



湖南湘怡电子科技有限公司

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# 规格书

## SPECIFICATION

品 名: CA45 片式固体电解质钽电容器

客户名称: /

型号规格: CA45-B010K476T

客户料号: /

| 制 作 | 检 查 | 审 批 |
|-----|-----|-----|
| 熊娟  | 胡乾琪 | 马腾双 |

客户确认: \_\_\_\_\_

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## 1.选型和应用须知 Selection & application:

### 1.1 使用电压和温度降额 Load voltage temperature derating:

| 产品型号<br>Product model | 阴极材质<br>Cathode material | 使用条件<br>Conditions of Use                                                                                                                    | -55℃ to 85℃ | 85℃ to 125℃ |
|-----------------------|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------|
| CA45                  | MnO <sub>2</sub>         | 直流工作电压根据工作温度降额<br>DC operating voltage derating according to operating temperature                                                           | $U_R$       | /           |
|                       |                          | 实际使用电压要求最大降额<br>Maximum derating required for actual voltage                                                                                 | $50\%U_R$   | /           |
|                       |                          | 使用在滤波电路中<br>Used in filter circuit                                                                                                           | $30\%U_R$   | /           |
| CA55                  | PEDOT                    | 直流工作电压根据工作温度降额<br>DC operating voltage derating according to operating temperature                                                           | $U_R$       | $80\%U_R$   |
|                       |                          | $U_R \leq 10V$ 产品实际使用电压要求最大降额<br>Maximum derating required for the actual voltage of products with $U_R \leq 10V$ used in the filter circuit | $90\%U_R$   | $72\%U_R$   |
|                       |                          | $U_R \geq 10V$ 产品实际使用电压要求最大降额<br>Maximum derating required for actual voltage of $U_R \geq 10V$ products                                     | $80\%U_R$   | $64\%U_R$   |

### 1.2 保护电阻 Protection resistance:

| 过程状态类别<br>Process status category                                    | 过程状态描述<br>Process state description                                           | 要求与说明<br>Requirements and instructions                                                                                                  |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 产品测试过程<br>Product testing process                                    | 稳态漏电流测试、耐压测试<br>Steady state leakage current test and withstand voltage test. | 电源正极至电容器之间需串联 1KΩ 的电阻<br>A 1K Ω resistor should be connected in series between the positive pole of the power supply and the capacitor. |
| 开关电源电路应用过程<br>Application process of switching power supply circuit. | 有瞬间电流通过<br>There is an instantaneous current passing through.                 | 至少串联 3Ω/V 的电阻<br>Resistance of at least 3 Ω / V in series.                                                                              |

### 1.3 反向电压 Reverse voltage:

| 环境温度 Ambient temperature | 允许最大反向电压 Maximum allowable reverse voltage |                                     |
|--------------------------|--------------------------------------------|-------------------------------------|
| 25℃                      | 10% $U_R$ or 1V, 取小者                       | 10% ur or 1V, whichever is smaller  |
| 85℃                      | 5% $U_R$ or 0.5V, 取小者                      | 5% ur or 0.5V, whichever is smaller |
| 125℃                     | 1% $U_R$ or 0.1V, 取小者                      | 1% ur or 0.1V, whichever is smaller |

1.3.1 钽电容器为极性电容，禁止施加反向电压；  
Tantalum capacitors are polar capacitors. Reverse voltage is forbidden;

1.3.2 如不可避免存在反向电压，施加的时间必须尽可能短，并且不能超过表内对应的电压值；  
If reverse voltage is unavoidable, the applied time must be as short as possible, and should not exceed the corresponding voltage value in the table

1.3.3 即使反向电压与温度符合表内要求，钽电容器也不能连续承受反向电压。  
Even if the reverse voltage and temperature meet the requirements in the table, tantalum capacitors can not withstand the reverse voltage continuously

## 1.4 耐受纹波电压能力 Ability to withstand ripple voltage:

| 计算公式<br>Formula | 说明<br>Explain                                                                                                              | 注意事项<br>Notices                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------|----------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $E = Z \cdot I$ | <p>E: 纹波电压<br/>Ripple voltage</p> <p>Z: 具体频率下的阻抗<br/>Impedance at specific frequency</p> <p>I: 纹波电流<br/>Ripple current</p> | <p>1、电容器中 ESR 的功率损耗不超过适当的值。<br/>The power loss of ESR in capacitor does not exceed the appropriate value.</p> <p>2、直流电压和波纹电压的峰值之和不超过额定电压。<br/>The sum of the peak values of DC voltage and ripple voltage shall not exceed the rated voltage.</p> <p>3、直流电压和波纹电压的负峰值之和不超过允许的反向电压。<br/>The sum of negative peaks of DC voltage and ripple voltage shall not exceed the allowable reverse voltage.</p> |

## 1.5 耐受纹波电流能力 Ability to withstand ripple current:

|                 |                                                                                                                                                                                                                                                                                                                                                                                         |  |                                                                                                                             |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----------------------------------------------------------------------------------------------------------------------------|
| 计算公式<br>Formula | $I = \sqrt{\frac{P}{ESR}} \times K \times F$                                                                                                                                                                                                                                                                                                                                            |  | <p>其中: <b>I</b>为可承受的最大纹波电流 (A),<br/> <b>P</b>为功率损耗 (mW), <b>ESR</b>为等效串联电阻 (mΩ),<br/> <b>K</b>为温度降额系数, <b>F</b>为频率降额系数。</p> |
| 说明<br>Explain   | <p>在电容器上施加波纹电流, 会在电容器内部产生焦耳热 (功率损耗), 影响电容器的可靠性。可按上述公式计算钽电容可耐受的最大波纹电流(A<sub>rms</sub>)。</p> <p>If ripple current is applied to the capacitor, Joule heat (power loss) will be generated inside the capacitor, which will affect the reliability of the capacitor. The maximum allowable ripple current (arms) of tantalum capacitor can be calculated according to the above formula</p> |  |                                                                                                                             |

| 温度<br>Temperature        | 45℃  | 75℃  | 95℃  | 105℃ | 125℃ | 频率<br>Frequency          | 10KHz | 100 KHz | 500KHz | 1MHz |
|--------------------------|------|------|------|------|------|--------------------------|-------|---------|--------|------|
| 降额因子K<br>Derating factor | 1.00 | 0.95 | 0.85 | 0.50 | 0.40 | 降额因子F<br>Derating factor | 0.80  | 1.00    | 1.15   | 1.20 |

| 壳号<br>Case code | 尺寸 Size<br>公制代码 | 功率耗损 P Power dissipation @+25℃ (mW) |               |
|-----------------|-----------------|-------------------------------------|---------------|
|                 |                 | CA45 型 Series                       | CA55 型 Series |
| A               | 3216-16         | 75                                  | 100           |
| B               | 3528-19         | 85                                  | 125           |
| C               | 6032-25         | 110                                 | 175           |
| H               | 7343-21         | 120                                 | 185           |
| F               | 7361-19         | 130                                 | 200           |
| D               | 7343-28         | 150                                 | 225           |
| E               | 7343-43         | 165                                 | 250           |
| V               | 7361-36         | 250                                 | 360           |
| W               | 7361-41         | 285                                 | 420           |

## 1.6 电路冗余设计建议 Suggestions on circuit redundancy design:

### 1.6.1 失效模式 Failure mode:

CA45 型二氧化锰钽电容器在大电流通过时会发热、并可能燃烧。CA55 型导电聚合物钽电容器在大电流通过时会发热, 并可能导致块体开裂、失效。这取决于超流情况、时间和其它被动因素影响, 电路设计时留足冗余, 可确保钽电容器的高可靠性。

CA45 type manganese dioxide tantalum capacitor will generate heat and burn when high current passes through. CA55 conductive polymer tantalum capacitor will generate heat when high current passes through, which may lead to cracking and failure of the capacitor. This depends on the over-current situation, time and other passive factors. Enough redundancy in the circuit design can ensure the high reliability of tantalum capacitor.

### 1.6.2 被动因素隐患 Hidden danger of passive factors:

虽然钽电容器绝大多数失效都是被动因素引起的，也不能轻视安全隐患。电容失效会造成使用该电容的设备故障风险上涨，所以电路设计时需要考虑常见电容失效模式下电路仍能正常工作的失效保护设计。常见失效模式有漏电流上涨或短路，其他的失效模式有容量衰减、损耗或阻抗上涨或开路等。超出数据表额定值使用为不安全使用。

Although the vast majority of failures of tantalum capacitors are caused by passive factors, safety hidden danger can not be ignored. Capacitor failure will increase the risk of equipment failure using the capacitor, so it is necessary to consider the failure protection design that the circuit can still work normally under the common capacitor failure mode in circuit design. Common failure modes are leakage current rise or short circuit, other failure modes are capacity attenuation, loss or impedance rise or open circuit. It is unsafe to use beyond the rated value of the data sheet.

## 1.7 储存 Store:

### 1.7.1 环境要求 Environmental requirements:

推荐真空储存，如采取非真空方式储存，需注意温度 10~30℃，湿度≤60%RH，无酸碱等腐蚀气体。

Vacuum storage is recommended. If non vacuum storage is adopted, attention should be paid to the temperature of 10 ~ 30 °C, humidity ≤ 60% RH, no acid, alkali and other corrosive gases.

### 1.7.2 储存要求 Storage requirements:

拆封真空密封袋后的电容器暴露在空气中的时间:

CA45 型二氧化锰钽电容器: 按 MSL 等级 1 进行管控;

CA55 型导电聚合物钽电容器: ≤24h (CA55 型产品防止产品吸潮)。

The capacitor after unpacking the vacuum sealing bag is exposed to the air :

CA45 manganese tantalum dioxide capacitor: controlled according to MSL grade 1;

The time for the capacitor to be welded after unpacking the vacuum sealing bag is less than or equal to 24h max (CA55 products prevent moisture absorption).

### 1.7.3 产品吸潮处理 Product moisture absorption treatment:

如真空包装贮存期超一年，建议按照下表烘干工艺除潮处理，测试合格后再行焊接。如贵司无合适设备对产品进行烘烤，可电话联系我司协助处理。

If the vacuum storage period exceeds one year, it is recommended to dry the capacitor first, and then weld it after passing the test. If you don't have the right equipment to bake the products, you can contact us by telephone for assistance.

| 壳号<br>Case code | 整盘烘干工艺<br>Whole tray drying process | 散粒电容器烘干工艺<br>Drying process of bulk products |          |
|-----------------|-------------------------------------|----------------------------------------------|----------|
| A、B、C           | 55℃、≤10%RH、72h                      | 85℃、24h or 105℃、12h                          | 125℃、12h |
| H、D、E、F、V       | 55℃、≤10%RH、96h                      | 85℃、36h or 105℃、18h                          |          |
| W、X             | 55℃、≤10%RH、144h                     | 85℃、48h or 105℃、24h                          |          |

## 1.8 焊接条件 Welding:

### 1.8.1 推荐焊接条件 Recommended welding conditions:

推荐采用回流焊 SMT 贴装建议，不建议使用波峰焊、手工焊。

Reflow soldering SMT mounting is recommended, but wave soldering and manual soldering are not recommended.

#### 1.8.1.1 回流焊接 Reflow soldering:

SMT 峰值设定温度  $T_p$  需≤250℃，在  $T_p$  峰值温度 0℃~5℃范围内的保持时间需≤5s 内。

The peak setting temperature  $T_p$  of SMT should be ≤ 250 °C, and the holding time within the range of 0 °C ~ - 5 °C of the peak temperature  $T_p$  should be ≤ 5s.

#### 1.8.1.2 手工焊接 Manual welding:

如特殊情况下需手工焊，电烙铁的功率需≤25W，温度需<300℃，焊接时间需<3s，禁止烙铁头直接接触产品本体，应熔化焊锡料使其与电容器引脚接触焊接。

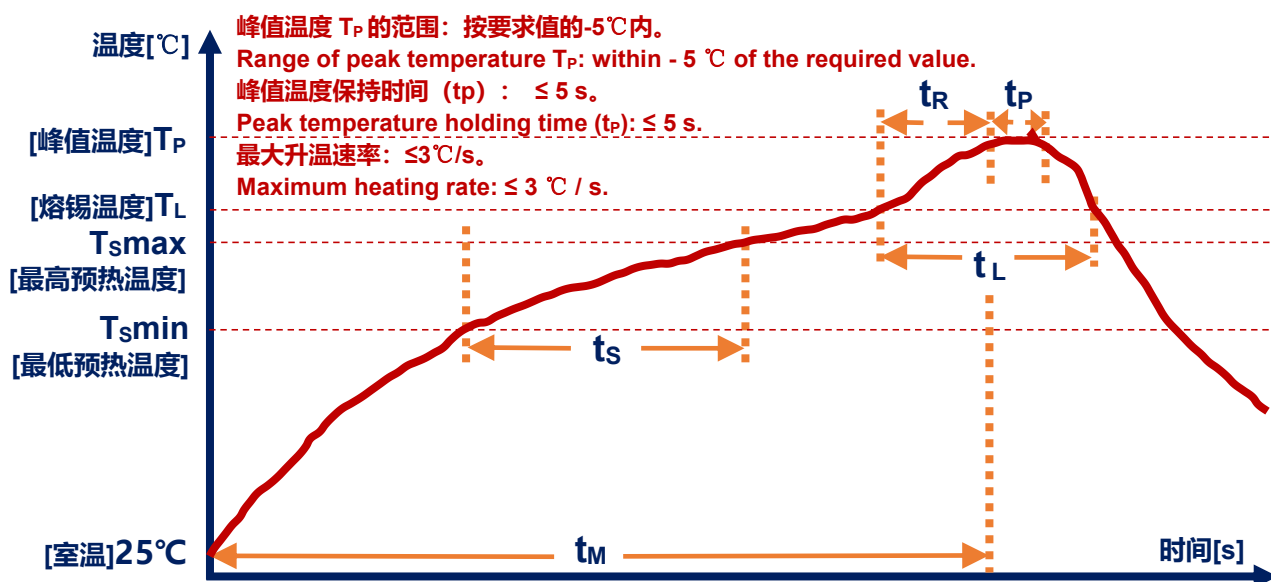
If manual welding is required under special circumstances, the power of electric iron should be ≤ 25W, the temperature should be < 300 °C, and the welding time should be < 3s. It is forbidden for the iron head to directly contact the product body, and the solder should be melted to make it contact with the capacitor pin for welding.

### 1.8.2 回流焊注意事项 Precautions for reflow soldering:

无铅焊接的回流焊炉温设定推荐建议，见下表：

The recommended reflow oven temperature setting for lead-free soldering is shown in the table below.

| 设备类型<br>Equipment type | 8 温区<br>8 temperature zone |           | 10 温区<br>10 temperature zone |           |
|------------------------|----------------------------|-----------|------------------------------|-----------|
| 温区类别 Category          | 上温区 Upper                  | 下温区 Lower | 上温区 Upper                    | 下温区 Lower |
| 1 温区 zone              | 120℃                       | 120℃      | 100℃                         | 100℃      |
| 2 温区 zone              | 150℃                       | 150℃      | 120℃                         | 120℃      |
| 3 温区 zone              | 160℃                       | 160℃      | 150℃                         | 150℃      |
| 4 温区 zone              | 170℃                       | 170℃      | 155℃                         | 155℃      |
| 5 温区 zone              | 200℃                       | 200℃      | 160℃                         | 160℃      |
| 6 温区 zone              | 230℃                       | 230℃      | 170℃                         | 170℃      |
| 7 温区 zone              | 250℃                       | 250℃      | 200℃                         | 200℃      |
| 8 温区 zone              | 180℃                       | 180℃      | 230℃                         | 230℃      |
| 9 温区 zone              | /                          | /         | 250℃                         | 250℃      |
| 10 温区 zone             | /                          | /         | 180℃                         | 180℃      |



| 焊料类别 Solder type |                                                                | 锡铅焊料 Tin lead solder | 无铅焊料 Lead free solder |
|------------------|----------------------------------------------------------------|----------------------|-----------------------|
| $T_s$ Min        | 预热最低温度 Minimum preheating temperature                          | 100℃                 | 150℃                  |
| $T_s$ Max        | 预热最高温度 Maximum preheating temperature                          | 150℃                 | 200℃                  |
| $t_s$            | 预热时间 Preheating time                                           | 60~120s              | 60~120s               |
| $T_L \sim T_P$   | 升温速率 Heating rate                                              | $\leq 3$ °C/s        | $\leq 3$ °C/s         |
| $T_L$            | 焊膏熔点 Melting point of solder paste                             | 183℃                 | 217℃                  |
| $t_L$            | 焊膏熔化时间 Melting time of solder paste                            | 60~150s              | 60~150s               |
| $T_P$            | 峰值温度 Peak temperature                                          | 220℃*/235℃**         | 245℃*/250℃**          |
| $t_P$            | 峰值温度负偏差小于 5℃的保持时间<br>Holding time of peak temperature (-5℃~0℃) | $\leq 10$ s          | $\leq 3$ s* or 5s**   |
| $T_P \sim T_L$   | 降温速率 Cooling rate                                              | $\leq 6$ °C/s        | $\leq 6$ °C/s         |
| $t_m$            | 室温 25℃ 到峰值温度时间<br>Time from 25 ° C to peak temperature         | $\leq 6$ min         | $\leq 8$ min          |

说明：所有温度都是基于产品尺寸，测量距离 PCB 板上方 1cm 高度处的气氛温度。 “\*”对应 A、B、C 壳，“\*\*”对应其它壳号。

Note: All temperatures are based on product size and measure the ambient temperature at 1cm height above the PCB board.

“\*” corresponds to a, B, C shells and “\*\*” corresponds to other shell numbers.

## 2.适用范围 Scope

本承认图适用于本公司生产的电子设备用CA45片式固体电解质钽电容器，

规格为：**CA45-B010K476T**，所供客户为：\_\_\_\_\_。

This admit diagram is suitable for the company production of electronic equipment with flake solid electrolyte tantalum capacitor.

specifications for:**CA45-B010K476T**,customer is:\_\_\_\_\_.

## 3.应用范围 Application scope

适用于高密度表面贴装的民用电子设备，例如：彩电、个人电脑、移动电话、摄像机、雷达等。

Most suitable for high-density surface mount consumer electronic equipment, such as colour TV sets, PC, mobile telephone sets, pickup camera, radar etc.

## 4.测试条件 Test condition

环境温度：25℃±5℃，相对湿度：≤80%RH。在2.0V的偏置电压下使用串联的方式，对电容器进行电容量、损耗及ESR的测量，其中ESR的测试频率为100KHz，电容量及损耗的测试频率为100Hz，使用额定电压 $U_R$ 对电容器充电5min进行漏电流的测量。

Ambient temperature:25℃±5℃, relative humidity :≤80% RH .The capacitance, loss and ESR of the capacitor are measured in series under 2.0V bias voltage, in which the ESR test frequency is 100kHz, the capacitance and loss test frequency is 120Hz, and the leakage current is measured when the capacitor is charged with rated voltage  $U_R$  for 5min.

## 5.注意事项 Notices

测定及实验时，为使试验结果不至发生问题，有必要将测试后的产品充分放电。本产品为有极性元器件，测试或使用时严禁将正负极接反，以免性能失效。

Test and experiment, in order to make the test results not problems, it is necessary to will test the product after fully discharge. This product is a polar components, testing or when using it is strictly prohibited to will is negative pick back, in order to avoid performance failure.

## 6.参数特性 Characteristics

| 项目 Item                                      | 特性 Characteristic                                                                                                                                                                                                                                                                                                                          |      |       |                                |         |         |                                           |                  |
|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------|--------------------------------|---------|---------|-------------------------------------------|------------------|
| MSL 等级 level                                 | 1 级                                                                                                                                                                                                                                                                                                                                        |      |       |                                |         |         |                                           |                  |
| 使用温度范围<br>Operating Temperature Range        | -55℃~+125℃                                                                                                                                                                                                                                                                                                                                 |      |       |                                |         |         |                                           |                  |
| 额定电压 Rated voltage Rang                      | 10V <sub>DC</sub>                                                                                                                                                                                                                                                                                                                          |      |       |                                |         |         |                                           |                  |
| 漏电流 (I <sub>0</sub> )<br>Leakage Current     | 施加额定电压 U <sub>R</sub> 充电 5 分钟读数, I <sub>0</sub> ≤0.01C <sub>R</sub> U <sub>R</sub> 或 0.5μA 取大者<br>Measured after 5 min application of rated voltage reading, I <sub>0</sub> ≤0.01C <sub>R</sub> U <sub>R</sub> or 0.5μA whichever is greater.<br>C <sub>R</sub> : 标称容量 (μF) Nominal Capacitance    U <sub>R</sub> : 额定电压 (V) Rated voltage |      |       |                                |         |         |                                           |                  |
|                                              | 根据上述漏电流计算公式及产品特性, 采用额定电压 10V 持续充电 5 分钟, 漏电流上限值: 4.7μA。<br>According to the above leakage current calculation formula and product characteristics, the rated voltage of 10V is used for continuous charging for 5 minutes, and the upper limit of leakage current is 4.7μA.                                                                 |      |       |                                |         |         |                                           |                  |
| 纹波电流 (I <sub>rms</sub> ) Ripple current      | 根据 14.2.2 的纹波电流计算公式, 25℃/100KHz, 可承受纹波电流上限值: 217mA<br>According to the ripple current calculation formula in 14.2.2, under the condition of 25℃ / 100kHz, the capacitance can withstand the ripple current of 217mA.                                                                                                                       |      |       |                                |         |         |                                           |                  |
| 额定电容量 (C <sub>R</sub> )<br>Capacitance       | C <sub>R</sub> (μF)                                                                                                                                                                                                                                                                                                                        |      |       | 47±10%                         |         |         | 25℃±5℃<br>120Hz                           |                  |
| 损耗角正切值 (tgδ)<br>Dissipation Factor           | tgδ <sub>max</sub> (%)                                                                                                                                                                                                                                                                                                                     |      |       | 8                              |         |         |                                           |                  |
| 等效串联电阻 (ESR)<br>Equivalent series resistance | ESR <sub>max</sub> (mΩ)                                                                                                                                                                                                                                                                                                                    |      |       | 1800                           |         |         | 25℃±5℃<br>100kHz                          |                  |
| 温度特性<br>Temperature characteristics          | 损耗角正切值(tgδ <sub>Max</sub> )<br>Dissipation Factor                                                                                                                                                                                                                                                                                          |      |       | 容量变化率(%)<br>Capacitance change |         |         | 漏电流(I <sub>Max</sub> )<br>Leakage Current |                  |
|                                              | -55℃                                                                                                                                                                                                                                                                                                                                       | +85℃ | +125℃ | -55℃                           | +85℃    | +125℃   | +85℃                                      | +125℃            |
|                                              | 12                                                                                                                                                                                                                                                                                                                                         | 12   | 16    | -10~+10                        | -10~+15 | -10~+20 | 8I <sub>0</sub>                           | 10I <sub>0</sub> |

## 7.电性能参数变化曲线 Electrical characteristics

同型号不同规格尺寸的电容器，其电性能变化趋势相同。

The change trend of electrical performance of capacitors with the same model and different sizes is the same.

电容量变化率与温度的关系  
Typical Capacitance vs. Temperature



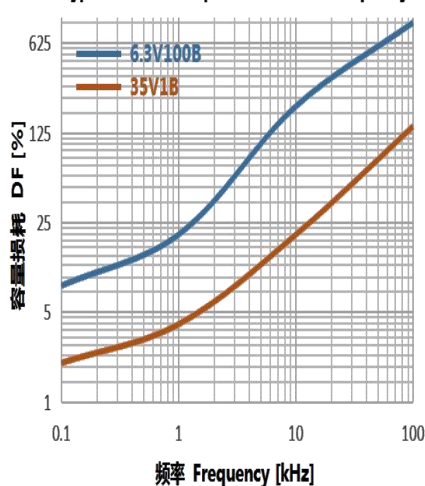
电容量与频率的关系  
Capacitance vs. Frequency



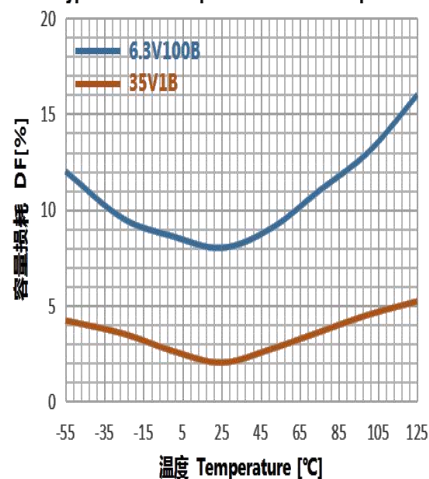
类别电压与温度的关系  
Category Voltage vs. Temperature



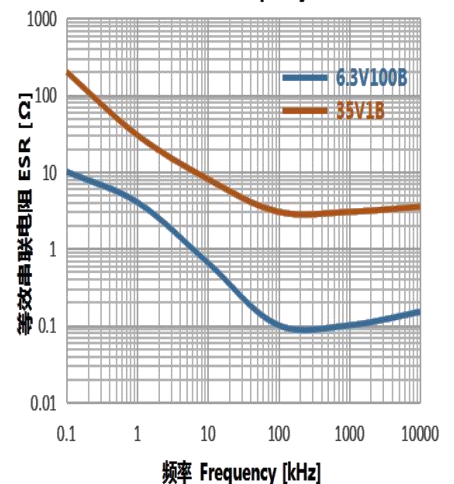
容量损耗与频率的关系  
Typical Curve-Dissipation Factor vs. Frequency



容量损耗与温度的关系  
Typical Curve-Dissipation Factor vs. Temperature



等效串联电阻与频率的关系  
ESR vs. Frequency



等效串联电阻与温度的关系  
ESR vs. Temperature



直流漏电流与温度的关系  
DCL vs. Temperature



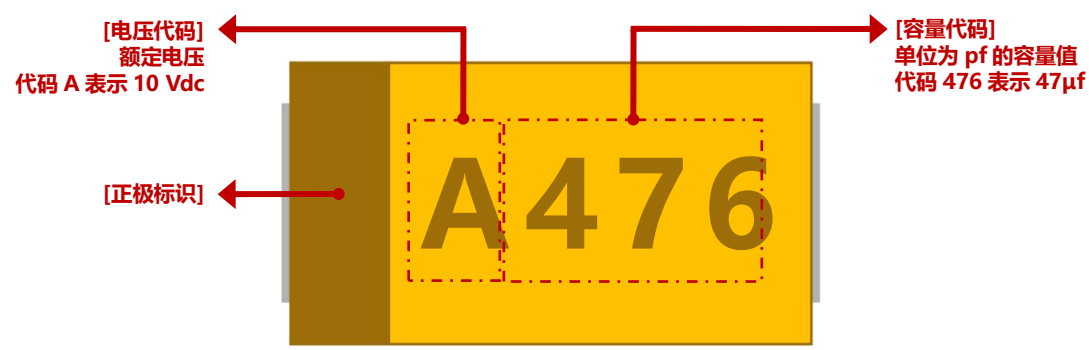
直流漏电流与负载电压的关系  
DCL vs. Voltage



8.产品编码 Product coding

|      |     |             |                                                                                                                        |                          |                                                                    |                               |
|------|-----|-------------|------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------------------------------------------------|-------------------------------|
| CA45 | -   | B           | 010                                                                                                                    | K                        | 476                                                                | T                             |
| 型号   | 隔离符 | 壳号尺寸<br>见下表 | 直流额定电压<br>2R5=2.5Vdc; 004=4Vdc;<br>6R3=6.3Vdc; 010=10Vdc<br>016=16Vdc; 020=20Vdc<br>025=25Vdc; 035=35Vdc<br>050=50Vdc; | 容量允差<br>K=±10%<br>M=±20% | 容量代码<br>前 2 位数字为有效数<br>字, 单位为 pF, 第 3<br>位数字为指数。(即有<br>效数字后跟多少个 0) | 镀层<br>T=100%哑<br>光锡镀层<br>(无铅) |

9. 产品标识 Marking



10.壳号与尺寸 Case code & Size

产品侧面

负极引脚面

正极引脚面

产品底面

| 尺寸代码<br>Case Code | EIA 代码<br>EIA Code | EIA 公制<br>EIA Metric | L         | W <sub>1</sub> | H         | S         | W <sub>2</sub> |
|-------------------|--------------------|----------------------|-----------|----------------|-----------|-----------|----------------|
| A                 | 1206               | 3216-16              | 3.20±0.20 | 1.60±0.20      | 1.60±0.30 | 0.70±0.20 | 1.20±0.20      |
| B                 | 1210               | 3528-19              | 3.50±0.20 | 2.80±0.20      | 1.90±0.30 | 0.70±0.20 | 2.20±0.20      |
| C                 | 2312               | 6032-25              | 6.00±0.30 | 3.20±0.30      | 2.50±0.30 | 1.30±0.30 | 2.20±0.20      |
| H                 | 2917               | 7343-21              | 7.30±0.30 | 4.30±0.30      | 2.10±0.30 | 1.30±0.30 | 2.40±0.20      |
| F                 | 2924               | 7361-19              | 7.30±0.30 | 6.10±0.30      | 1.90±0.30 | 1.40±0.30 | 3.00±0.20      |
| D                 | 2917               | 7343-28              | 7.30±0.30 | 4.30±0.30      | 2.80±0.30 | 1.30±0.30 | 2.40±0.20      |
| E                 | 2917               | 7343-43              | 7.30±0.30 | 4.30±0.30      | 4.30±0.30 | 1.30±0.30 | 2.40±0.20      |
| V                 | 2924               | 7361-36              | 7.30±0.30 | 6.10±0.30      | 3.60±0.30 | 1.40±0.30 | 3.00±0.20      |
| W                 | 2924               | 7361-41              | 7.30±0.30 | 6.10±0.30      | 4.10±0.30 | 1.40±0.30 | 3.00±0.20      |

## 11.产品可靠性试验的内容以及 FIT 值 Reliability test content and FIT value

| No. | 标准组别   | 标准<br>GB/T 6346 | 方法<br>GB/T 2693 | 检验项目 | 试验设备及仪表                                                    | 试验条件                                                                                                                                                                                                                                                                                                         | 测试项目及标准                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----|--------|-----------------|-----------------|------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | B      | 4.7.2           | 4.15            | 可焊性  | 1) 锡炉<br>2) 体视镜                                            | 1) 试验方式: 焊槽法;<br>2) 浸渍时长: $5 \pm 0.5s$ ;<br>3) 浸渍温度: $245 \pm 2^{\circ}C$ ;<br>4) 测试节点: 试验前后分别对样品的正负极引出端进行拍照留底。                                                                                                                                                                                              | 1) 外观: 引出端浸渍部分焊锡覆盖率大于 95%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 2   | C1     | 4.6.3           | 4.14            | 耐焊接热 | 1) 回流焊炉<br>2) 锡炉<br>3) LCR 数字电桥<br>4) 电解电容漏电流测试仪<br>5) 体视镜 | 1) 焊接温度: $250^{\circ}C$ ;<br>2) 持续时间: $5s$ ;<br>3) 恢复时间: $> 3h$ 。<br>4) 测试节点: 回流焊前、回流焊后冷却 1h、回流焊后静置 12h;                                                                                                                                                                                                     | 1) $\Delta C$ : 变化量应在初始测量值的 $\pm 10\%$ 范围内<br>2) DF: 应在标准值范围内<br>3) DCL: 应在标准值的 150% 范围内<br>4) 外观: 无明显变化                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 3   | C3.1   | 4.10            | 4.16            | 温度冲击 | 1) 高低温冲击试验箱<br>2) LCR 数字电桥<br>3) 电解电容漏电流测试仪<br>4) 体视镜      | 1) 过程温度: $-55^{\circ}C, 125^{\circ}C$ ;<br>2) 保温时长: 各 30min;<br>3) 转换时间: $\leq 2min$ ;<br>4) 循环次数: 5 次;<br>5) 恢复时间: 常温 16h;<br>6) 测试节点: 试验前、试验后恢复 16h。                                                                                                                                                       | 1) $\Delta C$ : 前后变化量应不超过初始测量值的 $\pm 10\%$<br>2) DF: 应在标准值的 150% 范围内<br>3) DCL: 应在标准值的 150% 范围内<br>4) 外观: 无明显变化                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 4   | C3.2   | 4.12            | 4.22            | 稳态湿热 | 1) 恒温恒湿箱<br>2) LCR 数字电桥<br>3) 电解电容漏电流测试仪<br>4) 体视镜         | 1) 预处理: 样品应在 $50^{\circ}C \pm 2^{\circ}C$ 、不控制相对湿度的条件下放置 24h;<br>2) 试验条件: $40^{\circ}C$ 、90~95%RH、500h;<br>3) 恢复时间: 在检验环境下, 静置 24h 后进行测试检查;<br>4) 测试节点: 试验前、试验后恢复 16h。                                                                                                                                       | 1) $\Delta C$ : 变化量应在初始测量值的 $\pm 20\%$ 范围内<br>2) DF: 应在标准值的 150% 范围内<br>3) DCL: 应在标准值的 150% 范围内<br>4) 外观: 无明显变化                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 5   | C3.3   | 4.15            | 4.23            | 寿命   | 1) 电热鼓风干燥箱<br>2) 线性直流稳压电源<br>3) LCR 数字电桥<br>4) 电解电容漏电流测试仪  | 1) 试验温度: $85 \pm 4^{\circ}C$ 或 $125 \pm 4^{\circ}C$ ;<br>2) 试验方式: 逐渐(不超过 5min)施加 $85^{\circ}C$ 的额定电压和/或 $125^{\circ}C$ 的类别电压;<br>3) 试验时长: 2000h;<br>4) 负载要求: 电源内阻不超过 $3\Omega$ , 电源短路时至少提供 1A 的电流;<br>5) 测试要求: 每隔 96h、500h、1000h、2000h 将产品取出, 在检验环境下静置 6h 后, 测量电性能并记录, 记录失效产品序号的最终失效时长, 然后将合格品继续按试验条件进行寿命试验。 | 试验类别 1: $85^{\circ}C \& 2000h$<br>1) $\Delta C$ : 变化量应在初始测量值的 $\pm 10\%$ 范围内<br>2) DF: 应在标准值的 150% 范围内<br>3) ESR: 应在标准值范围内<br>4) DCL: 应在标准值的 200% 范围内<br>试验类别 2: $125^{\circ}C \& 2000h$<br>1) $\Delta C$ : 变化量应在初始测量值的 $\pm 10\%$ 范围内<br>2) DF: 应在标准值的 150% 范围内<br>3) ESR: 应在标准值范围内<br>4) DCL: 应在标准值的 150% 范围内                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 6   | C3.4   | 4.13            | 4.29            | 温循   | 1) 恒温恒湿箱<br>2) LCR 数字电桥<br>3) 电解电容漏电流测试仪<br>4) 体视镜         | 试验开始前, 电容器应在 $125^{\circ}C \pm 5^{\circ}C$ 下干燥 300 -4min, 具体试验要求如下:<br>1) 温度要求:<br>步骤 1: $+25^{\circ}C$<br>步骤 2: $-55^{\circ}C$<br>步骤 3: $+25^{\circ}C$<br>步骤 4: $+85^{\circ}C$<br>步骤 5: $+125^{\circ}C$<br>步骤 6: $+25^{\circ}C$<br>2) 测试节点: 按上述规定的每一温度下达到热稳定后(约 30min), 分别测试电容器四参数值。                        | 步骤 1: $25^{\circ}C$<br>1) C: 应在标准值范围内<br>2) DF: 应在标准值范围内<br>3) ESR: 应在标准值范围内<br>4) DCL: 应在标准值范围内<br>步骤 2: $-55^{\circ}C$<br>1) $\Delta C$ : 变化量应在初始测量值的 $\pm 10\%$ 范围内<br>2) DF: 应在标准值范围内<br>3) DCL: 应在标准值范围内<br>步骤 3: $25^{\circ}C$<br>1) $\Delta C$ : 变化量应在初始测量值的 $\pm 10\%$ 范围内<br>2) DF: 应在标准值范围内<br>3) DCL: 应在标准值范围内<br>步骤 4: $85^{\circ}C$<br>1) $\Delta C$ : 变化量应在初始测量值的 $\pm 10\%$ 范围内<br>2) DF: 应在步骤 2 的 1.5 倍范围内<br>3) DCL: 应在标准值的 10 倍范围内<br>步骤 5: $125^{\circ}C$<br>1) $\Delta C$ : 变化量应在初始测量值的 $\pm 20\%$ 范围内<br>2) DF: 应在步骤 2 的 1.5 倍范围内<br>3) DCL: 应在标准值的 12 倍范围内<br>步骤 6: $25^{\circ}C$<br>1) $\Delta C$ : 变化量应在初始测量值的 $\pm 10\%$ 范围内<br>2) DF: 应在标准值范围内<br>3) ESR: 应在标准值范围内<br>4) DCL: 应在标准值范围内<br>5) 外观: 无明显变化 |
| 7   | C3.5 A | 4.14            | 4.26            | 浪涌电压 | 1) 高低温浪涌试验台<br>2) LCR 数字电桥<br>3) 电解电容漏电流测试仪<br>4) 体视镜      | 1) 环境温度: $85^{\circ}C$ ;<br>2) 限流电阻: $1K\Omega$ ;<br>3) 充电电压: $1.15UR$ ;<br>4) 充电时间: 30 秒;<br>5) 放电时间: 30 秒;<br>6) 空载持续时间: 5 分半;<br>7) 循环次数: 1000 次;<br>8) 测试节点: 试验前、试验后恢复 4h。                                                                                                                               | 1) $\Delta C$ : 应在初始测量值的 $\pm 10\%$ 范围内<br>2) DF: 应在标准值范围内<br>3) DCL: 在标准值范围内<br>4) 外观: 无明显变化                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

## 12.电压、电容量、外壳代号对应表 Comparison table (Voltage、Capacitance、Case code)

| 额定电压 [V] @ ≤85℃  | 2.5  | 4     | 6.3     | 10    | 16    | 20      | 25    | 35    | 50      |
|------------------|------|-------|---------|-------|-------|---------|-------|-------|---------|
| 类别电压 [V] @ +125℃ | 1.7  | 2.7   | 4.2     | 6.7   | 10.7  | 13.3    | 16.7  | 23.3  | 33.3    |
| 电压代码             | F    | G     | J       | A     | C     | D       | E     | V     | T       |
| 容量 [μF]          | 容量代码 | 壳号    |         |       |       |         |       |       |         |
| 0.1              | 104  |       |         |       |       |         |       |       |         |
| 0.15             | 154  |       |         |       |       |         |       | A     | A       |
| 0.22             | 224  |       |         |       |       |         |       | A     | A/B     |
| 0.33             | 334  |       |         |       |       |         | A     | A     | A/B     |
| 0.47             | 474  |       |         |       |       | A       | A     | A/B   | A/B     |
| 0.68             | 684  |       |         |       | A     | A       | A/B   | A/B   | A/B/C   |
| 1                | 105  |       |         | A/B   | A/B   | A/B     | A/B   | A/B   | A/B/C   |
| 1.5              | 155  |       | A       | A     | A/B   | A/B     | A/B   | A/B/C | A/B/C   |
| 2.2              | 225  | A     | A       | A/B   | A/B   | A/B     | A/B/C | A/B/C | B/C/D   |
| 3.3              | 335  | A     | A/B     | A/B   | A/B   | A/B/C   | A/B/C | B/C   | B/C/D   |
| 4.7              | 475  | A/B   | A/B     | A/B   | A/B/C | A/B/C   | A/B/C | B/C/D | C/D     |
| 6.8              | 685  | A/B   | A/B     | A/B/C | A/B/C | A/B/C   | B/C/D | B/C/D | C/D     |
| 10               | 106  | A/B   | A/B/C   | A/B/C | A/B/C | A/B/C   | B/C/D | C/D/E | C/D/E   |
| 15               | 156  | A/B/C | A/B/C   | A/B/C | A/B/C | B/C/D   | C/D   | C/D/E | D/E/V   |
| 22               | 226  | A/B/C | A/B/C   | A/B/C | A/B/C | B/C/D   | C/D   | C/D/E | D/E/V   |
| 33               | 336  | A     | A/B/C   | A/B/C | A/B/C | B/C/D   | C/D   | D/E   | D/E/V   |
| 47               | 476  | A     | A/B/C   | A/B/C | A/B/C | B/C/D/E | C/D/E | D/E   | D/E/V/W |
| 68               | 686  | A     | A/B/C   | A/B/C | B/C/D | C/D/E   | C/D/E | D/E/V | E/V/W   |
| 100              | 107  | A/B   | A/B/C   | A/B/C | B/C/D | C/D/E   | D/E/V | E/V/W |         |
| 150              | 157  | B     | B/C/D   | B/C/D | C/D/E | D/E/V   | D/E/V | E/V/W |         |
| 220              | 227  | B/D   | B/C/D   | B/C/D | C/D/E | D/E/V   | E/V/W |       |         |
| 330              | 337  | D     | C/D/E   | C/D/E | D/E/V | E/V/W   | E/V/W |       |         |
| 470              | 477  | C/D   | C/D/E   | D/E/V | E/V/W | E/W     |       |       |         |
| 680              | 687  | C/D/E | D/E     | E/V/W | E/W   |         |       |       |         |
| 1000             | 108  | D/E   | D/E/V/W | E/V/W |       |         |       |       |         |
| 1500             | 158  | D/E/V | E/V/W   |       |       |         |       |       |         |
| 2200             | 228  | V/W   |         |       |       |         |       |       |         |

## 13.包装 Packing

### 13.1 编带尺寸图表 Diagram of Taping Dimensions



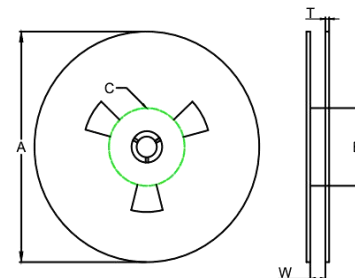
| XCase | A <sub>0</sub> ±0.10 | B <sub>0</sub> ±0.10 | K±0.10 | W±0.30 | E±0.10 | F±0.05 | P±0.10 | P <sub>1</sub> ±0.10 | P <sub>2</sub> ±0.10 | D+0.20 | D <sub>1</sub> +0.25 |
|-------|----------------------|----------------------|--------|--------|--------|--------|--------|----------------------|----------------------|--------|----------------------|
| A     | 1.88                 | 3.53                 | 1.85   | 8      | 1.75   | 3.5    | 4      | 4                    | 2                    | 1.55   | 1.00                 |
| B     | 3.07                 | 3.80                 | 2.22   | 8      | 1.75   | 3.5    | 4      | 4                    | 2                    | 1.55   | 1.10                 |
| C     | 3.60                 | 6.40                 | 2.85   | 12     | 1.75   | 5.5    | 4      | 8                    | 2                    | 1.55   | 1.60                 |
| H     | 4.60                 | 7.60                 | 2.16   | 12     | 1.75   | 5.5    | 4      | 8                    | 2                    | 1.55   | 1.55                 |
| F     | 6.50                 | 7.80                 | 2.20   | 12     | 1.75   | 5.5    | 4      | 8                    | 2                    | 1.55   | 1.5                  |
| D     | 4.60                 | 7.60                 | 3.10   | 12     | 1.75   | 5.5    | 4      | 8                    | 2                    | 1.55   | 1.55                 |
| E     | 4.60                 | 7.60                 | 4.40   | 12     | 1.75   | 5.5    | 4      | 8                    | 2                    | 1.55   | 1.55                 |
| V     | 6.40                 | 7.60                 | 4.40   | 12     | 1.75   | 5.5    | 4      | 8                    | 2                    | 1.55   | 1.55                 |
| W     | 6.40                 | 7.60                 | 4.40   | 12     | 1.75   | 5.5    | 4      | 8                    | 2                    | 1.55   | 1.55                 |
| X     | 6.40                 | 7.60                 | 6.40   | 12     | 1.75   | 5.5    | 4      | 8                    | 2                    | 1.55   | 1.55                 |

\*10 个以上定位孔孔距公差为±0.2mm

±0.2mm over 10 sprocket hole spaces

### 13.2 卷轮尺寸 Reel Dimensions

| Reel Size | 180mm (7") | 180mm (7")  | 180mm (7")  |
|-----------|------------|-------------|-------------|
| Tape Wide | 8mm        | 12mm        | 16mm        |
| A         | 178±2.00   | 178±2.00    | 178±2.00    |
| B         | 50 min     | 50 min      | 50 min      |
| C         | 13.0±0.50  | 13.0±0.50   | 13.0±0.50   |
| W         | 8.4+1.5/-0 | 12.4+1.5/-0 | 16.4+1.5/-1 |
| T         | 1.50±0.50  | 1.50±0.50   | 1.50±0.50   |



### 13.3 包装数量 Packaging Quantity

| 壳号       | Case size              | A    | B    | C   | H   | F   | D   | E   | V   | W   | X   |
|----------|------------------------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|
| 数量 (只/盘) | Quantity (pcs / plate) | 2000 | 2000 | 500 | 500 | 500 | 500 | 400 | 400 | 400 | 200 |

14.使用寿命 Life

在类别电压U<sub>C</sub>和类别温度T<sub>C</sub>下，电容器的平均故障率为0.5%/2000小时，符合U<sub>C</sub>和T<sub>C</sub>的工业试验标准。最短测试周期取决于产品寿命试验时间的长短（测试周期一般大于等于2000小时）。

当应用电压U<sub>A</sub>和应用温度T<sub>A</sub>低于类别电压U<sub>C</sub>和类别温度T<sub>C</sub>时，电容器的实际寿命比预期会增加。正常情况下，当U<sub>A</sub><0.9\*U<sub>C</sub>和T<sub>A</sub><85℃时，预期寿命通常会超过大多数电子元器件的使用寿命（即寿命>10年）。

电容器在特定的应用电压与应用温度下的寿命，可以使用下面的公式进行仿真计算。失效的表现为在足够的电流条件下，1A的保险丝被熔断。计算公式是基于可靠性试验经验结果的估算，不能确保完全符合实际情况。

The average failure rate of capacitors at category voltage U<sub>C</sub> and category temperature T<sub>C</sub> is 0.5%/2000 h, which meets the industrial test standards of U<sub>C</sub> and T<sub>C</sub>. The shortest test period depends on the length of the product life test time (the test period is generally greater than or equal to 2000 hours).

when the applied voltage U<sub>A</sub> and the applied temperature T<sub>A</sub> lower than the category voltage U<sub>C</sub> and the category temperature T<sub>C</sub>, the actual life of the capacitor will increase than expected. normally, when U<sub>A</sub><0.9\*U<sub>C</sub> 和 T<sub>A</sub><85℃, life expectancy usually exceeds that of most electronic components (>10 years).

The lifetime of the capacitor at a specific application voltage and application temperature can be simulated using the following formula. The failure of the capacitor shows that the fuse of 1a is blown under sufficient current condition. The calculation formula is based on the empirical results of reliability test, which can not ensure that it is completely in line with the actual situation.

| $ VAF = \left( \frac{U_C}{U_A} \right)^n $ |                                              |            |
|--------------------------------------------|----------------------------------------------|------------|
| 式中 where                                   | 含义 meaning                                   | 单位 units   |
| VAF                                        | 电压加速系数<br>Acceleration factor due to voltage | 无 unitless |
| U <sub>C</sub>                             | 类别电压<br>Category voltage                     | 伏特 volt    |
| U <sub>A</sub>                             | 应用电压<br>Application voltage                  | 伏特 volt    |
| n                                          | 指数<br>Exponent                               | 16         |

| $ TAF = e^{\left[ \frac{E_a}{k} \left( \frac{1}{273+T_A} - \frac{1}{273+T_C} \right) \right]} $ |                                                  |                             |
|-------------------------------------------------------------------------------------------------|--------------------------------------------------|-----------------------------|
| 式中 where                                                                                        | 含义 meaning                                       | 单位 units                    |
| TAF                                                                                             | 温度加速系数<br>Acceleration factor due to temperature | 无 unitless                  |
| E <sub>a</sub>                                                                                  | 活化能<br>Activation energy                         | 1.4eV                       |
| k                                                                                               | 玻尔兹曼常数<br>Boltzmann's constant                   | 8.617×10 <sup>-5</sup> eV/K |
| T <sub>A</sub>                                                                                  | 应用温度<br>Application temperature                  | ℃                           |
| T <sub>C</sub>                                                                                  | 类别温度<br>Category temperature                     | ℃                           |

| $ Life_{U_A,T_A} = Life_{U_C,T_C} * AF $    |                                                           |            |
|---------------------------------------------|-----------------------------------------------------------|------------|
| 式中 where                                    | 含义 meaning                                                | 单位 units   |
| Life <sub>U<sub>A</sub>,T<sub>A</sub></sub> | 应用电压与温度所对应的寿命<br>Life of load voltage and temperature     | 年 years    |
| Life <sub>U<sub>C</sub>,T<sub>C</sub></sub> | 类别电压与温度所对应的寿命<br>Life of category voltage and temperature | 年 years    |
| AF                                          | 加速系数<br>acceleration factor                               | 无 unitless |

| $ AF = VAF * TAF $ |                                                  |            |
|--------------------|--------------------------------------------------|------------|
| 式中 where           | 含义 meaning                                       | 单位 units   |
| AF                 | 加速系数<br>Acceleration factor                      | 无 unitless |
| TAF                | 温度加速系数<br>Acceleration factor due to temperature | 无 unitless |
| VAF                | 电压加速系数<br>Acceleration factor due to voltage     | 无 unitless |

**注意事项：** 类别电压，U<sub>C</sub>：在类别温度T<sub>C</sub>条件下持续负载的最大直流工作电压；  
额定电压，U<sub>R</sub>：在额定温度T<sub>R</sub>条件下持续负载的最大直流工作电压；  
类别温度，T<sub>C</sub>：允许的最高负载温度，在T<sub>C</sub>条件下需降额；  
额定温度，T<sub>R</sub>：允许的最高负载温度，无需降额。T<sub>R</sub>≤T<sub>C</sub>。

Notes: Category voltage, U<sub>C</sub>: Maximum DC working voltage of continuous load under category temperature T<sub>C</sub>;  
Rated voltage, U<sub>R</sub>: Maximum DC working voltage of continuous load at rated temperature T<sub>R</sub>;  
Class temperature, T<sub>C</sub>: Maximum allowable load temperature, derating is required under T<sub>C</sub> condition;  
Rated temperature, T<sub>R</sub>: The maximum allowable load temperature without derating. T<sub>R</sub> ≤ T<sub>C</sub>.