

# P recautions And Guidelines

## 固態鋁電容器用戶指導書

SMK is a solid aluminum capacitor with conductive polymer electrolyte. Please read the following points in order to take full advantages of the SMK performance and to ensure the most stable quality possible.

### Designing device circuits

#### 1. Polarity

The SMK is a polarized solid aluminum electrolytic capacitor. Do not apply either reverse voltages or AC voltages to the polarized capacitors, using reverse polarity may cause a short circuit. Refer to the catalog, product specifications or capacitor body to confirm the polarity prior to be used.

#### 2. Circuits prohibited

The leakage current of conductive polymer solid aluminum capacitors may vary depending on thermal stresses. Please don't use solid capacitors in the following types of circuits:

- a) High-impedance voltage retention circuits.
- b) Coupling circuits

#### c) Time constant circuits

In addition to the leakage current fluctuation, capacitance may also fluctuate depending on operational temperature and humidity. The fluctuation of the capacitance may cause problem if it is used as a time constant capacitor, which is extremely sensitive to the fluctuation of the capacitance. Do not use it as H time constant capacitor.

d) Other circuits that are significantly affected by leakage current. If you want to use two or more SMK in a series connection, please contact us before use.

#### 3. Applied voltage

Do not apply DC voltages exceeding the full rated voltage. The peak voltage of superimposed AC voltages (ripple voltages) on DC voltages must not exceed the full rated voltage. While there are specifications for surge voltages exceeding the rated voltage, usage conditions apply, and continued operation for extended periods of time under such conditions cannot be guaranteed. Use the within 20% of the rated voltage for applications which may cause the reverse voltage during the transient phenomena when the power is turned off or the source is switched.

#### 4. Ripple current

Do not apply currents in excess of the rated ripple current. The superimposition of a large ripple current increases the rate of heating within the capacitor. This may reduce the service life of the capacitor or damage the capacitor.

#### 5. Operating temperature

Do not use the SMK capacitor at high temperatures (temperatures exceeding the maximum temperature for the capacitor category). Use of the capacitor outside of the maximum temperature for the capacitor category may decrease the service life of the capacitor.

#### 6. Sudden charge and discharge

Do not use the SMK capacitor in circuits where the capacitor is repetitively charged and discharged rapidly. Repetitively charging and discharging the capacitor rapidly may reduce the capacitance or may cause damage due to internal heating. Use of a protective circuit to ensure reliability is recommended when

rush currents exceed 10A or the rush current is over 10 times of allowable ripple current of SMK

A protection resistor (1 kΩ) must be inserted to the circuit during the charge and discharge when measuring the leakage current.

#### 7. Failures and life-span

The SMK failure rate is 0.5%/1,000 hours (applied rated voltage at category temperature). The failure modes mainly have 2 types as follows.

##### a) Contingency failure

The contingency failure mainly has short circuit. The phenomenon of after short is on following.

(i) In the event a short circuit causes the current to become relatively small (less than approximately 1A for  $\phi$  10, less than approximately 0.5A for  $\phi$  8 and less than approximately 0.2A for smaller than  $\phi$  6.3), the SMK itself will generate a little heat, but its appearance will not be affected even when electricity is supplied continuously. However, if the short circuit current value exceeds the mentioned values above, the temperature inside the SMK will increase, the internal pressure is raised, rubber sealing is turned over, and odorous gas is released. In this case, keep your face and hands away from the area.

(ii) The electrolyte, electrolytic paper, sealing rubber, and plastic spacer used in the SMK are all combustible. If an extremely large electric current flows through the capacitor after shorting, the shorted part may spark, and in a worst case scenario, may ignite. Ensure safety by fully considering the design issues described below when using this capacitor in equipment where safety is a priority.

- Increase safety by using in conjunction with a protective circuit or protective equipment.
- Install measures such as redundant circuits so that the failure of a part of the equipment will not cause unstable operation.

##### b) Performance characteristic and failure (life-span)

SMK characteristics can possibly change (capacitance reduction and ESR increase) within the specified range in specifications when it is used in the condition of rated voltage, electric and mechanical performance.

When life span exceeded the specified guarantee time of endurance and damp heat, electric characteristic might change and cause electrolyte insulation. This is

$$L_X = L_0 \times 10^{\frac{T_0 - T_X}{20}}$$

**Where:**

$L_X$ : Life expectancy[h]

$L_0$ : Catalogue life[h]

$T_0$ : Max Operating Temperature[ °C ]

$T_X$ : Ambient Temperature[ °C ]

There is no need to apply a temperature-compensating coefficient for the ripple current in the solid capacitors which use conducting polymer as cathode. The self-heating temperature under application of rated ripple current is approx. 20 °C in the conducting polymer capacitors, but the estimated life expectancy can be calculated without consideration of self-heating under application of the ripple current because of the excellent heat-proof characteristics of conductive polymer.

**8. Circuit design**

Verify the following before designing the circuit:

- a) The electrical characteristics of the capacitor will vary depending on differences in temperature and frequency. Only design your after verifying the scope of these factors.
- b) When connecting two or more capacitors in parallel, ensure that the design takes current balancing into account.
- c) When two or more capacitors are connected in series, variability in applied voltage may cause over-voltage conditions. Contact SMK before using

**9. Capacitor usage environmental restrictions**

**10. Capacitor mounting**

**11. Leakage current**

Heat pressure from soldering and mechanical stress from transportation may cause the leakage current to become large. In such a case, leakage current will gradually decrease by applying voltage less than or equal to the rated voltage at a temperature within the upper category temperature.

In close conditions to the upper category temperature, the nearer the applied voltage is to the rated voltage, the faster the leakage current recovery speed is.

**Mounting precautions**

**1. Note**

- a) For the surface mount capacitor, design the copper pads on the PC board in accordance with the catalog or the product specification.
- b) For radial capacitors, design the terminal holes on the PC board to fit the terminal pitch of the capacitor.

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- a) For the surface mount capacitor, design the copper pads on the PC board in accordance with the catalog or the product specification
- b) For radial capacitors, design the terminal holes on the PC board to fit the terminal pitch of the capacitor.
- c) Mount after checking the capacitance and the rated voltage.
- d) Mount after checking the polarity.
- e) Do not apply excessive external force to the lead terminal and the SMK itself.
- f) Ensure that the soldering conditions meet the specifications recommended by SMK. Note that the leakage current may increase due to thermal stresses that occur during soldering, etc. Note that increased leakage currents gradually decrease when voltage is applied.

**2. Soldering using a soldering iron:**

- a) The soldering conditions (temperature and time) are within the ranges specified in the catalog or product specifications.
- b) The tip of the soldering iron does not come into contact with the capacitor itself.

**3. Flow soldering**

- a) Do not dip the body of a capacitor into the solder bath only dip the terminals in. The soldering must be done on the reverse side of PC board.
- b) Soldering conditions (preheat, solder temperature and dipping time) should be within the limits prescribed in the catalog or the product

|                      | Temperature                         | Duration          | Flow number           |
|----------------------|-------------------------------------|-------------------|-----------------------|
| Preheating           | 125°C max.<br>(ambient temperature) | 120 sec. or less  | Flow number<br>1 time |
| Soldering conditions | 260°C max.                          | 10+1 sec. or less | Twice or less         |

c) Do not apply flux to any part of capacitors other than their terminals.  
 d) Make sure the capacitors do not come into contact with any other components while soldering.

#### 4. Handling after soldering

Do not apply any mechanical stress to the capacitor after soldering onto the PC board.

- a) Do not lean or twist the body of the capacitor after soldering the capacitors onto the PC board
- b) Do not use the capacitors for lifting or carrying the assembly board.
- c) Do not hit or poke the capacitor after soldering to PC board. When stacking the assembly board, be careful that other components do not touch the aluminum electrolytic capacitors.
- d) Do not drop the assembled board.

#### 5. Washing the PC boards

a) Do not wash capacitors by using the following cleaning agents. Solvent resistant capacitors are only suitable for washing using the cleaning conditions

prescribed in the catalog or the product specification. In particular, ultrasonic cleaning will accelerate damage to capacitors.

- Halogenated solvents; cause capacitors to fail due to corrosion.

Alkali system solvents; corrode (dissolve) an aluminum case.

- Petroleum system solvents; cause the rubber seal material to deteriorate.

• Xylene; causes the rubber seal material to deteriorate.

• Acetone; erases the markings.

b) Verify the following points when washing capacitors.

- Monitor conductivity, pH, specific gravity and the water content of cleaning agents. Contamination adversely affects these characteristics.
- Be sure not to expose the capacitors under solvent rich conditions or keep capacitors inside a closed container. In addition, please dry the solvent sufficiently on

the PC board and the capacitor with an air knife (temperature should be less than the maximum rated category temperature of the capacitor) for 10 minutes.

Aluminum electrolytic capacitors can be characteristically and catastrophically damaged by halogen ions, particularly by chlorine ions, though the degree of the damage mainly depends upon the characteristics of the electrolyte and rubber seal material. When halogen ions come into contact with the capacitors, the foil corrodes when a voltage is applied. This corrosion causes an extremely high leakage current which results venting and an open circuit.

#### Storage and Disposal

##### 1. Storage

The following conditions for storage are recommended.

- a) Store capacitors in a cool, dry place. Store at a temperature between 5 and 35 °C, with a humidity of 75% or less. SMD products are sealed in a special laminated aluminum bag. Use all capacitors once the bag is opened. Return unused capacitors to the bag, and seal it with a zipper. Be sure to follow our recommendations for reflow soldering.
- b) Store the capacitors in a location free from direct contact with water, salt water, and oil.
- c) Store in a location where the capacitor is not exposed to toxic gas, such as hydrogen sulfide, sulfuric acid, nitrous acid, chlorine or chlorine compounds, bromine or other halogen gases, methyl bromide or other halogen compounds, ammonia, or similar.
- d) Store in a location where the capacitor is not exposed to ozone, ultraviolet radiation, or other radiation.
- e) It is recommended to store capacitors in their original packaging whenever possible.
- f) Do not store the SMK in places susceptible to ozone, ultraviolet rays and radiation.

| Type                                    | Before unseal   | After unseal               |
|---|---|----------------------------|
| Radial lead type<br>Bag packing product | Within 30 months after delivery<br>(unopened condition) | 120 sec. or less           |
| Radial lead type<br>Taping product      | Within 24 months after delivery<br>(unopened condition) | Within 7 days from opening |

##### 2. Disposal

Since the SMK comprises solid organic compounds, various metals, resin, rubber, etc. treat it as industrial waste when disposing of it.

#### RoHS Compliant

SMK is committed to comply with the European Union Restriction of Hazardous Substance (RoHS) Directive. We hereby guarantee that our products do not contain the following materials exceeding the content regulated in RoHS Directive.

|                                       |          |
|---------------------------------------|----------|
| Lead(Pb)                              | ≤1000ppm |
| Mercury(Hg)                           | ≤1000ppm |
| Cadmium(Cd)                           | ≤100ppm  |
| Hexavalent Chromium(Cr)               | ≤1000ppm |
| Polybrominated Biphenyls(PBBs)        | ≤1000ppm |
| Polybrominated Diphenyl Ethers(PBDEs) | ≤1000ppm |

## Halogen Free Compliant

The products identified in the catalogue, and their homogeneous subcomponents, do not contain any of the

| Substance   | Maximum Limit |
|---|---------------|
| Bromine(Br)                                       | 900 ppm       |
| Chlorine(Cl)                                      | 900 ppm       |
| Total concentration of Chlorine(Cl) + Bromine(Br) | 1500 ppm      |

## 電路設計

## 重要預知事項

## 1. 極性

固態鋁電容器具有正負極之分，不要反接固態鋁電容器，反接固態鋁電容器可以導致漏電流的急劇增加或者使用壽命的降低。

## 2. 電路設計

請在確認以下內容的基礎上進行電路設計。隨著溫度及頻率的變化，電容器的電氣性能會隨之變化。請在確認這些變化以後進行電路的設計。

- 當并聯2個以上電容器時，請在設計電路時考慮電流的平衡；
- 當串聯2個以上的電容器時，因加載電壓存在差異，有可能加載過電壓，請使用時諮詢我們；
- 請勿在電容器的周圍以及印刷配線板的背面安裝發熱。

## 3. 被禁止使用的電路

即使客戶嚴格按照我們所給定的焊接條件安裝固態鋁電容器，固態鋁電容器的漏電流也可能會升高，甚至大幅度升高。高溫無負載測試、高溫高濕無負載測試、溫度急變測試等都可能導致漏電流的增大。因此，請不要將固態鋁電容器應用於對漏電流敏感的電路中。

比如：

- 高阻抗電路；
- 耦合電路；
- 時間常數電路。

## 4. 工作電壓

- 直流電壓與紋波峰值電壓的總和不得超過額定工作電壓；
- 當直流電壓比較低的時候，反向紋波峰值電壓不能超過額定工作電壓的10%；
- 對於25v以上產品，當環境溫度超過85°C時，請降壓使用固態鋁電容器，溫度每上升10°C，施加於產品上的電壓請下降10%。

## 5. 請依據規格書中規定的電容特性選擇合適的固態電容器。

- 切勿超電壓使用，即便是短時間的過電壓都可能導致固態電容器的短路；
- 使用的環境溫度必須在規格書中規定的範圍內；
- 切勿給固態電容器施加超過額定的紋波電流值，過大的紋波電流會導致電容器內部發熱過量，從而會導致產品提前失效甚至短路。

## 6. 瞬時充放電：瞬時充放電可能會導致固態鋁電容器短路或漏電流增大，因此請在下列情形下設計保護電路：

- 衝擊電流大于10A；
- 衝擊電流大于10倍允許紋波電流值。另外，在測試產品漏電流時，請設置一個1kΩ的保護電阻。

## 7. 失效模式與壽命

## 失效模式：

- 偶然失效：主要由電路的短路導致。當短路電路中的電流超過1A，電容器內部溫度將會上升，內部壓力增大，封口膠膜將可能會凸起甚至開啓。電容器會釋放出有害氣體，這時請離開這個場合；
- 壽命失效：長期使用後，固態鋁電容器的特性會發生衰減，比如容量下降、ESR上升等。當使用時間超過額定壽命，電容器的特性劣化，並可導致電解質絕緣。這稱為開路失效模式。
- 固態電容器壽命計算公式

式中：

Lx: 實際使用溫度下的預期壽命 [h]

L0: 最高額定工作溫度下的額定壽命 [h]

T0: 最高額定工作溫度 [°C]

Tx: 實際使用時的環境溫度 [°C]

$$L_x = L_0 \times 10^{\frac{T_0 - T_x}{20}}$$

## 特別提醒

### 1. 亂電流

焊接熱和來源于運輸途中的機械應力都可導致電容器的漏電流增大，但是，給產品施加不超過額定工作電壓的直流電壓會逐漸降低漏電流。在不超過額定工作電壓和工作上限溫度的前提下，施加的電壓越高、環境溫度越高，漏電流下降速度越快。

### 2. 電容器的絕緣性

電容器外的絕緣紙膜或絕緣膠膜層並不是絕對絕緣的，另外，鋁殼與負極引出線間不絕緣。安裝的時候，請務必將鋁殼、正負導針及PC板印刷圖完全隔離開。

### 3. 工作環境限制

請不要在以下環境中使用固態鋁電容器：

- a) 水、鹽水、油可以直接滴落的地方，以及容易發生收縮的電路板；
- b) 有害氣體(H2S、硫酸、硝酸、氯氣、鹽酸等)聚集的場合；
- c) 紫外線、放射性射線、臭氧等輻射的場合。

### 4. PCB板設計

- a) 不要把固態電容器安裝于熱源組件周圍或其上面；
- b) PCB板上的安裝孔位直徑和間距要與電容器導針的直徑和針距相匹配。
- 6. 固態鋁電容器的電性能會受頻率波動的影響，設計電路的時候要考慮這一因素。
- 7. 在雙面PCB板上安裝固態鋁電容器的時候，請不要在連接前後PCB板的穿孔處安裝固態鋁電容器。

## 安裝前的準備

### 1. 焊接：請按照SPEC.中規定的焊接條件進行焊接。否則，將可能導致外絕緣層的破損、漏電流的急劇增大以及容量的下降；

### 2. 安裝前的注意事項：

- a) 請不要重新使用已經被安裝使用過的固態鋁電容器；
- b) 固態鋁電容器儲存時間久了會導致漏電流的增大，這時，可以給電容器進行一次電壓處理，推薦的處理條件為：60~70°C額定電壓1小時，並給電容器串聯1kΩ保護電阻。

### 3. 安裝：

- a) 仔細核對電容器的容量和工作電壓；
- b) 請注意電容器的極性；
- c) 請注意勿將固態鋁電容器跌落于地面，跌落的電容器請勿使用；
- d) 不要使固態鋁電容器變形；
- e) 安裝前請檢查電容器導針型號是否與PCB板上的孔直徑和間距相匹配，當使用自動插入機安裝時，請不要使用太大的攝入力；
- f) 請關注由自動插入和安裝機、產品檢查儀器等產生的震動強度不要太大；
- g) 不要施加額外的外部力量給電容器導針和電容器本身。

### 4. 當使用電烙鐵焊接時：

- a) 請按照電容器規格書的規定設置焊接條件(溫度、時間)；
- b) 當固態鋁電容器的導針型號與PCB板不相匹配，不得不對導針進行處理時，請在焊接前處理，以便在焊接後不會在固態鋁電容器上留下應力；
- c) 焊接時，不要給固態鋁電容器額外的應力；
- d) 當用電烙鐵從電路板上移除一個安裝不佳的固態鋁電容器時，請確認電烙鐵已經完全將焊錫熔化，然後才能取下固態鋁電容器，以免給固態鋁電容器留下應力；
- e) 不要將電烙鐵的頭部接觸到固態鋁電容器；
- f) 焊接後，固態鋁電容器的漏電流可能會有所增大，施加電壓後，漏電流會逐漸降低。

### 5. 焊接

- a) 請不要將固態鋁電容器淹沒在焊錫中焊接。請在PCB板安裝固態鋁電容器的對立面焊接；
- b) 請按照電容器規格書的規定設置焊接條件(溫度、時間)；
- c) 焊接後，固態鋁電容器的漏電流可能會有所增大，施加電壓後，漏電流會逐漸降低；
- d) 焊接時請注意電路板上其他組件不要接觸到固態鋁電容器或掉落到固態鋁電容器上；
- e) 當使用極端不正常的焊接工藝時，可能會導致固態鋁電容器的容量下降或損害電容器的其他特性。

## 推薦使用下列焊接工藝：

|       | 溫度         | 時間    | 次數  |
|-------|------------|-------|-----|
| 預處理條件 | ≤125°C     | ≤120秒 | 1次  |
| 焊接條件  | 260°C max. | 10秒   | ≤2次 |

## 6. 焊接後的注意事項

- a) 當固態鋁電容器完成焊接後，請不要使用外力傾斜、彎曲、扭曲它；
- b) 請不要抓住固態鋁電容器來移動PCB板；
- c) 當堆放焊接有固態鋁電容器的PCB板時，請不要將固態鋁電容器互相接觸或接觸到其他組件；
- d) 不要讓焊接在PCB板上的固態鋁電容器承受外力。

## 7. PCB板的清洗：

請選用乙醇類清洗劑，並注意以下條件：

- a) 使用浸沒方式和超聲波清洗時，請不要超過2分鐘；
- b) 清洗溫度須低於60°C；
- c) 請注意清潔劑帶來的污染問題；
- d) 清洗結束後，請用低於額定工作溫度以下的熱空氣進行乾燥。

## 8. 其他注意事項：

- a) 不要用手直接接觸固態鋁電容器的引出線；
- b) 不要使用導體接觸固態鋁電容器的正負極，不要讓固態鋁電容器接觸導電性溶液（如酸和鹼的水溶液）；

## 存儲與處置

## 1. 儲存條件

- a) 不要將固態鋁電容器儲存在高溫高濕環境中，較好的儲存溫度為5~35°C，濕度為75%以下；
- b) 要使固態鋁電容器保持好的可焊性，請不要開啓出廠包裝，並且，儲存期限不要超過1年；
- c) 僅僅在安裝前打開包裝，並一次性安裝全部產品，如果有產品剩餘，則請放回包裝袋並封好袋口。各類型產品的存儲期限請參考下表：

| 產品類型      | 開啓包裝前 | 開啓包裝後 |
|-----------|-------|-------|
| 插件型（袋裝品）  | 30個月  | 7天    |
| 插件型（貼片包裝） | 24個月  | 7天    |

- d) 不要將固態鋁電容器儲存于有害氣體環境。

## 2. 廢棄品處置

因爲固態鋁電容器包含有一些固體有機物、一些金屬物質以及樹脂材料等，因此請當做工業廢料處置廢棄的固態鋁電容器。

## 有害物質限用指令(RoHS)

森美康產品符合歐盟對有害物質限制使用之規定要求，我們保證我們的產品中不包含超出下表RoHS指令規定的各物質含量範圍：

|                       |          |
|-----------------------|----------|
| 鉛(Pb)                 | ≤1000ppm |
| 汞(Hg)                 | ≤1000ppm |
| 鎘(Cd)                 | ≤100ppm  |
| 六價鉻, Cr <sup>6+</sup> | ≤1000ppm |
| 多溴聯苯(PBBs)            | ≤1000ppm |
| 多溴聯苯醚(PBDEs)          | ≤1000ppm |

## 無鹵申明

森美康產品滿足下表所列溴素含量限制：

| 物質名稱          | Maximum Limit |
|---------------|---------------|
| 溴(Br)         | 900ppm        |
| 氯(Cl)         | 900ppm        |
| 溴素總量(Cl + Br) | 1500ppm       |