电力电子电容器
Capacitors for power electronics

一、电容器选用指南  Guide for capacitors choosing

<table>
<thead>
<tr>
<th>序号 No.</th>
<th>功能 Function</th>
<th>PCB 安装系列 For PCB mounting series</th>
<th>螺纹式、焊片式引出系列 Screw, lug terminals series</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>直流滤波 DC Link</td>
<td>C3D, C3L</td>
<td>C3A, C3A(G), C3B, C36, C3N, C3E</td>
</tr>
<tr>
<td>C2</td>
<td>IGBT 吸收 IGBT Snubber</td>
<td>C3H, C16, C82, C32 (Please refer to the PCB Catalogue for C82 &amp; C32)</td>
<td>C38</td>
</tr>
<tr>
<td>C3</td>
<td>交流滤波 AC filter</td>
<td>C6A</td>
<td>C66, C6M, C69 (单相 Single phase)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C65(A), C67, C6E (三相 Three phases)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C6D (单相或三相, Single or Three phase)</td>
</tr>
</tbody>
</table>

其它系列 Other series

C3G：插片式、螺栓式、螺孔式引出，用于高压直流吸收滤波，如dV/dt滤波器
Tabs, bolt, thread hole terminals, for high DC voltage snubber application, such as dV/dt filter

C3T：螺栓式引出，用于高压交流吸收滤波，特别适用于缓冲电路
Bolt terminals, for high AC voltage snubber application, especially suitable for snubber circuits

C3K：螺孔式、螺栓式引出，用于GTO缓冲/吸收保护
Thread hole, bolt terminals, damper/snubber for GTO protection

C3S：绝缘电子线引出，用于除颤器或其它脉冲储存等应用
Insulated wires, used in external defibrillator or pulse power applications
二、电力电子电容器的标准体系

电力电子电容器的主要标准是由中国国家标准化管理委员会发布的GB/T 17702和GB/T 12747.1、GB/T 12747.2（分别等同于由IEC 33技术委员会（电力电容器）制定IEC 61071，IEC 60831-1，IEC 60831-2）。

作为补充，我司也引用了GB/T 25121（等同于IEC 61881）、GB/T 21563（等同于IEC 61373）和AEC-Q200等标准，以满足铁路、汽车等特定场合的应用要求。

我司主要在上述标准的基础上制定了各个型号电力电子电容器的企业标准，以供内部引用。

另外，电力电子电容器的部分标准术语也参考了其它电容器标准中的定义，不再一一列出。

以上，构成了电力电子电容器的标准体系

电力电子电容器的标准体系，举例如下：

<table>
<thead>
<tr>
<th>标准号 (No.)</th>
<th>标  准 (Standards)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GB/T 17702 (IEC 61071)</td>
<td>电力电子电容器 Capacitors for power electronics</td>
</tr>
<tr>
<td>GB/T 12747.1 (IEC 60831-1)</td>
<td>标称电压1KV及以下交流电力系统用自愈式并联电容器 第1部分：总则—性能试验和定额—安全性要求—安装于导则 Shunt power capacitors of the self – healing type for a.c. systems having a rated voltage up to 1000V Part 1: General—Performance, testing and rating—Safety requirements—Guide for installation and operation</td>
</tr>
<tr>
<td>GB/T 12747.2 (IEC 60831-2)</td>
<td>标称电压1KV及以下交流电力系统用自愈式并联电容器 第2部分：老化试验、自愈性试验和破坏试验 Shunt power capacitors of the self – healing type for a.c. systems having a rated voltage up to and including 1000V – Part 2: Ageing test, self – healing test and destruction test</td>
</tr>
<tr>
<td>GB/T 25121 (IEC 61881-1)</td>
<td>轨道交通 机车车辆设备 电力电子电容器 Railway applications – Rolling stock equipment – Capacitors for power electronics</td>
</tr>
<tr>
<td>JB/T 8168</td>
<td>脉冲电容器及直流电容器 Pulse capacitors and direct current capacitors</td>
</tr>
<tr>
<td>GB/T 21563 (IEC 61373)</td>
<td>轨道交通 机车车辆设备 冲击和振动试验 Railway applications – Rolling stock equipment – Shock and vibration tests</td>
</tr>
<tr>
<td>AEC-Q200</td>
<td>STRESS TEST QUALIFICATION FOR PASSIVE COMPONENTS</td>
</tr>
<tr>
<td>GB/T 4798.1 (IEC 60721-3-1)</td>
<td>电工电子产品应用环境条件 第1部分 贮存 Classification of environmental conditions – Part 3 Classification of groups of environmental parameters and their severities – Section 1 Storage</td>
</tr>
<tr>
<td>GB/T 4798.2 (IEC 60721-3-2)</td>
<td>电工电子产品应用环境条件 第2部分 运输 Classification of environmental conditions – Part 3 Classification of groups of environmental parameters and their severities – Section 2 Transportation</td>
</tr>
<tr>
<td>GB/T 4798.3 (IEC 60721-3-3)</td>
<td>电工电子产品应用环境条件 第3部分 有气候防护场所固定使用 Classification of environmental conditions – Part 3 Classification of groups of environmental parameters and their severities – Section 3 Stationary use at weatherprotected locations</td>
</tr>
</tbody>
</table>

详细规范：Detail specification for each type.
三、Terminologies

1. Rated capacitance \( C \)
   Designed capacitance of the capacitor at 20°C/50 to 120Hz.

2. Rated voltage \( U_n \)
   For the capacitor referenced to IEC 60831-1/-2, it only means the r.m.s. value of a.c. voltage for which the capacitor has been designed. For the capacitor referenced to IEC 61071, it is divided into:
   - Rated a.c. voltage \( U_n \): maximum operating peak recurrent voltage of either polarity of a reversing type waveform for which the capacitor has been designed.
   - Rated d.c. voltage \( U_{dnc} \): maximum operating peak voltage of either polarity but of a non-reversing type waveform, for which the capacitor has been designed, for continuous operation.
   If just use rated a.c. voltage or rated d.c. voltage, \( U_n \) is useable. But if use both rated voltages, we should use both \( U_n \) and \( U_{dnc} \) to divide them.

3. Effective value voltage \( U_{rms} \)
   In the case of a capacitor, it is the root mean square of the total voltage over time. It is a measure of the energy stored in the capacitor.

4. Ripple voltage \( U_r \)
   Peak-to-peak alternating component of the unidirectional voltage.

5. Non-recurrent surge voltage \( U_s \)
   Peak voltage induced by a switching or any other disturbance of the system which is allowed for a limited number of times and for durations shorter than the basic period.

6. Insulation voltage \( U_i \)
   \( U_i \) is defined as the rms value of a.c. voltage designed for the insulation between terminals of the capacitor to case or earth. The insulation voltage is equal to the rated voltage of the capacitor, divided by \( \sqrt{2} \), unless otherwise specified.

7. Maximum current \( I_{max} \)
   Maximum rms current for continuous operation.
8. 最大峰值电流

在连续运行中允许重复出现的最大峰值电流。其数值为:

\[ I = C \times \left( \frac{dV}{dt} \right) \]

其中C为电容量，dV/dt表示电压爬升速率，即在运行中允许重复出现的最大电压爬升速率，常用来代替电流使用。

9. 最大冲击电流

由切换或系统中任何别的扰动所导致的允许出现的峰值电流，此电流只允许出现有限的次数，且每次持续时间应比基本周期短。

10. 串联电阻R_s

在规定的运行条件下，电容器的等效电阻。串联电阻随温度升高而增大，其电阻温度系数约为0.004°C，近似公式为:

\[ R_s(T_2) = \left[ 1 + 0.004 \times (T_2 - T_1) \right] \times R_s(T_1) \]

11. 等效串联电阻ESR

一个等效电阻，当它和所探讨的电容器有相同电容值的理想等效串联时，在规定的运行条件下，该电阻的损耗功率将等于该电容器中耗散的有功功率。

12. 介质损耗角正切tan δ_d

电容器的介质材料在额定频率下的损耗常数。聚丙烯薄膜的典型介质损耗因素为2x10^-4。

13. 电容器的损耗角正切tan δ

在规定频率的正弦波电压作用下，电容器的损耗功率除以电容器的无功功率，其值为等效串联电阻和容量之比。

14. 介质损耗功率P_d

电容器的介质由于极化或电导引起的损耗，其数值为:

\[ P_d = \omega^2 \times \pi \times f_0 \times C \times \tan \delta_d \]

直流电容器：\( \omega = U_r / 2 \)
交流电容器：\( \omega = \sqrt{2} U_{rms} \)
GTO吸收电容器：\( \omega = U_{ac} / 2 \)
\( f_0 \)：施加在电容器上电压的基本频率
\( C \)：电容量

15. 焦耳损耗功率P_j

当电容器通过有效电流时，由于串联电阻R_s发热而引起的损耗，其数值为:

\[ P_j = P_{rms} \times R_s \]

8. Maximum peak current \( \dot{I} \)

Maximum permitted repetitive peak current that can occur during continuous operation. The value is following:

\[ I = C \times \left( \frac{dV}{dt} \right) \]

Where C is capacitance and dV/dt indicates rate of voltage rise, which means maximum permitted repetitive rate of voltage rise of operational voltage, usually using instead of I.

9. Maximum surge current \( I_s \)

Peak non-repetitive current induced by switching or any other disturbance of the system which is allowed for a limited number of times, for durations shorter than basic period.

10. Series resistance R_s

Effective ohmic resistance of the conductors of a capacitor under specified operating conditions. It depends on temperature and the approximate TCR is 0.004°C. The approximate formula is following,

\[ R_s(T_2) = \left[ 1 + 0.004 \times (T_2 - T_1) \right] \times R_s(T_1) \]

11. Equivalent series resistance ESR

Effective resistance which, if connected in series with an ideal capacitor of capacitance value equal to that of the capacitor in question, would have a power loss equal to active power dissipated in that capacitor under specified operating conditions.

12. Dielectric dissipation factor tan δ_d

Constant dissipation factor of the dielectric material for all capacitors at their rated frequency. The typical loss factor of polypropylene film is 2x10^-4.

13. Loss factor of the capacitor tan δ

The dissipation factor is ratio between reactive power of the impedance of the capacitor and effective power when capacitor is submitted to a sinusoidal voltage of specified frequency, it is that ratio between the equivalent series resistance and the capacitive reactance of a capacitor.

14. Dielectric power loss P_d

Loss power induced by dielectric polarization or dielectric conductance. The value is following:

\[ P_d = \omega^2 \times \pi \times f_0 \times C \times \tan \delta_d \]

Where, for DC capacitors: \( \omega = U_r / 2 \)
for AC capacitors: \( \omega = \sqrt{2} U_{rms} \)
for GTO snubber capacitors: \( \omega = U_{ac} / 2 \)
\( f_0 \)：fundamental frequency
\( C \)：capacitance

15. Joule power loss P_j

Loss power induced by series resistance of the capacitor under rms current. The value is following:

\[ P_j = P_{rms} \times R_s \]
16. Capacitor losses $P_l$
Active power dissipated in the capacitor, consists of dielectric loss and joule loss, i.e., $P_l = P_d + P_i = P_{rms} \times ESR$

17. Maximum power loss $P_{max}$
Maximum power loss at which the capacitor may be operated at the maximum case temperature.

18. Self-inductance $L_s$
Represents the sum of all inductive elements which are for mechanical and construction reasons contained in any capacitor.

19. Resonance frequency $f_r$
Lowest frequency at which the impedance of the capacitor becomes minimum. The value is following: $f_r = 1/(2\pi \times \sqrt{L_s \times C_n})$

20. Rated frequency $f_n$
Specified frequency for which the capacitor has been designed.

21. Operating temperature $\theta_{case}$
Temperature of the hottest point on the case of the operating capacitor in thermal equilibrium.

22. Maximum operating temperature $\theta_{max}$
Highest temperature of the case at which the capacitor may be operated.

23. Lowest operating temperature $\theta_{min}$
Lowest temperature of the dielectric at which the capacitor may be energized.

24. Cooling-air temperature $\theta_{amb}$
Temperature of the air measured at the hottest position of the capacitor, under steady-state conditions, midway between two units. If only one unit is involved, it is the temperature of surrounding air, measured 10cm away and at 2/3 of the case height of the capacitor under steady-state conditions.

25. Contained temperature rise $\Delta \theta_{case}$
Difference between the temperature of the hottest point of the container and the temperature of the cooling air.

26. Thermal resistance $R_h$
The thermal resistance indicates by how many degrees the capacitor temperature at the hotspot rises above $\theta_{amb}$ per watt of the heat dissipation loss. $R_h$ consists of $R_{ihc}$ (thermal resistance from internal hotspot to case) and $R_{hec}$ (thermal resistance from case to ambient).
28. 容量温度系数 $\alpha$
电容器在规定的湿度范围内容量随温度的变化率。通常以20°C时电容量为参考，用百万分之一摄氏度 (10⁻⁴/°C) 表示。 (10⁻⁴/°C = 1 ppm/°C)

$$\alpha = \frac{C_T - C_0}{C_0[T_i - T_0]}$$

$C_T$: 电容器在温度$T_i$时的容量
$C_0$: 电容器在$T_0(20 \pm 2)$°C时的容量

29. 气候类别
电容器所在的气候类别用斜线分隔的三个数来表示（IEC 60068-1: 例：40/85/56）。

<table>
<thead>
<tr>
<th>40 / 85 / 56</th>
</tr>
</thead>
<tbody>
<tr>
<td>稳态湿热实验的天数 (56 天)</td>
</tr>
<tr>
<td>上限类别温度 (+85°C)</td>
</tr>
<tr>
<td>下限类别温度 (-40°C)</td>
</tr>
</tbody>
</table>

30. 绝缘电阻(IR)/时间常数(t)
绝缘电阻为电容器充电1分钟后所加的直流电压和流经电容器的漏电流值的比值，单位为MΩ。时间常数为绝缘电阻和电容量的乘积，通常以秒表示，公式如下：

$$t = \frac{R \times C}{10^6}$$

一般情况下，绝缘电阻用于描述小容量电容器的绝缘特性，时间常数用于描述大容量（如：$C_n > 0.33 \mu F$）电容器的绝缘特性。

另外，对于1分钟内无法充满电的更大容量的产品，需选5分钟、10分钟，甚至更长时间作为充电时间，或者由供需双方协商决定。

31. 自愈性(仅对金属化膜电容器)
电容器的电性能在发生局部电介质击穿后迅速而地基本恢复到击穿前的值的过程。
金属化膜的金属镀层是通过真空蒸发的方法将金属沉积在膜上，厚度只有几十个纳米，当介质上存在突点、杂质时，局部电击穿就可能发生，电击穿处的电弧放电所产生的能量足以使电击穿点邻近的金属镀层蒸发，使击穿点与周围镀层隔开，电容器电气性能即可恢复正常。

32. 失效率 $\lambda$
表示元件在单位时间内发生失效的概率，数值得上等于单位时间内失效的元件数与元件总数的比值。其单位为FIT（也写成Fit或ft），1FIT = 1/10⁹小时。

举例：10,000只元件在给定条件下工作10,000小时出现了10只失效，则 $\lambda = \frac{10}{(10,000 \times 10,000)} = 100$ FIT。

28. Temperature coefficient of capacitance $\alpha$
The change rate of capacitance with temperature measured over a specified range of temperature. It is normally expressed in parts per million per Celsius degree (10⁻⁴/°C) and referred to 20°C.

$$\alpha = \frac{C_T - C_0}{C_0[T_i - T_0]}$$

$C_T$: Capacitance at temperature $T_i$.
$C_0$: Capacitance at temperature $T_0(20 \pm 2)$°C.

29. Climatic category
The climatic category which the capacitor belongs to is expressed in three numbers separated by slashes, (IEC 60068-1: example 40/85/56).

<table>
<thead>
<tr>
<th>40 / 85 / 56</th>
</tr>
</thead>
</table>
| The number of days relevant to the damp heat test (56 days).
| The upper category temperature (+85°C).
| The lower category temperature (-40°C) |

30. Insulation Resistance(IR) / Time Constant (t)
The insulation resistance is the ratio between an applied D.C. voltage and the resulting leakage current after a minute of charge. It is expressed in MΩ. The time constant is expressed in seconds with the following formula: 

$$t = \frac{R \times C}{10^6}$$

In general, insulation resistance is used for describing smaller capacitance capacitors' insulation character, Time Constant for describing bigger one's (example: $C_n > 0.33 \mu F$).

In addition, if the capacitor with larger capacitance couldn't fully charge in one minute, we may choose 5 min, 10 min, even longer time as charging time, or it is to be determined by both purchaser and manufacturer.

31. Self-healing (Only for metallized film capacitor)
Process by which the electrical properties of the capacitor, after a local breakdown of the dielectric, are rapidly and essentially restored to the values before the breakdown.
The metal coatings of the metallized film, which are vacuum-deposited directly onto the plastic film, have a thickness of only several tens nm. At weak points or impurities in the dielectric, a dielectric breakdown would occur. The energy released by the arc discharge in the breakdown channel is sufficient to totally evaporate the thin metal coating in the vicinity of the channel. The insulated region thus resulting around the former faulty area will cause the capacitor to regain its full operation ability.

32. Failure rate $\lambda$
It indicates the failure probability of components in unit time and the value is the number of failure components in unit time compared to the total number of components. The unit of $\lambda$ is FIT (also expressed as Fit or ft) and 1FIT = 1/10⁹ hrs.
For example, 10,000 pcs of components work at given conditions for 10,000 hrs and 10 pcs of components failed, so $\lambda = 10 / (10,000 \times 10,000) = 100$ FIT.
四、电容器的预期寿命

电容器的预期寿命与电容器的运行电压及热点温度有关。对于应用在不同场合的电容器，它们的设计寿命是不同的。一般而言，应用在直流滤波电路中电容器，在额定电压及热点温度为70°C的应用条件下，它们的预期寿命可达到100 000 h。

电容器的预期寿命是一个基于实践经验与理论计算的统计学数值。以下图表是电容器的预期寿命与运行电压及热点温度之间的特性曲线，仅作为理论参考。对于工作条件与额定条件有差别的情况，可以联系我们的技术部门。

四、Expected lifetime of the capacitor

The expected lifetime of the capacitor depends on the applied voltage and the hot spot temperature during operation. For capacitors applied in different situation, the designed average service lifes are different. Generally speaking, capacitors used in DC-Link circuits will have a expected lifetime of probable 100 000 h at rated voltage and 70°C hot spot temperature.

Expected lifetime is a statistical value calculated on the basis of experience and on theoretical evaluations. The following diagrams show the correlation between expected life, operating voltage and hot spot temperature. The diagrams should be considered only as a theoretical reference. Please consult our technical department in case of working condition different from the rated ones.

**Expected life VS voltage**
(The diagrams should be considered only as a theoretical reference)

**Expected life VS hot spot temperature at U_{N}**
(The diagrams should be considered only as a theoretical reference)
五、Caution items in using plastic film capacitors

1. Operating Voltage
The plastic film capacitor varies in the maximum applicable voltage depending on the applied voltage waveform, current waveform, frequency, ambient temperature (capacitor surface temperature), capacitance value, etc. Be sure to use capacitors within the specified values by checking the voltage waveform, current waveform, and frequency applied to them. In the application of high frequency, the permissible voltage varies with the type of the capacitor. For detail see the specification.

2. Operating Current
The pulse (or AC) current flowing through the capacitor is expressed as: \( I = C \times \frac{dV}{dt} \).
Due to the fact that dissipation factor of the capacitor will generate the internal heat under the application of high frequency or high pulse current, temperature rise in it will occur and may cause deterioration of withstand voltage, even lead to break down (smoking or firing). Therefore, the safety use of capacitor must be within the rated voltage (or category voltage) and the permissible current. The operating current must be considered by dividing into pulse current (peak current) and continuous current (rms current) depending on the break down mode, and when using, should make sure the both currents are within the permissible values.

3. Calculation of rms in various waveforms.
In each waveform, calculate the rms value in the following formula.

<table>
<thead>
<tr>
<th>种类(type)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>波形(waveform)</td>
<td><img src="image1" alt="waveform1" /></td>
<td><img src="image2" alt="waveform2" /></td>
<td><img src="image3" alt="waveform3" /></td>
<td><img src="image4" alt="waveform4" /></td>
</tr>
<tr>
<td>有效值(rms)</td>
<td>( E/\sqrt{2} )</td>
<td>( E/\sqrt{2} )</td>
<td>( E\sqrt{v/(2T)} )</td>
<td>( E/\sqrt{3} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>种类(type)</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>波形(waveform)</td>
<td><img src="image5" alt="waveform5" /></td>
<td><img src="image6" alt="waveform6" /></td>
<td><img src="image7" alt="waveform7" /></td>
<td><img src="image8" alt="waveform8" /></td>
</tr>
<tr>
<td>有效值(rms)</td>
<td>( E\sqrt{v/(3T)} )</td>
<td>( E )</td>
<td>( E\sqrt{T} )</td>
<td>( \sqrt{2T(E_1+E_2+E_3+E_i)} )</td>
</tr>
</tbody>
</table>
4. 电容器充放电

由于电容器充放电电流取决于电容量和电压上升速率的乘积，即使是低电压充放电，也可能产生大的瞬变充放电电流，这可能会导致电容器性能的损害，比如说短路或开路。当进行充放电时，请串联一个20Ω/V-1 000Ω/V或更高的限流电阻，将充放电电流限制在规定的范围内。

当多个薄膜电容器串联进行耐电压测试或寿命测试时，请为每个电容器串联一个20Ω/V-1 000Ω/V或更高的限流电阻。详情见电容器标准。

另外，在用手操作电容器之前必须对电容器进行充分放电，否则电容器内部残存的能量可能会对操作人员产生致命的伤害。

5. 因薄膜振动产生的嗡鸣声

电容器的嗡鸣声是由于电容器薄膜受到两极间库仑力的作用，产生的振动而发出的声音。施加的电压和频率波形失真越严重，所产生的嗡鸣声越大。但这种嗡鸣声对电容器不会产生任何破坏作用。

6. 外壳温升（△θ case）

当电容器中通过持续电流时，热量积累会使电容器内部温度升高。当温度超出允许的热点温度时，可能会导致电容器短路甚至燃烧。因此，流经电容器的电流不允许超过产品目录所规定的最大值，而且如要监测电容器加载时的温升。

7. 高温环境

如果长时间使用在高温环境下，电容器可能会吸收潮气，电极被氧化，导致电容器损坏。如果是在AC条件下使用，高温环境将会加剧电晕的影响，从而引起电容量下降，损耗增加。

8. 贮存条件

8.1 电容器不能贮存在腐蚀性的空气环境中，特别是存在氯化物、硫化物、酸、碱、盐、有机溶剂或类似物质时。

8.2 产品不能暴露在高温和高湿状态，必须保存在以下环境中：（在不拆开原包装的基础上）

- 温度：-40 °C 到 35 °C
- 湿度：年平均值不超过70% RH
- 全年任意30天不超过80% RH

4. Charging and discharging

Because the charging and discharging current of capacitor is obtained by the product of voltage rise rate(dv/dt)and capacitance, low voltage charging and discharging may also cause deterioration of capacitor such as shorting and open due to sudden charging and discharging current. When charging and discharging, pass though a resistance of 20Ω/V to 1 000Ω/V or more to limit current.

When connecting multiple film capacitors in parallel in withstand voltage test or life test, connect a resistance of 20Ω/V to 1 000Ω/V or more in series to each capacitor. (For detail see the specification).

In additional, capacitors must be discharged with resistor before handling. Because the capacitor hasn’t discharge resistor inside, so there is residual but maybe deathful electric energy contained.

5. Buzzing noise

Any buzzing noise produced by capacitor is caused by the vibration of the film due to the coulomb force that is generated between the electrodes with opposite poles. If the wave-form with a high distortion rate or frequency is applied across the capacitor, the buzzing noise will become louder. But the buzzing noise is of no damage to capacitor.

6. Contained temperature rise (△θ case)

When continuing current flows through the capacitor, the temperature inside the capacitor will rise, induced by accumulated heat. If the temperature exceeds allowed hot-spot temperature, it might cause a short circuit or fire. The limits described in the catalogue are not exceeded and it’s necessary to check the temperature on the capacitor surface when it works.

7. Humid ambient.

If used for a long time in a humid ambient, the capacitor might absorb humidity and oxidise the electrodes causing breakage of the capacitor. If case of AC application, high humidity would increase the corona effect. This phenomenon causes a drop of capacitance and an increase of capacitor losses.

8. Storage conditions:

8.1 Capacitors may not be stored in corrosive atmospheres, particularly not when chlorides, sulfides, acids, lye, salts, organic solvents or similar substances are present.

8.2 It shouldn’t be located in particularly high temperature and high humidity, it must submit to the following conditions (unchanging primal package):

- Temperature: -40 °C to 35 °C
- Humidity: Average per year ≤ 70% RH; For 30 full days randomly
六、绿色产品
RoHS符合性
在此产品目录中的法拉公司的产品均符合RoHS指令和《电子信息产品污染控制管理办法》的要求。

七、客户订购指南
请尽量提供以下信息：

1.应用场合：如UPS、变频器、整流器等
2.额定电容量及允许偏差
3.电压：包括额定电压、工作电压、纹波电压、非周期冲击电压等
4.电流：包括最大电流、工作电流、最大峰值电流、最大冲击电流等
5.频率：包括工作频率，脉冲频率，纹波电压的频率等
6.工作场所：如固定场所、车辆、船舶等
7.工作环境：如温度范围、湿度、海拔、散热方式等
8.产品尺寸：如直径、高度或长度、宽度、高度等
9.端子类型：如螺栓式、螺孔式、接线片、插片式等
10.安全要求：如阻燃、防爆等
11.预期寿命：在给定的工作条件下的预期寿命
12.安装方式：如底部螺栓、中部卡扣、安装耳等
13.其它

distributed throughout the year≤80%RH
Storage time: ≤24 months (from the date marked on the capacitor’s body or the label glued to the package)

Faratronic products in the catalogue are RoHS Compliant.

七、Guide for customer ordering
Please provide following information as possible as you can

1. Application: for example, UPS, transducer, rectifier etc.
2. Rated capacitance and tolerance
3. Voltage: including rated voltage, working voltage, ripple voltage, non-recurrent surge voltage etc.
4. Current: including maximum current, working current, maximum peak current, maximum surge current etc.
5. Frequency: including working frequency, pulse frequency, frequency of ripple voltage etc.
6. Working location: for example, fixed-location, vehicle, watercraft, etc.
7. Working environment: for example, temperature range, humidity, altitude, cooling mode etc.
8. Dimensions: for example, diameter, height or length, width, height etc.
9. Terminal form: for example, stud, thread hole, lug, tab, etc.
10. Safety: for example, flame resistance, anti-explosion etc.
11. Expected lifetime: under given working conditions.
12. Fixed style: for example, bottom-stud, middle-clip, mounting ears etc.
13. Others
八、产品编码说明  Part number system

- 18位产品代码如下:

The 18 digits part number is formed as follow:

<p>| | | | | | | | | | | | | | | | |</p>
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第1~3位  型号代码  Digit 1 to 3  Series code
第4~5位  额定电压（参见table 1）  Digit 4 to 5  Rated voltage (refer to table 1)
第6~8位  标称容量  Digit 6 to 8  Rated capacitance value
  $107 = 10 \times 10^7 \mu F = 100 \mu F$
第9位  容量偏差  Digit 9  Capacitance tolerance
  $G = \pm 2\%, H = \pm 3\%, J = \pm 5\%,$
  $K = \pm 10\%, N = 0 \sim 10\%$
第10位  引线脚距（参见table 2）  Digit 10  Pitch（refer to table 2）
  （适用于C3D,C3H,C6A系列）
  For C3D, C3H, C6A series
第10位  外形尺寸代码  Digit 10  Dimension code
  （适用于C3B,C3A,C3B,C3G,C3K,C6B(A),C66,
  C67,C69等系列，参照各个系列的说明）
  For C3B, C3A, C3B, C3G, C3K, C6B(A), C66,
  C67, C69 related to each series
第11位  内部特征码  Digit 11  Internal use
第12~15位  引出端代码  Digit 12 to 15  Terminals code
  （参照各个系列的说明）
  （related to each series）
第16~18位  内部特征码  Digit 16 to 18  Internal use

■ 例如  for example

```
C3K  1V  106  J  A  0  2417  000
```

---

Internal code
Terminals code
Internal code
D=90mm, H=55mm(case size)
Capacitance tolerance: &pm; 5%
10\mu F
$U_n = 700Vdc$
Series code
### Table 1  额定电压代码  Rated voltage code

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**说明：** 字母加数字表示交流，数字加字母表示直流，例如A2表示100Vac，2A表示100Vdc

**Exapmation:** Letter and then number indicate AC, but number and then Letter indicate DC, for example, 2A indicate 100Vdc, A2 indicate 100Vac.

### Table 2  脚距代码  Pitch code

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