

I . Lifetime Estimation

Conductive polymer(hybrid) aluminum solid capacitors (hereinafter referred to as PC-CON)are finite life electronic components like aluminum electrolytic capacitors. The lifetime is affected by ambient temperature, humidity, ripple current and surge voltage.

The lifetime of aluminum electrolytic capacitors is affected mainly by the loss of electrolyte as the result of the liquid electrolyte evaporating through the rubber seal materials, resulting in capacitance drop and tanδ rise. On the other hand, the lifetime of conductive polymer(hybrid) aluminum solid capacitors is affected mainly by oxidation degradation of the conductive polymer caused by osmose of oxygen or the thermal degradation of the conductive polymer by ambient temperature or self-heating, resulting in ESR rise and tanδ rise. The infiltration rate of the oxygen is depend on the temperature as the liquid electrolyte evaporation and the relationship follows the Arrhenius's Law, too. Similarly, thermal degradation of the conductive polymer by self-heating follows the Arrhenius's Law, too.

1.1 Conductive Polymer Solid aluminum Capacitors Lifetime Estimation

Subject series : FR/FH/FG/FF/FS/FL/FT/FP/VB/VP/VS/VQ/VC

Equation (1) can be used for estimating the lifetime of the conductive polymer aluminum solid capacitors based on the ambient temperature and the rise of internal temperature due to ripple current.

$$L_x = L_0 \times 10^{(T_0 - T_x)/20} \text{-----(1)}$$

Lx : Estimation of actual lifetime (hour)

Lo : Specified lifetime with the rated voltage at the upper limit of the category temperature (hour)

To : Maximum category temperature (°C)

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

Longer lifetime is expected by lowering the ripple current and the ambient temperature.

The (ripple) life expectancy at a lower temperature than the specified maximum temperature may be estimated by the above equation, but this expectancy formula does not apply for ambient below +40°C.

1.2 Conductive Polymer(Hybrid) aluminum Solid Capacitors Lifetime Estimation

Subject series : FB/FC/VD/VA/YA/YD/YS/YX

Equation (2) can be used for estimating the lifetime of the conductive polymer(hybrid) aluminum solid capacitors based on the ambient temperature and the rise of internal temperature due to ripple current.

$$L_x = L_0 \times 2^{(T_0 - T_x)/10} \text{-----(2)}$$

Lx : Estimation of actual lifetime (hour)

Lo : Specified lifetime with the rated voltage at the upper limit of the category temperature (hour)

To : Maximum category temperature (°C)

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

Longer lifetime is expected by lowering the ripple current and the ambient temperature.

The (ripple) life expectancy at a lower temperature than the specified maximum temperature may be estimated by the above equation, but this expectancy formula does not apply for ambient below +40°C.

2. Rated Ripple Current Frequency Multipliers

Self-heat rise is generated by the ripple current even though the conductive polymer(hybrid) aluminum solid capacitors have low ESR compared to liquid based electrolyte aluminum electrolytic capacitor. Longer lifetime is expected by lowering the ripple current and the ambient temperature.

Table 1 shows Frequency Multipliers of Rated ripple current.

Frequency Multipliers

Frequency [Hz]	120 ≤ F < 1K	1K ≤ F < 10K	10K ≤ F < 100K	100K ≤ F ≤ 500K
SMD type	0.05	0.3	0.7	1
Radial lead type	0.05	0.3	0.7	1
Hybrid type	0.1	0.3	0.6	1

Conductive polymer(hybrid) aluminum solid 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 1 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 Calculated Lifetime

- (1) The result calculated by the estimated lifetime formula, it is not guaranteed lifetime.
- (2) When designer calculate the lifetime of apparatus, please include an ample margin in consideration to the estimated lifetime of a capacitor.
- (3) The estimated life is limited to 15 years, if it exceeds 15 years, take 15 years as standard.
- (4) If 15 years or more may be required as an expected lifetime, please consult us.

II . About Failure and Shelf-Life

Failure rate (failure rate level) subject to 0.5 %/1000 h of JIS C 5003 (Credibility level 60 %)

The main failure mode of polymer(hybrid) solid aluminum electrolytic capacitor of is shown below.

1. Random Failure

The main cause of failure mold is short circuit due to heat stress, electrical stressing and mechanical stress in using environment or welding.

- (1) applied voltage more than rated voltage
- (2) applied reverse voltage
- (3) Excessive mechanical stress
- (4) Applying fast charging and discharging that more than specifications and cause surge current

a. If the short circuit current flows through the solid(hybrid) capacitor will cause the following phenomenon.

- (1) When the electric current is less after short circuit (φ10 : about below 1 A , φ8 : about below 0.5 A , φ6.3 : about below 0.2 A) PC-CON body will have little heat but appearance is normal even continuous electricity.
- (2) When the short circuit current value exceeds the above numerical, internal temperature will increased, encapsulation adhesive pad summoned and the odorous gases to overflow.

b. In order to ensure the safety in case of occurs short circuit, please take the following countermeasures

- (1) Cut off the main power supply and stop using immediately if overflow the odorous gases.
- (2) Due to the different conditions , the odorous gases occurrence generally takes a few seconds to several minutes, When using protection circuits we recommend to start protect function in this period.
- (3) Cleaned immediately if the gas enters into eye , gargle immediately if inhalation into mouth.
- (4) Don't lick the electrolyte if electrolyte contact with the skin please washing with soap immediately.
- (5) PC-CON including combustible material, current value greatly after the short circuit and short circuit parts will have a possibility of spark. In order to protect safety, please pay attention to the design structure and use protection circuit.

2. The Wear Failure (Shelf Life)

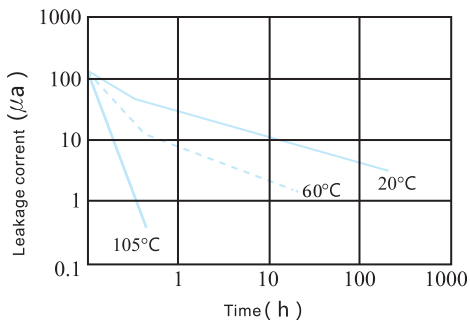
Electrical characteristics can make a big change when more than the guarantee time of durability and high temperature and high humidity test, electrolyte will insulation (degradation) formation of open mode eventually.

Even used within the prescribed scope of electrical and mechanical properties, it may also reducing capacitance and increase ESR, so please take care when design.

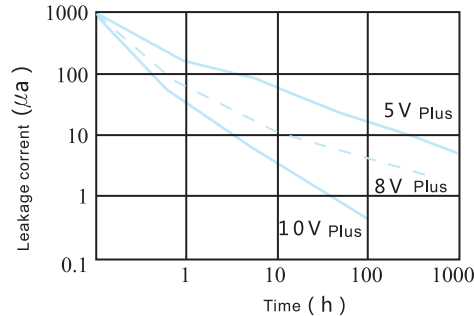
III. Leak Current

The leak current of conductive polymer(hybrid) solid aluminum electrolytic capacitor will increase due to the mechanical stress . In this case, if the solid capacitor apply voltage below the high using temperature, the repairing effect of leak current will reducing gradually. If the solid(hybrid) capacitor applies rated voltage within the high using temperature, the repairing speed of leak current will faster.

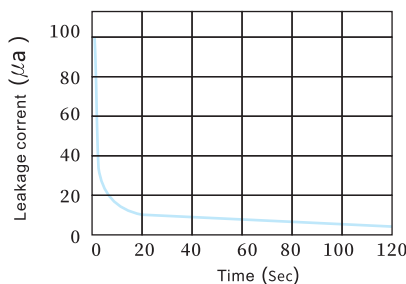
Conductive polymer solid aluminum electrolytic capacitor
Repairing character of leak current
10 μ F/16 V.DC (apply 16 V.DC)



Conductive polymer solid aluminum electrolytic capacitor
Repairing character of leak current
33 μ F/10 V.DC (ambient temperature 65°C)
(Test voltage 10V.DC)



Conductive polymer hybrid capacitor
Repairing character of leak current
100 μ F/25 V.DC (apply 25 V.DC)



※In order to show more clearly said repair of leakage current , we use the sample of apply stress to PC-CON that increased leak current on purpose.

IV. The Limited of Faster Charging and Discharging

Faster charging and discharging will lead to large surge current and then result in short circuit or increase leak current.

When the surge current value as below, we recommend to use protection circuit in order to maintain high reliability.

- (1) more than 10 A
- (2) exceed rated ripple current 10times

V. Correct Mounting

1. About The Soldering Iron Soldering

- (a) Avoiding applying stress on PC-CON body when it need to process lead due to unconformity between lead gap and circuit board gap of plugin mounting.
- (b) Avoiding applying excessive stress on PC-CON body when soldering.
- (c) When need to take out PC-CON after soldering, please melt molten solder sufficient, implement under the condition of not put stress on the PC-CON body.
- (d) Don't let the tip of the soldering iron to touch the PC-CON body.

2. Wave-Soldering

- (a) Do not have wave soldering to SMD product.
- (b) Do not dip the PC-CON body into dissolved soldering flux.
- (c) Welding parts only limited between the circuit board and the opposite side of the PC-CON.
- (d) Don't splash other place expectation rosin.
- (e) Avoiding other parts lie down and touching PC-CON when soldering.

3. Reflow Soldering

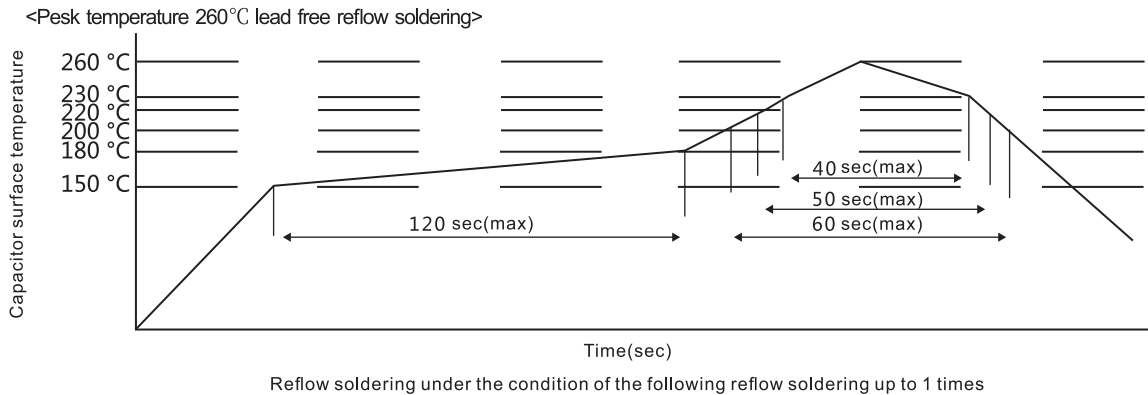
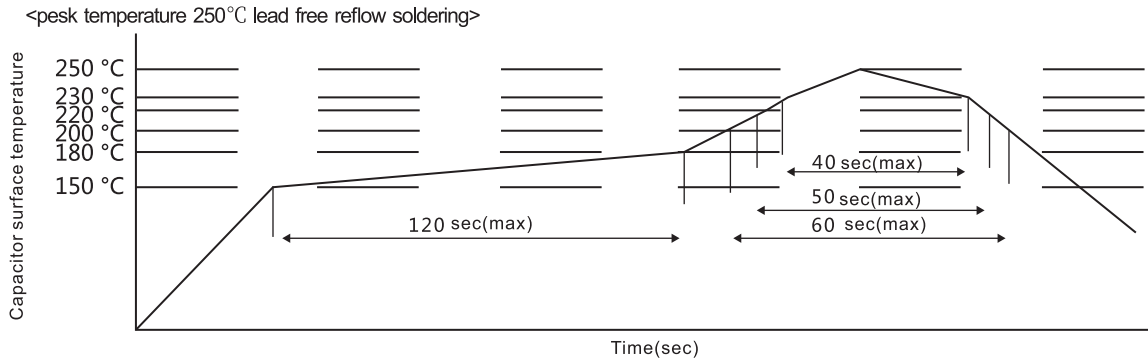
- (a) Do not have reflow soldering to plugin mounting product .
- (b) Please consult us when use VPS for soldering.

4. Precaution After Soldering

Take care for not to apply the following excessive stress for polymer(hybrid) solid aluminum electrolytic capacitor.

- (a) Do not tilt down or distorted capacitor.
- (b) Mobile circuit board can not handle PC-CON.
- (c) Do not crash PC-CON.
- (d) Do not make the PC-CON touch PCB circuit boards and other components when stacked.

5. Recommended Conditions for Solder



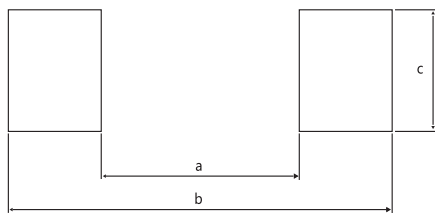
6. Solder Iron Temperature : At 320 °C~400 °C ± 10 °C ; working hours : within 10s

Wave-soldering

	Temperature	Time	Number of Time
Preheat	120°C below (ambient temperature)	less than 300s	once
Welding Condition	280°C ± 10°C below	less than 10 ± 1s	less than twice*1

*1 : For 2 times, solder dipping time total of 10 + 1 seconds.

7. Recommend the Bonding Pad Size



Unit : mm

Size Code	a	b	c
φ5.0	1.4	7.4	1.6
φ6.3	2.1	9.1	1.6
φ8.0	2.8	11.1	1.9
φ10.0	4.3	13.1	1.9