 2^{(-\Delta Tx)/5} .$$

Where: Lx = Lifetime (hours) of the capacitor to be estimated
Lo = Base lifetime (hours) of the capacitor
To = Maximum rated operating temperature (°C)
Tx = Actual ambient temperature (°C) of the capacitor within device (This is not the environment temperature of the device, but the environment temperature of the capacitor that has been placed within the device.)

ΔTx = Actual rise (°C) in the core temperature of the capacitor due to actual ripple current at device operating conditions.
To calculate the ΔTx from the surface temperature of the capacitors, refer to the appendix 1.
Also, to simply estimate the ΔTx from the actual rms ripple current, use the following equation:
ΔTx = ΔTo x [**(actual rms ripple)** / **(rated rms ripple)]^**2
The actual and rated maximum rms ripple current shall be equaled in frequency by using frequency multipliers prescribed for each product series in the catalog.

ΔTo	Radial Type	Chip Type
5	KRE, KMA, KRG-series	MVK, MVE, MKA, MZA, MVZ,MVY, MLA, MLD, MVJ, MVL, MZD, MKB, MHB-series
10	SRM, SRE, SRA, SRG, SMQ, SMG, SME-series	MVS, MVA, MV-series
3	-	MVH-series

Note) For the estimated life time (Lx), the maximum lifetime is 15 years(131,400H).

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Appendix 1. How to obtain the ΔTx from the surface temperature of the capacitor

Temperature rise inside capacitor

ΔTx = (Ts − Tx) x Kc

Where: Ts = Surface temperature (°C) of the aluminum case
Tx = Actual ambient temperature (°C) of the capacitor
Kc = Coefficient standing for the ratio of the ΔTx to the (Ts−Tx)
For the Kc's, refer to the table below:

Kc :

Capacitor diameter (mm)	φ5- φ8	φ10	φ12.5	φ16	φ18	φ22	φ25	φ30	φ35
Kc	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.50	1.65

Appendix 2. How to measure the temperatures of the Tx and Ts

Actual ambient temperature of capacitor

Surface temperature of capacitor case

Measuring the actual ambient temperature (Tx) and surface temperature (Ts) shall follow the following ways respectively.

Tx (actual ambient temperature of capacitor):

The Tx should be measured at the place 20~30mm (at least 10mm) away from the surface of the aluminum case. If any part adjacent to the capacitor produces heat and causes the temperature (Tx) to be inconstant with places around the capacitor, more than 4 places around the capacitor are preferable to be measured for temperatures and then the average value of the temperatures shall be used as the temperature (Tx).

Ts (surface temperature of capacitor aluminum case)

The Ts shall be measured on the surface of the capacitor body, at the half-height of the body. If any part adjacent to the capacitor produces heat and causes the temperature (Ts) to be inconstant with places around the capacitor, more than 4 places on the side of the capacitor are preferable to be measured for temperatures and then the average value of the temperatures shall be used as the temperature (Ts).

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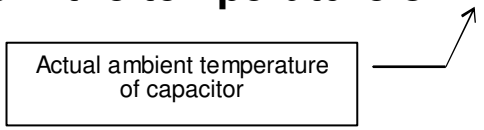
Appendix 3. How to obtain the temperature of Tx



If surface temperature of a capacitor (Ts) and temperature rise (ΔTx) are known, actual ambient temperature around the capacitor shall be estimated by using the following formula. When the surface temperature(Ts) is lower than ambient temperature(Tx), the following equation is not applicable.

Tx = Ts — (ΔTx/Kc)

Where: Ts = Surface temperature (°C) of the aluminum case

Tx = Actual ambient temperature (°C) of the capacitor

Kc = Coefficient standing for the ratio of the ΔTx to the (Ts—Tx)

Note) Coefficient Kc is shown in Appendix 1.

ΔTx = Actual rise (°C) in the core temperature of the capacitor due to actual ripple current

To simply estimate the ΔTx from actual ripple rms ripple current, use the following formula:

ΔTx = ΔTo x [(actual rms current) / (rated ripple current)] ^ 2

Note) ΔTo is shown in each section.

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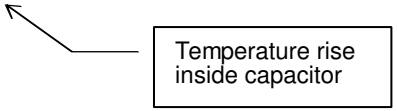
Appendix 4. *Guide Limits of Maximum ΔTx and Temperature Coefficients:*



105°C max. capacitors

Capacitor ambient temperature	**~85°C**	**105°C**
Guide limit of max. ΔTx	15°C	5°C
Temperature coefficient $\left(\frac{\text{Actual rms ripple}}{\text{Rated rms max. ripple}}\right)$	1.73	1.00

85°C max. capacitors

Capacitor ambient temperature	**~65°C**	**75°C**	**85°C**
Guide limit of max. ΔTx	20°C	15°C	10°C
Temperature coefficient $\left(\frac{\text{Actual rms ripple}}{\text{Rated rms max. ripple}}\right)$	1.41	1.22	1.00

Note:
- In the temperature coefficient, the actual and rated maximum rms ripple current shall be equaled in frequency by using frequency multipliers prescribed for each product series in the catalog.
- Actual rms ripple current may exceed the value using the temperature coefficient if the ΔTx does not exceed the maximum limit.
- The ΔTx should not exceed the maximum limits.