1. The standard system of fixed plastic film capacitor for use in electronic equipment

The standard system of fixed plastic film capacitor for use in electronic equipment includes the foundational standard, generic specification, sectional specification, blank detail specification and detail specification, or manufacturer specification.

Generic specification specifies the terminology, inspection procedures and test methods applied in sectional and detail specifications. Sectional specification is classified according to the specific dielectric material and construction of capacitor, it prescribes preferred rating and characteristics and to select from generic specification the appropriate quality assessment procedures, tests and measuring methods and to give general performance requirements for this type of capacitor. Blank detail specification is a supplementary document to the sectional specification and contains requirements for style, layout and minimum contents of detail specifications.

The corresponding specification lists for plastic film capacitors are as follows.

1、电子设备用薄膜电容器的标准体系

电子设备用固定电容器的标准体系是由基础标准、总规范、分规范、空白详细规范以及详细规范（即企业标准）组成。

总规范规定了分规范和详细规范中使用的标准术语、检验程序和试验方法。分规范是按电容器的介质和结构分类的，它是对该类电容器规定优先额定值和特性，并从总规范中选择适当的质量评定程序、试验和测量方法，以及给出一般性能要求。空白详细规范是分规范的一种补充文件，它规定了详细规范的格式、编排和最基本的要求。

薄膜电容器的标准体系，举例如下：

标准号 (No.)	标准(Standards)
GB/T 2693 (IEC 60384-1)	电子设备用固定电容器 第1部分：总规范 Fixed capacitors for use in electronic equipment Part 1: Generic specification
GB/T 17702 (IEC 61071)	电力电子电容器 Power electronic capacitors
AEC-Q200	被动元件应力测试认证规范 Stress test qualification for passive components
GB/T 25121 (IEC61881)	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
GB/T 21563 (IEC61373)	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
GB/T 4798-1 (IEC 60721-3-1)	电工电子产品应用环境条件 第1部分：贮存 Classification of groups of environmental parameters and their severities Section 1 Storage
GB/T 4798-2 (IEC 60721-3-2)	电工电子产品应用环境条件 第2部分：运输 Classification of groups of environmental parameters and their severities Section 2 Transportation
GB/T 4798-3 (IEC 60721-3-3)	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 groups of environmental parameters and their severities Section 3 Stationary use at weather protected locations

2. General Description of Film Capacitors

2-1 Principle of Capacitor Construction

The principle construction of a parallel plate capacitor is shown in Fig.1. When a voltage V is applied between the conducting electrodes placed opposite to each other, a certain amount Q of electric charge proportional to the voltage can be stored on the surfaces of the dielectric. The proportional constant is called capacitance C, designating the ability of a capacitor to store energy in an electric field.

Q=C•V

Q: Charge [Coulomb]

V: Voltage [Volt]

C: Capacitance [Farad]

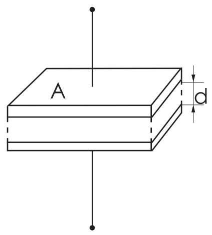


Fig. 1

The capacitance C of capacitor can be expressed by the following equation:

$$C = \varepsilon_0 \cdot \varepsilon \cdot A/d$$

ε: dielectric constant

ε_0: dielectric constant in vacuum (= 8.85×10^{-12} F/m)

A: electrode area [m^2]

d: electrode distance [m]

The dielectric constant of Polypropylene film is 2.2. Larger capacitances can be obtained by enlarging the electrode area A or by reducing the distance.

Table 1 shows the dielectric constants of typical film dielectrics used in capacitors. In many cases, capacitor naming are related to their dielectric material used.

Table-1

Dielectric	Dielectric Constant
Polypropylene	2.2
Polyester	3.3
Polyimide	3.5
Polyethylene	2.3
Polycarbonate	2.8
Polytetrafluoroethylene	2

The schematic of an film capacitor is shown in Fig.2

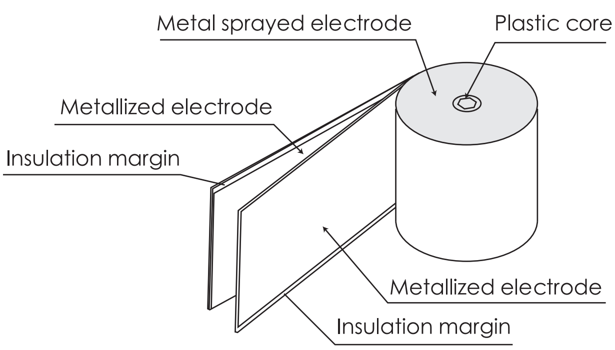


Fig. 2

2. 薄膜电容器的基本概要

2-1. 电容器的结构原理

平行板电容器的基本结构原理可以用图1来描述。当一个电压V施加在彼此正对的两块导电极板两端时，与电压成正比的电荷量Q将被储存在电介质的表面。这个用来标称电容器在电场中储能能力的比例常数被称作容量C。

Q=C•V

Q:电量 [库伦]

V:电压 [伏特]

C:电容量 [法拉]

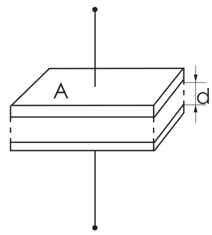


图 1

电容器的容量可以用以下公式来表示：

$$C = \varepsilon_0 \cdot \varepsilon \cdot A/d$$

ε: 电介常数

ε_0: 真空中的电介常数(= 8.85×10^{-12} F/m)

A: 极板面积 [m^2]

d: 极板距离 [m]

聚丙烯膜的相对介电常数为2.2。要想获得更大的电容，可以通过增加表面积A或者减少其厚度d来获得。

表1-1列出了电容器中常用的几种典型介质的相对介电常数，在很多情况下，电容器的命名通常是与介质所使用的材料相关的。

表-1

介质	相对介电常数
聚丙烯	2.2
聚酯	3.3
聚酰亚胺	3.5
聚乙烯	2.3
聚碳酸酯	2.8
聚四氟乙烯	2

图2 是薄膜电容器的示意图

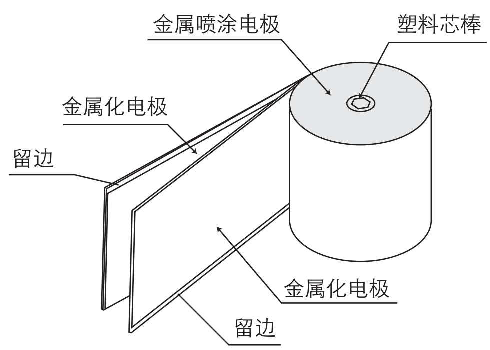


图2

3. Basic parameters and terms

3-1. Rated capacitance C_R

Nominal capacitance value is measured at 20℃ and the measuring frequency range is from 50 to 120 Hz.

3-2. Rated voltage U_R

Maximum operating peak voltage of either polarity but of a non-reversing type waveform, for which the capacitor has been designed, for continuous operation. It shall be higher than the sum of operating d.c. voltage and operating ripple peak voltage.

3-3. Ripple voltage U_r

Peak-to-peak alternating component of the unidirectional voltage.

3-4. 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.

- Maximum duration: 50 ms/pulse
- Maximum number of occurrences: 1000 (during load)

3-5. Insulation voltage U_i

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.

3-6. Maximum current I_{max}

Maximum rms current for continuous operation.

3-7. Maximum rate of voltage rise dV/dt

Maximum permissible repetitive rate of voltage rise of the operational voltage.

3-8. Maximum peak current $\hat{I}$

Maximum permitted repetitive peak current that can occur during continuous operation.

The value is following: $\hat{I}=C_R\times(dV/dt)$

3-9. Maximum surge current $\hat{I}_s$

Admissible peak current induced by a switching or any other disturbance of the system.

- Maximum duration: 50 ms / pulse
- Maximum number of occurrences: 1000

3-10. Series resistance R_s

Effective ohmic resistance of the conductors of a capacitor under specified operating conditions.

3-11. Equivalent series resistance ESR

The equivalent series resistance (ESR) represents all of the ohmic losses of the capacitor.

$$ESR=\frac{tg\delta}{\omega\bullet C}=R_S+\frac{tg\delta_0}{\omega\bullet C}$$

3-12. Dielectric dissipation factor $tg\delta_0$

Constant dissipation factor of the dielectric material for all capacitors at their rated frequency. The typical loss factor of polypropylene film is 2×10^{-4}.

3、基本参数和术语

3-1、额定容量C_R

标称电容值在20℃和50~120Hz 频率下测定。

3-2、额定电压U_R

设计电容器时所采用的非反复型波形的任一极性的可连续运行的最高运行峰值电压。其值应大于直流工作电压与纹波电压峰值之和。

3-3、纹波电压U_r

单向电压的峰到峰的交流分量。

3-4、非周期冲击电压U_s

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

-最大持续时间：50毫秒/脉冲

-最大出现次数：1000（负载）

3-5、绝缘电压U_i

设计电容器时规定的电容器端子对外壳或对地交流电压的均方根值。若未作说明，此绝缘电压等于额定电压除以$\sqrt{2}$。

3-6、最大电流I_{max}

连续运行时的最大电流的均方根值。

3-7、最大电压爬升速率dV/dt

在运行中允许的可重复出现的最大电压爬升速率。

3-8、最大峰值电流$\hat{I}$

在连续运行中允许的可重复出现的最大峰值电流。

其数值为：$\hat{I}=C_R\times(dV/dt)$

3-9、最大冲击电流$\hat{I}_s$

由开关切换或其它扰动所导致的、允许出现的峰值电流。

-最大持续时间：50毫秒/脉冲

-最大出现次数：1000

3-10、串联电阻R_s

在规定的运行条件下，电容器的导体部分的等效内阻。

3-11、等效串联电阻ESR

等效串联电阻（ESR）是表征电容器全部欧姆损耗的量值。

$$ESR=\frac{tg\delta}{\omega\bullet C}=R_S+\frac{tg\delta_0}{\omega\bullet C}$$

3-12、介质损耗因素$tg\delta_0$

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2×10^{-4}。

3-13. Loss factor of the capacitor tgδ

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.

3-14. Dielectric power loss P_d

Loss power induced by dielectric polarization or dielectric conductance.

3-15. Joule power loss P_j

Loss power induced by series resistance of the capacitor under rms current.

3-16. Capacitor losses P_t

Active power dissipated in the capacitor.

$$P_t \approx I^2_{rms} \times ESR$$

3-17. Maximum power loss P_{max}

Maximum power loss at which the capacitor may be operated at the maximum case temperature.

3-18. Self-inductance L_s

Represents the sum of all inductive elements which are for mechanical and construction reasons contained in any capacitor.

3-19.Resonance frequency f_r

Lowest frequency at which the impedance of the capacitor becomes minimum. The value is following:

$$f_r = 1/(2\pi \times \sqrt{L_S \times C_R})$$

3-20. Ambient temperature Θ_A

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.

3-21.Maximum operating temperature Θ_{max}

Highest temperature of the case at which the capacitor may be operated.

3-22.Lowest operating temperature Θ_{min}

Lowest temperature of the dielectric at which the capacitor may be energized.

3-23.Thermal resistance R_{th}

The thermal resistance indicates by how many degrees the capacitor temperature at the hotspot rises above Θ_A per watt of the heat dissipation losse.

3-24.Hotspot temperature $\Theta_{hotspot}$

Temperature at the hottest spot inside the capacitor. The value is following:

$$\Theta_{hotspot} = \Theta_A + P_t \times R_{th}$$

3-13、电容器的损耗因素tgδ

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

3-14、介质损耗功率P_d

电容器的电介质由于极化或电导引起的损耗。

3-15、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Rs发热而引起的损耗。

3-16、电容器的损耗功率P_t

电容器所消耗的有功功率。

$$P_t \approx I^2_{rms} \times ESR$$

3-17、最大损耗功率P_{max}

在最高运行温度下电容器可以承载的最大损耗功率。

3-18、自感L_s

电容器由于自身结构或组成的原因所表现出来的电感。

3-19、谐振频率f_r

电容器的阻抗成为最小时的最低频率。其值为：

$$f_r = 1/(2\pi \times \sqrt{L_S \times C_R})$$

3-20、环境温度Θ_A

在稳定状态条件下，在电容器组最热区域的两个单元之间中途所测得的空气温度。

如果仅设计一单元，则指在离电容器外壳10cm且距其底部2/3高度处所测得的空气温度。

3-21、最高运行温度Θ_{max}

电容器可以运行的最高外壳温度。

3-22、最低运行温度Θ_{min}

电容器可以运行的最低电介质温度。

3-23、热阻R_{th}

热阻表征的是电容器的发热功率每上升1瓦，电容器内最热点的温度在环境温度Θ_A基础上升高的度数。

3-24、热点温度$\Theta_{hotspot}$

电容器内部最热点处的温度。其值为：

$$\Theta_{hotspot} = \Theta_A + P_t \times R_{th}$$

3-25.Temperature coefficient of capacitance α

The change rate of capacitance with temperature measured over a specified range of temperature.

3-26. Voltage between terminals U_{TT}

Voltage between terminals

3-27. Voltage between terminals and case U_{TC}

Voltage between terminals and case

3-28. 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)

40 / 85 / 56

- 56: days relevant to the damp heat test (56days)
- 85: the upper category temperature (+85℃)
- 40: the lower category temperature (-40℃)

3-29.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[s]=IR [MΩ]×C[μF]

3-30. Self-healing (Only for metallized film capacitor)

Process by which the electrical prorerties 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 vivinity of the channel. The insulated region thus resulting around the former faulty area will cause the capacitor to regain its full operation ability.

3-31、Failure rate λ

It indicates the failure probability of components in unit time and the value is the number of failure components in unit compared to the total number of components.the unit of λ is FIT,1 FIT=1/10^{-9}h

$$\lambda=\frac{r}{n \cdot t}$$

t: test time
n: test number
r: number of failures

3-25、容量温度系数α

电容器在规定的温度范围内容量随温度的变化率。

3-26. 端子与端子间耐压 U_{TT}

电容器端子与端子间耐压

3-27. 端子与外壳间耐压 U_{TC}

电容器端子与外壳间耐压

3-28、气候类别

电容器所属的气候类别用斜线分隔的三个数来表示
(IEC 60068-1：如：40/85/56)

40 / 85 / 56

- 56：稳态湿热实验的天数（56天）
- 85：上限类别温度（+85℃）
- 40：下限类别温度（-40℃）

3-29、绝缘电阻（IR）/时间常数（t）

绝缘电阻为电容器充电一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[s]=IR[MΩ]×C[μF]

3-30、自愈性（仅对金属化膜电容器）

电容器的电特性在发生局部电介质击穿后迅速而基本地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薄膜上，厚度只有几十个纳米，当介质上存在弱点、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处的金属镀层蒸发，使击穿点与周围极板隔开，电容器电气性能即可恢复正常。

3-31、失效率 λ

失效率表示元件在单位时间内发生失效的概率，数值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，1FIT=1/10^{-9}h

$$\lambda=\frac{r}{n \cdot t}$$

t：测试时间
n：测试产品数
r：失效产品数

4. 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. The capacitors used in DC-Link circuits will have a expected lifetime of probable 100000 hrs at rated voltage and 70t hot spot temperature.

4-1、The hotspot temperature estimation

During operation, the ripple current flowing through the capacitor will generate heat due to the series resistance (Rs) of the capacitor. Considering the above factors hotspot temperature estimation formula is as follows:

$$\Theta_{hotspot} = \Theta_A + I_{rms}^2 \times ESR \times R_{th}$$

$\Theta_{hotspot}$: Hotspot Temperature, ℃
Θ_A: Environment Temperature, ℃
I_{rms}: Ripple Current, A
ESR: Equivalent series resistance, Ω
R_{th}: Thermal Resistance, K/W

4-2.Estimation of lifetime calculation

Considering the fever caused by ripple current, internal resistance (hotspot temperature), as well as the applied voltage, life estimation formula:

$$L = L_0 \times (U_R/U)^n \times 2^{(\Theta - \Theta_{hotspot})/m}$$

L: The calculation of Lifetime, hrs
L_0: Rated Lifetime (100000hrs)
U: Working Voltage, V_{DC}
U_R: Rated Voltage, V_{DC}
n: Acceleration Coefficient of Voltage, experienced value: 6~12
$\Theta_{hotspot}$: The Actual or Calculated Hotspot Temperature, ℃
Θ: Rated Hotspot Temperature, 70℃
m: Acceleration Coefficient of Temperature, experienced value: 5~10
PS: Typically When the capacity change rate is above ± 3%, the capacitor fails.

Expected lifetime is a statistical value calculated on the basis of experience and on theoretical evaluations. The above formula is only as a theoretical reference. Please consult our technical department in case of working condition different from the rated ones.

4、电容器的预期寿命

薄膜电容器的预期寿命与电容器的工作电压及热点温度有关。对于不同的应用场合，电容器的设计寿命不同。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℃ 的应用条件下，预期寿命可达到100000小时。

4-1、热点温度估算

在工作时，由于电容器内部存在内阻（Rs），流过的纹波电流会引起电容器的发热。考虑上述因素热点温度估算公式如下：

$$\Theta_{hotspot} = \Theta_A + I_{rms}^2 \times ESR \times R_{th}$$

$\Theta_{hotspot}$： 热点温度，℃
Θ_A： 环境温度，℃
I_{rms}： 纹波电流，A
ESR： 等效串联电阻，Ω
R_{th}： 热阻，K/W

4-2、寿命估算

考虑由纹波电流、内阻引起的发热（热点温度），以及施加的电压，寿命估算公式为：

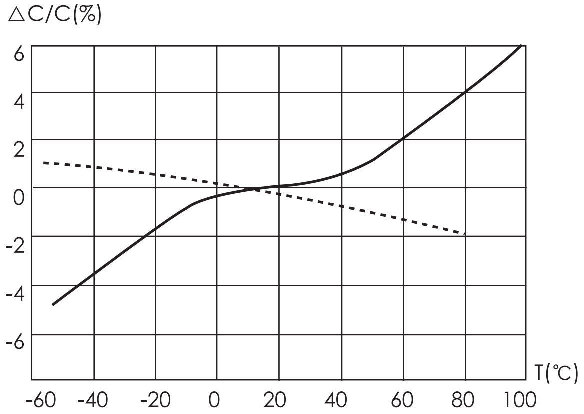
$$L = L_0 \times (U_R/U)^n \times 2^{(\Theta - \Theta_{hotspot})/m}$$

L：计算的寿命，hrs
L_0：额定电压和额定热点温度下的寿命（100000hrs）
U：使用电压，V_{DC}
U_R：额定电压，V_{DC}
n：电压加速系数，n值一般取：6~12
$\Theta_{hotspot}$：实际或计算的热点温度，℃
Θ：额定热点温度，70℃
m：温度加速系数，m值一般取：5~10
注：通常容量变化率超出±3%的范围时，判定产品失效

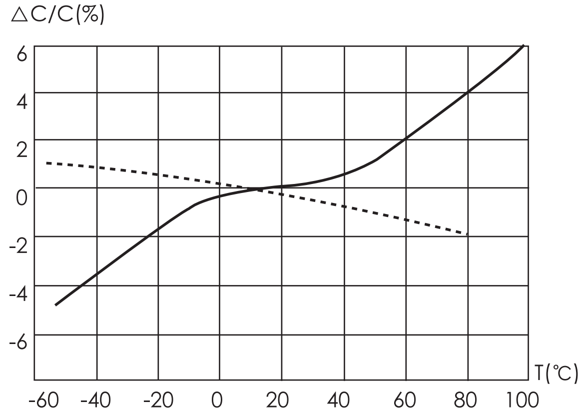
电容器的预期寿命是一个基于实践经验和理论计算的统计学数值。上述公式仅仅作为理论参考。对于工作条件与额定条件有差别的情况，可以联系我们的技术部门。

5. Electrical behaviour

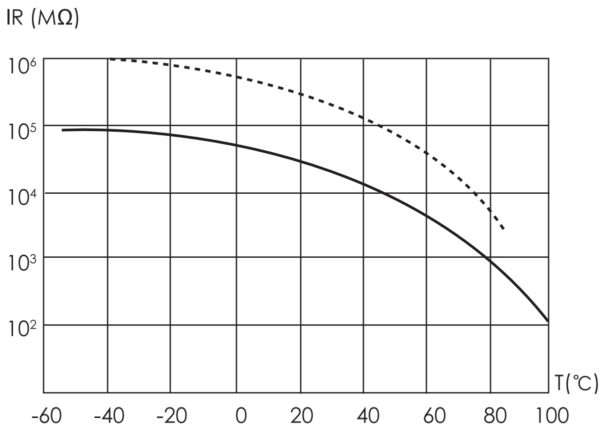
5. 电气特性



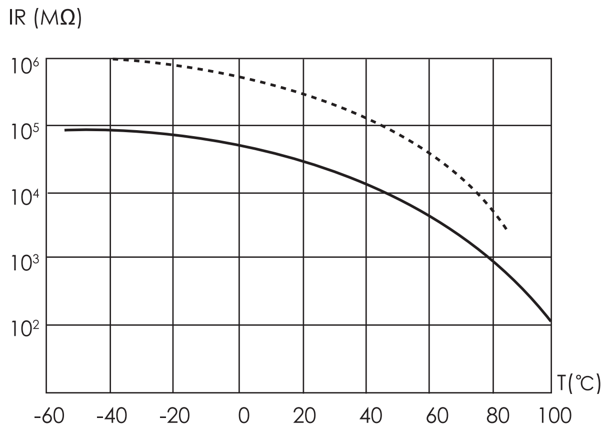
Capacitance vs. temperature at 1kHz



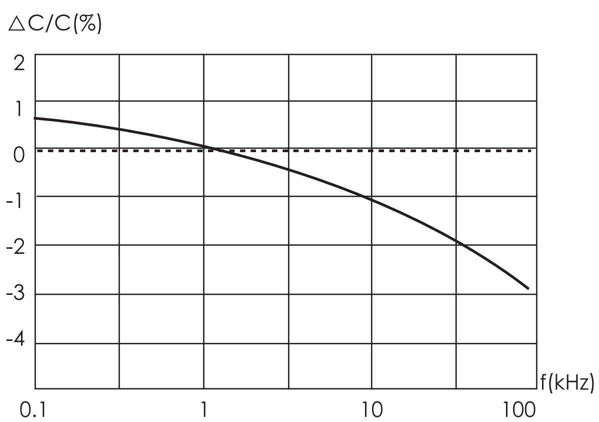
1kHz时容量与温度的关系



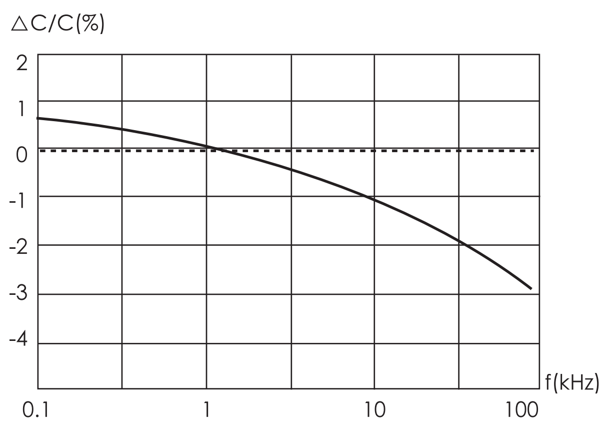
IR vs. temperature



IR与温度之间的关系



Capacitance vs. frequency (Room temperature)



容量与频率的关系（常温条件下）

- - - - 聚丙烯薄膜（Polypropylene Film）

—— 聚酯薄膜（Polyester Film）

6. Caution items in using plastic film capacitors

6-1. Operation 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. Refer to the specification for detail).

6-2. Operating current

The pulse (or AC) current flowing through the capacitor is expressed as: I=C x 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, This leads to the temperature rising and also causes the danger of breaking down (smoking or firing). Therefore, the safety use of capacitor must be within the rated voltage(or category voltage)and the permissible current.

The rated 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.

6-3. Calculation of rms in various waveforms

In each waveform, calculate the rms value in the following formula.

6、使用薄膜电容器的注意事项

6-1、工作电压

薄膜电容器的选用取决于施加的最高电压，并受施加的电压波形、电流波形、频率、环境温度（电容器表面温度）、电容量等因素的影响。使用前请先检查电容器两端的电压波形、电流波形和频率（在高频场合，允许电压随着电容器类型的不同而改变，详细资料请参阅说明书）是否在额定值内。

6-2、工作电流

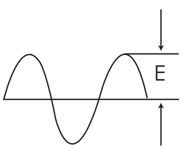
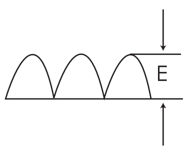
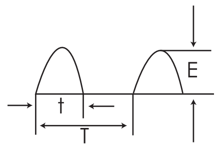
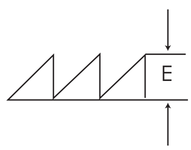
通过电容器的脉冲（或交流）电流等于电容量C与电压上升速率的乘积，即I=C×dV/dt。

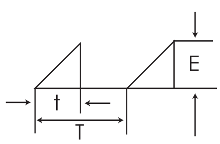
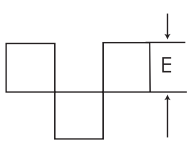
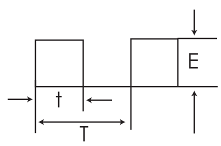
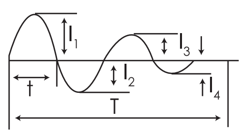
由于电容器存在损耗，在高频或高脉冲条件下使用时，通过电容器的脉冲（或交流）电流会使电容器自身发热而有温升，将会有热击穿（冒烟、起火）的危险。因此，电容器安全使用条件不仅受额定电压（或类别电压）的限制，而且受额定电流的限制。

额定电流被认为是由击穿模式决定的脉冲电流（峰值电流，即由dV/dt指标所限制的）和连续电流（以峰峰值或有效值表示）组成，当使用时，需确认这两个电流都在允许范围之内。

6-3、各种波形的有效值换算关系

不同的波形有效值按下面的公式计算。

种类(type)	1	2	3	4
波形 (waveform)				
有效值(rms)	$E/\sqrt{2}$	$E/\sqrt{2}$	$E\sqrt{t/(2T)}$	$E/\sqrt{3}$

种类(type)	5	6	7	8
波形 (waveform)				
有效值(rms)	$E\sqrt{t/(3T)}$	E	$E\sqrt{t/T}$	$\sqrt{\frac{t}{2T}(I_1^2+I_2^2+I_3^2+I_4^2)}$

6-4. 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 to1000Ω/V or more to limit current.

When multiple film capacitors which are connected in parallel are undergoing withstand voltage test or life test, connect a resistor valued at 20Ω/V to1000Ω/V or more in series to each capacitor. (Refer to the specification for more details). In addition, capacitors must be discharged with resistors before handling. If the capacitor doesn’t discharge resistor inside, there will be residual heat inside which maybe cause danger to the operator’s life.

6-4、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，也可能产生大的瞬间充放电电流，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，请根据电压串联限流电阻（20~1000Ω/V），将充放电电流限制在规定的范围内。

当多个薄膜电容器并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限流电阻（20~1000Ω/V）。详见电容器标准。

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。

6-5. 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.

6-6. Surface over temperature $\Delta\theta_{case}$

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.

6-7. 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 a increase of capacitor losses.

6-8. Storage conditions

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

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℃~+35℃

Humidity: The annual average value shall not exceed 70%RH, and the average value for any 30 days of one year shall not exceed 80%RH.

Storage time:≤24 months (from the date marked on the capacitor's body or the label glued to the package)

6-5、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电极间库仑力的作用，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。

6-6、表面温升$\Delta\theta_{case}$

当电容器中通过持续电流时，热量累积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数值，而且有必要监测电容器加载时的温升。

6-7、高湿环境

如果长时间使用在高湿环境下，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，高湿环境将会加剧电晕的影响，从而引起电容量下降，损耗增加。

6-8、储存条件

1）电容器不能储存在腐蚀性的空气环境中，特别是存在氢化物、硫化物、酸、碱、盐、有机溶剂或类似物质时。

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）

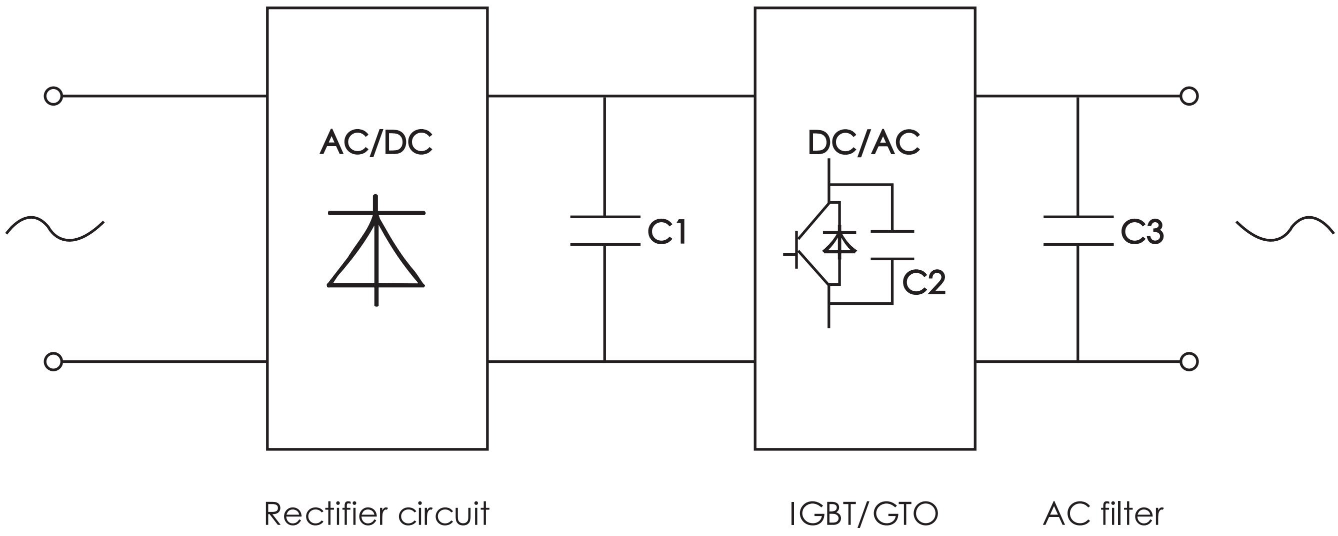
温度：-40℃~+35℃

湿度：年平均值不超过70%RH，全年任意30天不超过80%RH

储存时间：不超过24个月（从产品包装或产品本体上的日期算起）

7. 电容器选用指南 Guide for capacitors choosing

典型电路Typical circuit



电容 Capacitor	功能 Function	型号 Series
C1	直流滤波 DC Link	CBB131、CBB132、CBB133、CBB135、CBB136、CBB136G、CBB138
C2	缓冲吸收 Snubber	CBB161、CBB162、CBB165、CBB167
C3	交流滤波 AC filter	CBB235、CBB237、CBB238

8. Typical failure modes and factors of film capacitors

8、薄膜电容器失效模式及原因分析