CAUTION AND WARNING

- Please contact us for complete technical specifications before use and confirm the appropriate operating condition of your application.
- If used in a specific appliance that requires an extremely high reliability directly impacting personal safety, please consult us and use within the conditions designated in the specification.
- In the event of a circuit malfunction such as shorting and opening, provide proper means for preventing voltage, current or temperature exceeding the capacitor's rating from being applied to the film capacitor.
- For film capacitors for AC use, ask for our specification, and use within the specified guidelines and conditions.
- Under worst case conditions, a film capacitor may smoke or catch fire. Therfore, as the specific application demands, we recommend that the resin part of the periphery is covered with a flame-retardent material and case.

Note:

1. Technical information in this catalog is intended to convey examples of typical performances and/or applications, and is not intended to convey patents rights, if any.
2. For the products which are controlled items subject to the Foreign Exchange and Foreign Trade Control Law, the export permission according to the Law is necessary.
3. No ozone depleting substances (ODS) listed under the Montreal Protocol are used in the manufacturing process of the Electronic Circuit Capacitor Division, Matsushita Electric Industrial Co., Ltd.
4. Design and specifications are subject to change without notice.

■When placing an order or making an inquiry, please specify the following :

1. Working voltage : DC, AC
2. Capacitance value
3. Capacitance tolerance
4. Finished product:color tv, stereo, switching power supply, lighting fixture, etc.
5. Application or circuit diagram; noise suppression, resonance, etc.
6. Operating condition : pulse, frequency, waveform, current, etc.
7. Operating temperature
8. Dimensions : body, leadspacing, etc.
9. Shape : enclosure (dip, case, etc.), lead wire (straight, crimped, taping, etc.)
10. Safety : There is an affect on other components and circuit operation of the device when the capacitor becomes short-circuited or open.
    There is an affect on the capacitor, when other components in the circuit work irregularly.
11. Others :

※Product specifications, materials and other points mentioned in the catalog are subject to change without notification.

■Cautions about Safety in Use

1. Operating voltage ⚠ Caution!

For film capacitors, the maximum applicable voltage varies depending on the applied voltage waveform, current waveform, frequency, ambient temperature (capacitor surface temperature), capacitance value, etc. Use within the specified values by checking the voltage waveform, current waveform, and frequency applied to both ends of the capacitor prior to use. (In the case of high frequency, the permissible voltage varies with the type of the capacitor. For details please see the relevant specifications.)

1.1 Rated voltage

- The rated voltage refers to the maximum voltage that can be applied continuously within the rated operating temperature range. If used beyond the rating, it may induce insulation breakdown of the film and cause a short circuit.The product lifetime at the maximum rated condition depends on the type of capacitor.
- In a metallized capacitor which has a self-healing property, short circuits or other failures may not occur immediately after application of a voltage over the rated voltage. However, the insulation resistance is lowered and it may lead to smoke or fire, depending on the circuit conditions.
- Intereference suppresion capacitors shall not be used in high frequency circuits, because depending on circuit conditions, the capacitor may smoke or catch fire due to its self-heating property.
- The rated voltage of the capacitor for electronic appliance is usually indicated in the DC voltage except for special purposes.

If a DC rated capacitor is used in an AC circuit (except for interference suppression and for electric appliances), the maximum operating voltage is limited by heat generation or electric discharge.The maximum operating voltage converted to AC varies with each type. Please consult with us for detail.

*****Use within the voltage specified in the chart to the right (according to respective type).**

DC Rated Voltage	AC Maximum working voltage [Vrms (50, 60 Hz)					
	ECWU ECHU	ECQV	ECQB	ECQE	ECQP	ECQM
16V	12	-	-	-	-	-
50V	40	40	40	-	40	40
100V	63	63	63	63	63	63
200V	-	-	100	-	100	100
250V	-	-	-	150	-	-
400V	-	-	-	200	160	200
600V	-	-	-	-	-	250
630V	-	-	-	250	200	-
1000V	-	-	-	400	-	-
1250V	-	-	-	500	-	-

Note: This table cannot be used to convert AC rated voltage to DC rated voltage. Please contact us for information regarding conversion from AC to DC voltage.

capacitor itself has its own temperature rise,

1.2 Derating of rated voltage where operating temperature is high

In film capacitors, the usable upper limit temperature (the capacitor surface temperature) is determined by the type of dielectric (see table below).

In certain types (models) when used beyond the rated upper limit temperature (up to the usable upper limit temperature), it is necessary to derate the voltage and therefore when using beyond the rated upper limit temperature, be sure to lower the voltage and make sure the capacitor surface temperature is below the usable upper limit temperature. Other types (models) cannot be used beyond the rated upper limit temperature. When using at high frequency, however, since the capacitor itself has its own temperature rise, the following derating ratio cannot be applied.

- The polyester (PET) capacitor is relatively high in dissipation factor (tan δ), and when used at high frequency, the self-heating temperature rise increases. Limit the self-heating temperature rise to 10˚C or less, with the capacitor surface temperature not exceeding the rated upper limit temperature.

Rated upper limit temperature : Upper limit temperature usable continuously at DC rated voltage, including capacitor's own self-heating temperature rise value.

Usable upper limit temperature : Upper limit temperature usable continuously by derating of DC rated voltage, including capacitor's own self-heating temperature rise value.

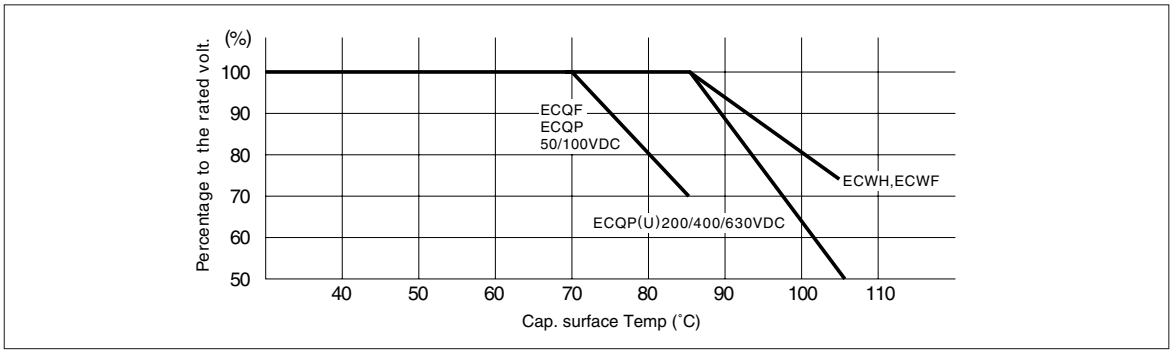
Usable upper limit voltage: Upper limit voltage usable continuously at upper limit temperature.

<Rated upper limit temperature, usable upper limit temperature, and derating ratio of usable upper limit temperture by types in DC use> (Example)

Dielectric	Type	Rated upper limit temperature	Usable upper limit temperature	Usable upper limit voltage
Polyester	ECQE (F)	85˚C	105˚C	Rated Volt.×75%
Polypropylene	ECQF, ECQP	70˚C	85˚C	Rated Volt.×70%
	ECQP (U)	85˚C	105˚C	Rated Volt.×50%
PPS	ECHS	125˚C	125˚C	Rated Volt.
Polyester/Polypropylene	ECQK	85˚C	85˚C	Rated Volt.

• Derating of rated voltage to operating temperature

Polypropylene capacitors (ECQP type, ECQF type, etc.), require derating the voltage as shown below depending on the operating temperature to compensate for dissipation of the dielectric.



1.3 Derating of rated voltage to capacitance value

Generally, in film capacitors, as the capacitance value is increased, the withstand voltage performance is decreased. For polypropylene capacitors (ECQP and ECQF series) with capacitance values of 0.1µF and greater, please use the following rated voltages:

Cap.value (μF)	Rated volt.				
	50VDC	100VDC	200VDC	400VDC	630VDC
0.11–0.12	49V	98V	195V	390V	615V
0.13–0.15	47V	95V	190V	380V	600V
0.16–0.18	46V	93V	185V	370V	585V
0.20–0.22	45V	90V	180V	360V	570V
0.24–0.27	44V	88V	175V	350V	——
0.30–0.33	42V	85V	170V	340V	——
0.36–0.39	41V	83V	165V	320V	——
0.43–0.47	40V	80V	160V	300V	——

1.4 Derating of rated voltage when using at high frequency

When using at high frequency, there is a risk of thermal runaway (smoke, fire) due to self heat generation in the capacitor. Derate the rated voltage according to the example below.

NOTE:

For use at high frequency, we recommend ECHU, ECHS, ECQP, ECQF, ECWF, and ECWH types.

EXAMPLE:

<Derating example of rated voltage>

Capacitor used : ECWF2224JS (250VDC, 0.22μF)

Operating frequency : 30kHz (sine wave)

Permissible current (entry value by specification) : 30kHz, 2.7Arms

Usable upper limit voltage : 60Hz, 150Vrms,
30kHz, 65Vrms

$$V = \frac{I}{2\pi fC} = \frac{2.7}{2\times 3.14\times 30\times 10^{3}\times 0.22\times 10^{-6}} = 65\text{Vrms}$$

Therefore, the rated voltage at sine wave 30 kHz is lowered to 65 V rms (derating ratio 57%), as compared with AC rated voltage of 150Vrms at commercial frequency.

(It is necessary to derate until the self heating temperature rise of the capacitor is below the specified value.)

Notes

(1) Use the peak value (Vo-p) of the Pulse voltage applied to both ends of the capacitor within the DC rated voltage.

(2) When using at high frequencies, self-heat generation may cause withstand voltage deterioration which could lead to breakdown. Therefore, measure the self-heating temperature rise value of the capacitor, and make sure it is within the specified limit.

(3) Protective circuits for safety should be used in your design in case a voltage over the rated voltage (permissible voltage) may be applied to the capacitor due to abnormal action such as trouble elsewhere in the circuit.

2. Permissible current ⚠ Caution!

Film capacitors hav low internal impedance, and therefore a very large current may flow depending on the circuit. In particular, when turning the power switch on and off, a very high pulse current may flow.

When a current exceeding the permissible range flows into capacitor, it can cause the capacitance value to deteriorate or an open circuit condition. Additionally, a temperature rise occurs due to self heat generation, which can cause deterioration of withstand voltage and result in a short circuit possibly leading to smoke or fire.

In an application, make sure current is within the permissible current or self-heating temperature is within permissible self-heating temperature rise limit.

2.1 Permissible current

The permissible current must be considered by dividing into pulse current (peak current) and continuous current (rms current) depending on the breakdown mode. Therefore, make sure both currents are within the permissible values.

2.2 Permissible current and operating frequency

For film capacitors, the dissipation factor (tan δ) vs. frequency varies depending on dielectric material, therefore the permissible rms current for a given operating frequency differs depending on the capacitor type. In particular, when operating at high frequency, the dissipation factor (tan δ) increases, and when using over the permissible current, it may trigger thermal runaway, possibly leading to smoke or fire.

Shown below are typical examples of permissible current vs. frequency (rms value) of the ECQE(F) type using polyester film and ECWF type using polypropylene film.

For details, contact us and provide the operating conditions, or make sure the temperature rise of the capacitor and the capacitor surface temperature are within the permissible range under the worst operating conditions.

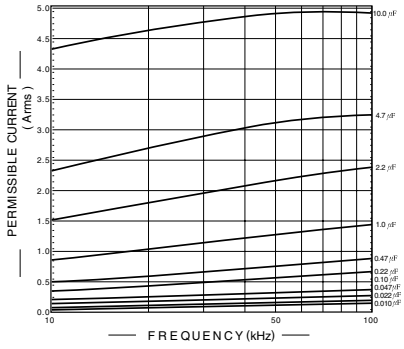
2.3 Capacitance value and permissible current

The permissible rms current varies with the capacitance value. The permissible current (rms) varies by frequency and by capacitance as shown below for the representative types. Ask us for details for your specific application by measuring the voltage and current waveforms, ambient temperature, and temperature rise.

Type : **ECQE(F)(Polyester)**

Rated voltage : 250VDC⇨150Vrms 60Hz (at sine wave)

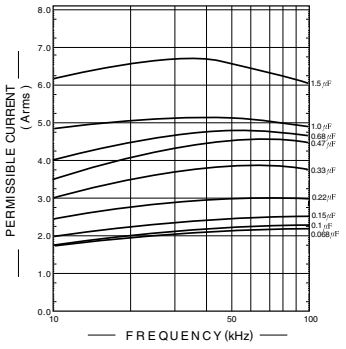
Operating temperature range : −40 to 85℃ (Capacitor surface)



Type : **ECWF2(S)(Polypropylene)**

Rated voltage : 250VDC⇨150Vrms 60Hz (at sine wave)

Operating temperature range : −40 to 85℃(Capacitor surface)



(Note)
The graphs illustrated are for reference only. Waveform of current and temperature rise of capacitor are key factors to determine permissible current. For actual application, consult our sales representative or sales office.

2.4 Permissible current to pulse current

- When used in switching circuits or snubber circuits a momentary high current pulse may cause local heat generation which may dissipate the evaporated film, causing the capacitance value to deteriorate or an open circuit condition.
  Local heat generation may also induce smoke or fire.
  The permissible pulse current (10000 times) is obtained by the product of dV/dt (V/μs) and the capacitance (μF) as shown in the specification.
- The dV/dt (V/μs) value of a film capacitor is determined by the element structure, and in the metallized type, in particular, the internal evaporated electrode and external takeout electrode are connected by a metallized contact (metal spraying), and hence due caution is needed because the upper limit of dV/dt value is low.
- The dV/dt values corresponding to rated voltage and capacitance value of representative types are shown. When used in a high current pulse circuit check the permissible pulse current (Ao-p).
- Please consult us, if pulses are applied more than 10,000 times.

<How to determine permissible pulse current>

- When voltage V(V) is applied to capacitor C (F for farad), the electric charge Q(C) is expressed as formula ①.
  Q=C·V ·····①
- The charging current I(A)flow in the capacitor is expressed as formula ②.
  I=dQ/dt ·····②
- Differentiating both sides of formula ① by time t and putting into formula ② yields formula ③.
  dQ/dt=C·dV/dt
  I=C·dV/dt ·····③

Therefore, the pulse current is determined as the product of the capacitance value C (μF) and voltage change dV/dt per μs.

(Example) In the case of ECQE4224KF permissible dV/dt value
Rated voltage : 400VDC,
Capacitance : 0.22μF,
permissible dV/dt value : 37
pulse permissible current : 0.22 (μF)×37≈8 Ao-p
(however, number of repetitions is 10,000 times or less), that is, momentary pulse current can be used up to 8 Ao-p.
Make sure the rms current is within the permissible value.

[ECQE (F) Permissible dV/dt value <within 10,000pulses>]

Unit : V/μs

(Cap. : μF)	Type			
	ECQE (F) 100VDC	ECQE (F) 250VDC	ECQE (F) 400VDC	ECQE (F) 630VDC
103 (0.01)	82 *(5.0P)	48 *(7.5P)	131 *(7.5P)	273 *(10.0P)
123 (0.012)				
153 (0.015)				
183 (0.018)				
223 (0.022)				
273 (0.027)				
333 (0.033)				
393 (0.039)			78 *(10.0P)	116 *(15.0P)
473 (0.047)				
563 (0.056)				
683 (0.068)				
823 (0.082)				
104 (0.1)				
124 (0.12)	30 *(7.5P)	33 *(10.0P)	37 *(15.0P)	63 *(22.5P)
154 (0.15)				
184 (0.18)				
224 (0.22)				
274 (0.27)				
334 (0.33)				
394 (0.39)				
474 (0.47)				
564 (0.56)	22 *(10.0P)	18 *(15.0P)	22 *(22.5P)	48 *(27.5P)
684 (0.68)				
824 (0.82)				
105 (1.0)				
125 (1.2)	11 *(15.0P)	10 *(22.5P)	18 *(27.5P)	
155 (1.5)				
185 (1.8)				
225 (2.2)				
275 (2.7)				
335 (3.3)				
395 (3.9)	6 *(22.5P)	8 *(27.5P)		
475 (4.7)				
565 (5.6)				
685 (6.8)				
825 (8.2)				
106 (10.0)				

⚠ Caution!
Protective circuits for safety should be used in your design in case the pulse and rms current may exceed the permissible values due to abnormal action such as trouble elsewhere in the circuit.

* Asterisk denotes the lead pitch.
· The value of dV/dt is mainly determined by the lead spacing (element width) and element sectional area.

3. Operating temperature ⚠ Caution!

3.1 Self-heating temperature rise

When the film capacitor is used in an AC circuit, especially in high frequency applications, the capacitor generates heat by itself from the flowing current. If the self-heat generation is large, the capacitor may deteriorate, and smoke or fire may result. Check the self-heating temperature rise value in actual conditions of use, and use within the limit specified.

Measure the self-heating temperature rise value in an indoor, wind-free condition.

* The details of self heating temperature rise value are described in the specification. (Please contact us for details as the specified value varies by each type.)

3.3 Operating temperature range

The operating temperature range of a film capacitor varies with the dielectric material (type of film), and the usable temperature range is specified for each model.

It must be noted, however, that the temperature range mentioned in the catalog is the surface temperature of the film capacitor, not the ambient temperature of the capacitor.

In actual use, make sure the sum of the ambient temperature +capacitor's self heating temperature rise value (within specified value), that is, the capacitor surface temperature, is within the rated operating temperature range.

⚠ Caution!

When used above the rated operating temperature range, dissipation factor (tan δ) increases, and the self-heat generation may exceed the permissible value, possibly causing deterioration of dielectric film, short circuit, and smoke or fire.

If there is a cooling plate of another part or any resistance heated to high temperature near the film capacitor, the capacitor may be locally heated by the radiation heat, exceeding the operating temperature range, and smoke or fire may result.

Check the capacitor surface temperature at the heat source side.

4. Other cautions

4.1 Capacitor for prevention of AC power supply (across the line) noise

When using a capacitor across-the-line as a means for the prevention of noise, not only is the supply voltage always applied, but also abnormal surges such as lightning, which may lead to smoke or fire. Therefore, the across-the-line capacitors are strictly regulated in the safety standards of each country, and it is necessary to use the product conforming to the standards.

<Representative examples of models authorized in major safety standards in the world>

Shape	Type	Standard
Resin coating type	ECQUY	UL, CSA, and standards in Europe
Plastic case type	ECQUL	UL, CSA, and standards in Europe
〃	ECQUG	UL, CSA, and standards in Europe
〃	ECQUV	UL, CSA, and standards in Europe

When using across-the-line in Japan, use the following models or the above overseas authorized models.

ECQE 1000VDC (125VAC) rating
ECQE 1250VDC (125VAC) rating
ECQE 125VAC (1A) rating
ECQE 250VAC (2A) rating

However, when using the ECQE (1A), (2A) rating model as across-the-line capacitor, at least one of the following conditions must be satisfied.

1. A varistor with the varistor voltage not more than the value shown in the table below should be connected in parallel with the capacitor.
2. A pulse voltage more than the value shown in the table below should not be applied across the capacitor.

(Note) When using together with a varistor, check the varistor specification, and select a value free from surge deterioration.

Cap.Rated Voltage	Varistor Voltage	Pulse Voltage
125VAC (1A)	250V	250Vo-p
250VAC (2A)	470V	630Vo-p

<Reference> · Safety standards of overseas.

Organization (country)	Standard
UL (USA)	UL 1414 UL 1283
CSA (Canada)	CSA C22.2 No.0, No.1
VDE (Germany)	IEC384-14 2nd. Ed.
FIMKO (Finland)	IEC384-14 2nd. Ed.
SEMKO (Sweden)	IEC384-14 2nd. Ed.
NEMKO (Norway)	IEC384-14 2nd. Ed.
DEMKO (Denmark)	IEC384-14 2nd. Ed.
SEV (Switzerland)	IEC384-14 2nd. Ed.

4.2 Flame retardation

- The dielectric film is not a flame retardant material.
- In the ECQE type polyester capacitor, although a flame retardant epoxy resin (94V-O) is used in the coating resin, the flame retardation (UL 1414 flame test) is not guaranteed (satisfied) at DC 630V or less because of the conditions of the capacitor main body shape, resin thickness, etc.

<Flame retardation guaranteed models>

- ECQE 1000V rating or more
- ECWH
- Safety agency approved products (Interference Suppressor)

4.3 Environments of use

4.3.1 When used in humid environments

When used for a long period in humid environments, the elements absorb moisture through the coating with the passing of time. Water is low in insulation resistance, and oxidizes the electrode (evaporated film and metallized contact), and leads to trouble.Also, make sure the capacitance value can be very large depending on type of capacitor.

4.3.2 When used in high temperature environment

When ECQUV, ECQUT, ECQUY and ECQUG are used in high temperature environment (more than 70˚C), it may be possible for oil to leak from the capacitor. However, the quality and reliability of the capacitor is not affected by the leaking oil.

4.3.3 Cautions for using in a gaseous atmosphere

When used in an oxidizing gas such as hydrogen chloride, hydrogen sulfide and sulfurous acid, the evaporated film (A1) or metallized contact (zinc compound) may be oxidized, which may result in smoke or fire. Avoid such an atmosphere.

4.3.4 When using a resin coating

Contact us when using resin coating or resin potting components to improve humidity resistance or gas resistance, or to fix parts in place.

- The solvent contained in the resin may permeate into the metallized contact or electrode (aluminum foil or evaporated film) and deteriorate the characteristics.
- When curing the resin, chemical reaction heat (curing heat generation) occurs, which may adversely affect the capacitor.

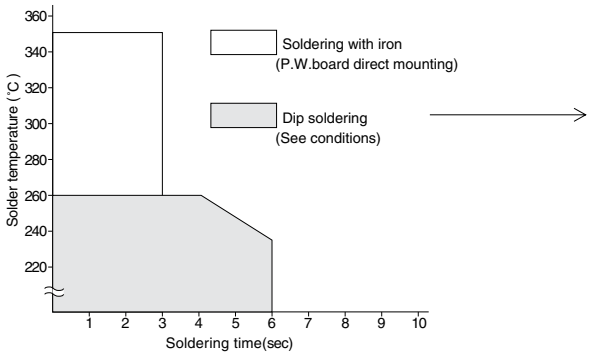
■Cautions for Mounting

1. Soldering of lead type

The heat resisting temperature of the film capacitor varies with the type of dielectric film, structure of the capacitor, manufacturing method, etc.
When mounting, set the mounting temperature so that the capacitor's inside (element) temperature is lower than the mounting heat resisting temperature given below.
(Measure the type ECQV with 0.1μF or less.)

Dielectric	Type	Mounting heat resisting temperature
Polypropylene	ECQP	110˚C
〃	ECQF	110˚C
〃	ECWF	110˚C
〃	ECWH	110˚C
Polyester	ECQV(Z)	130˚C
〃	ECQV(L)	160˚C
〃	ECQV(M)	160˚C
〃	ECQB	160˚C
〃	ECQE	160˚C
PPS	ECHS	170˚C

- Solder within the following temperature condition range.
(Dipping is within twice, the second dip should be carried after the capacitor itself has returned to normal temperature.)



Conditions

P.W. Board	Through holes both sides t=0.8 or more
Pre-heating	110˚C 1 minute
Capacitor	Raised from P.W.board (processed products)

● Polyprolylene capacitor have a lower mounting heat resisting temperature (110℃) than other polyester and PPS capacitors, and hence the following cautions are needed.

1) In the case of ECQP type, if directly mounted on the printed wiring board, the element internal temperature may exceed 110℃ due to heat from the lead wire, and hence a lead forming type should be used.

2) Avoid passing through an adhesive curing oven in order to cure the resin used for fixing the leaded parts in combination with chip parts. (Otherwise, if the mounting heat resisting temperature is exceeded, the dielectric film will suffer heat shrinkage which induces short-circuiting.)
When combining with chip parts, after curing the adhesive, insert film capacitor and solder.

● Avoid reflow soldering by combining the lead type with chip parts. (Otherwise excessive heat beyond the mounting heat resisting temperature may be applied, leading to breakage of coating resin or deterioration of the capacitor's characteristics.) Also, please consult with us if passing the capacitor through an adhesive curing oven, which may possibly cause damage to the coating resin.

● When using in multilayer Printed wiring board, or in the case of a capacitor with a copper lead wire, please contact us. (In the case of copper lead wire, the thermal conductivity of the copper wire is high, and the internal temperature of the capacitor rises rapidly and may exceed the mounting heat resisting temperature.)

2. Soldering of chip type

The chip type film capacitor is available in two types, ECWU(X),ECWU(C),ECHU(X) exclusively for reflow soldering and ECHU(C) for both flow and reflow soldering. Although there are specific restrictive conditions for the chip type film capacitor, please check and consider the following items in order to guarantee soldering quality.Please contact us when using adhesive for mounting because there is a possibility this type of adhesive affects the characteristics and the reliability of the capacitor.

2.1 Printed wiring board

2.1.1 Selection of printed wiring board

The chip parts are directly mounted on the printed wiring board without using lead wires, and therefore thermal expansion of the printed wiring board may affect the characteristics of the film chip capacitor, and hence the following cautions should be observed.

<Remarks for selecting the printed wiring board>

Item	Point of notice
Coefficient of thermal expansion of printed wiring board	If there is a large difference in coefficient of thermal expansion between the capacitor and Printed wiring board, a mechanical stress is applied due to temperature changes after mounting and the element's main body may change, the soldered area may crack, and the performance may decrease. Check sufficiently beforehand. *In particular, contact us if you are using ceramic Printed wiring boards.

Type of Printed wiring board / Item	Chip film capacitor		Resin Printed wiring board			Ceramic Printed wiring board
	ECHU (PPS film)	ECWU (PEN film)	Paper phenol	Paper epoxy	Glass epoxy	Alumina
Coefficient of thermal expansion ($\times 10^{-6}$/℃)	22	10	1~30	1~15	1~25	7~8

2.1.2 Parts layout on Printed wiring board

Film chip capacitors, unlike the leaded type film capacitors do not have a coating.
Radiated heat from nearby heated components may cause the temperature to exceed the usable temperature range.

● Without coating, if there is an exposed live part in the vicinity, a short circuit may form through the capacitor. Consider the arrangement.

2.1.3 Land dimension design

If the land area is wide, tombstone phenomenon (chip rising) is likely to occur in relation to the solder amount.
It is disadvantageous to maintain the mounting clearance of the mounting machine, but it is advised to design-in the recommended land dimension shown on chip specification page.

2.2 Flow soldering

2.2.1 Flow soldering conditions

In flow soldering, the chip capacitor is soaked in molten solder, and only the ECHU(C) type using heat resistant PPS film can be used.
The ECWU type using PEN film cannot be used in flow soldering.

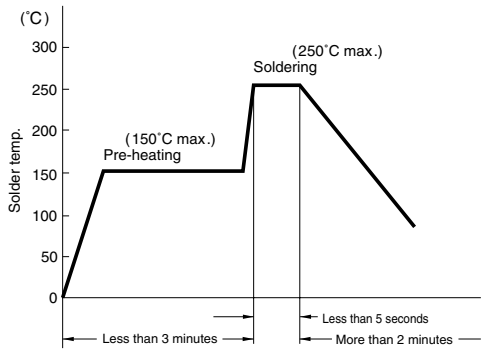
2.2.2 Cautions for flow soldering

- The film chip capacitor has no coating on the capacitor element, and the capacitor internal electrode may deteriorate due to activating agents (halogen, etc.) in the flux, and the capacitance value may decrease or the characteristics may deteriorate.
  Use flux with halogen content of 0.1wt.% or less.

- When washing right after soldering, make sure the capacitor surface temperature is lower than 60℃.

ECHU(C) Flow soldering conditions

(Dip no more than twice, the second dip should be carried out after the capacitor itself has returned to normal temperature.)

Method	Recommendable condition	Note
Flow soldering		Flow soldering is applicable to only ECHU(C) type.

2.3 Reflow soldering

Reflow soldering is a method of soldering by printing a proper amount of cream solder on the mounting land of the surface mount Printed Wiring Board, putting a film chip capacitor thereon, heating, and fusing the cream solder to fix the capacitor to the board.

2.3.1 Reflow soldering conditions

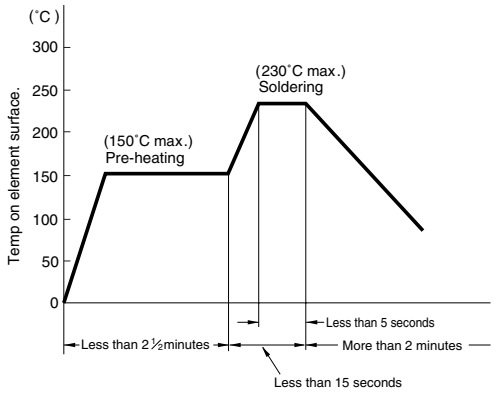
Perform reflow soldering within the following temperature profile.

※ When performing reflow soldering, an appropriate coating thickness of cream solder is 0.10 to 0.15 mm.

2.3.2 Cautions for reflow soldering

- The film chip capacitor has no coating on the capacitor element, and the internal evaporated electrode may deteriorate due to activating agents (halogen, etc.) in the cream solder, and the capacitance value may decrease, dissipation factor (tan δ) may increase, or the characteristics may deteriorate.
  Use cream solder with halogen content of 0.1 wt.% or less.

(Dip no more than twice, the second dip should be carried out after the capacitor itself has returned to normal temperature.)

Method	Recommendable condition	Note
Reflow soldering		External temperature of P. W. B. will be different according to P. W. B. materials and soldering method. For temperature measuring we recommend glass epoxy P. W. B. (115mm×50mm. 0.8t) as standard.

❊When performing reflow soldering, an appropriate coating thickness of cream solder is 0.10 to 0.15 mm.

- When washing right after soldering, make sure the capacitor surface temperature is lower than 60℃.
- The maximum temperature reached on the element surface in reflow is as follows. If a higher temperature is applied, an abnormality may result with the appearance or electrical characteristics.

Type	Max. temperature on element surface
ECHU	260℃
ECWU	230℃ or 240℃

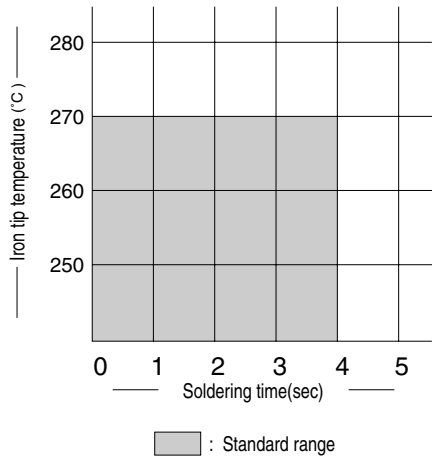
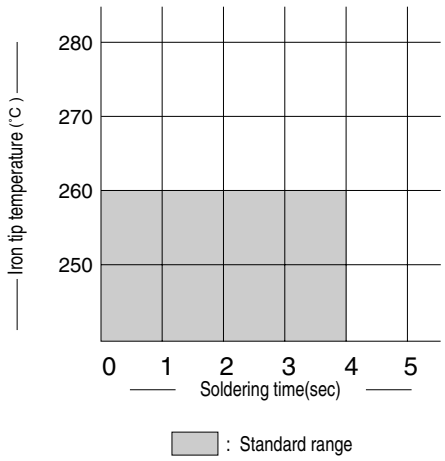
If exceeding the specified temperature, it must be noted that the reliability of the part cannot be guaranteed. The maximum temperature allowed on the element surface of ECWU is fixed at the specification.

2.4 When using soldering iron

With a soldering iron, high temperature is directly applied to the film chip capacitor. Abide by the following soldering iron conditions, and strictly control the iron tip temperature.

2.4.1 Soldering conditions when using soldering iron

Observe the following cautions, and use within the soldering conditions below.

	ECHU	ECWU
	270℃max.−4s max.	260℃max.−4s max.
Conditions for use of soldering iron		
	Soldering iron capacity : 30W	

2.4.2 Cautions for use of soldering iron

●Be careful that the soldering iron does not directly touch the main body of the chip film capacitor. In particular, don't touch the side (cut section). If touched by the heated soldering iron, lowering of insulation resistance, shortcircuit or other characteristic deterioration may occur.

●Preheat the printed wining board land sufficiently with the soldering iron, and then solder. Solder without directly touching the iron tip to the electrode of the capacitor.

●Don't reuse the product (part) once removed by the soldering iron.

●Avoid mass mounting of chip film capacitors by soldering iron. (Temperature control is difficult, and the characteristics may deteriorate.)

●Please do not resolder with heat directly from bottom side of P. C. B. because capacitor will likely be damaged.

3. Washing

<Usable detergent and washing method>

(Usable detergent)

Classification	Detergent name	Maker
Alcohol derivative	IPA (isopropyl alcohol)	(Reagent for general industrial use)
Halogenated hydrocarbon	AK-225AES	Asahi Glass Co.

(Washing method)

Condition / Item	Temperature	Time
Immersion washing	50℃	Within 5 minutes
Steam washing	50℃	Within 5 minutes
Ultrasonic washing	50℃	Within 5 minutes

<CFC substitute detergent>

As a result of regulation of CFC and chlorine derivative detergents, many substitute detergents are being used. The performance of the chip type capacitor may decrease depending on the type of detergent or washing condition. Check sufficiently beforehand. Consult us in advance if planning to use CFC substitute detergent.

<Drying after washing>

Dry after washing so that no detergent is left over. If drying is insufficient, and the detergent is left over on the element surface, the insulation resistance will be reduced. Dry just enough so as not to leave detergent.

3.1. Washing of chip type

●Since the chip type capacitor does not have a coating, components of flux or detergent left over on the element at the time of washing may be activated and invade the inside of the capacitor, and adverse effects may result. Observe the following cautions.

●In the case of washing, use flux and cream solder with halogen content of 0.1wt.% or less when mounting.

●In the case of ultrasonic washing, note that peeling of the protective film, electrode separation due to resonance, or characteristics deterioration may occur depending on the detergent used or ultrasonic output. Check carefully beforehand.

●When using a CFC substitute detergent, with the washing method of spraying detergent (rinsing water) to the substrate at high pressure, the protective film on the element surface may peel off due to the water pressure. Check carefully beforehand.

3.2. Washing of leaded type

The effect of washing on the film capacitor varies significantly depending on the structure and material. Generally it is less affected by CFC or alcohol derivative washing solvents, but is likely to be affected by highly polarized solvents.

The lead type film capacitor is coated with an epoxy resin that has excellent chemical resistance, and is hardly affected by detergent, but it is recommended that it be washed only for a short duration.

Applicability of detergents in film capacitors is listed for reference.

<List of applicability of detergents>

Washing condition			Chip type	Lead type	Box type ECQUV
Solvent	Alcohol	Ethanol Ultrasonic washing or immersion washing for 5 min	○	○	○
		Isopropyl alcohol (IPA) Ultrasonic washing or immersion washing for 5 min	○	○	○
	Silicon	FRW-17 Ultrasonic washing for 5 min, 60℃ →FRW-1N Ultrasonic washing for 5 min, 60℃ →FRW-100 Steam drying for 1 min, 100℃	○	○	○
	Halogen	Asahi Clean AK-225AES Ultrasonic washing or immersion washing for 5 min	○	○	×
		HCFC141b-MS Ultrasonic washing or immersion washing for 5 min	○	○	×
	Petroleum hydrocarbon	P3 Cold Cleaner 225S Ultrasonic washing for 5 min, 60℃ → IPA ultrasonic rinsing for 5 min at ordinary temperature → hot air drying for 5 min, 40℃	○	○	○
		Toluene Ultrasonic washing or immersion washing for 5 min	×	○	×
	Terpene	Terpene Cleaner EC-7 Spray washing for 5 min at ordinary temperature → purified water spraying for 5 min, 50℃ → hot air drying for 5 min, 80℃	×	○	○
Water	Purified water	Ultrasonic washing for 5 min 60℃ → wind-free drying for 5 min, 85℃	※ △	○	○
	Surface active agent	Clean Through 750H Ultrasonic washing for 5 min, 60℃ → purified water ultrasonic washing for 5 min, 60℃ → hot air drying for 5 min, 85℃	×	○	×
		Clean Through 750L Ultrasonic washing for 5 min, 60℃ → purified water ultrasonic washing for 5 min, 60℃ → hot air drying for 5 min, 85℃	×	○	–
		Clean Through 710M Ultrasonic washing for 5 min, 60℃ → purified water ultrasonic washing for 5 min, 60℃ → hot air drying for 5 min, 85℃	×	○	–
		Clean Through LC-841 Ultrasonic washing for 5 min, 60℃ → purified water ultrasonic washing for 5 min, 60℃ → hot air drying for 5 min, 85℃	×	○	○
		Ultrasonic washing for 5 min, 60℃ → purified water ultrasonic washing for 5 min, 60℃ → hot air drying for 5 min, 85℃	×	○	○
		Shower washing for 1 min, 60℃ → purified water ultrasonic washing for 5 min, 60℃ → hot air drying for 5 min, 85℃	×	○	○
○ Washing enabled × Washing disabled △ Washing enabled conditionally – Not confirmed					

<Wash-free flux>

Wash-free	Low residue flux	ULF-500VS	○	○	○
	Inactivated flux	AM-173	○	○	○

※ (Note) Insulation resistance is lowered by invasion of water. However it is usable by drying for 4 hours at 125℃.

● Washing disabled (x mark) detergent should be avoided because the appearance may be impaired, the characteristic may be deteriorated, and the reliability cannot be guaranteed.

4. Temperature measuring in soldering of film capacitor

When using film capacitors of low heat resisting temperature in mounting or chip type, measure the element temperature profile in mounting in the following manner, and make sure the soldering is done below the heat resisting temperature.

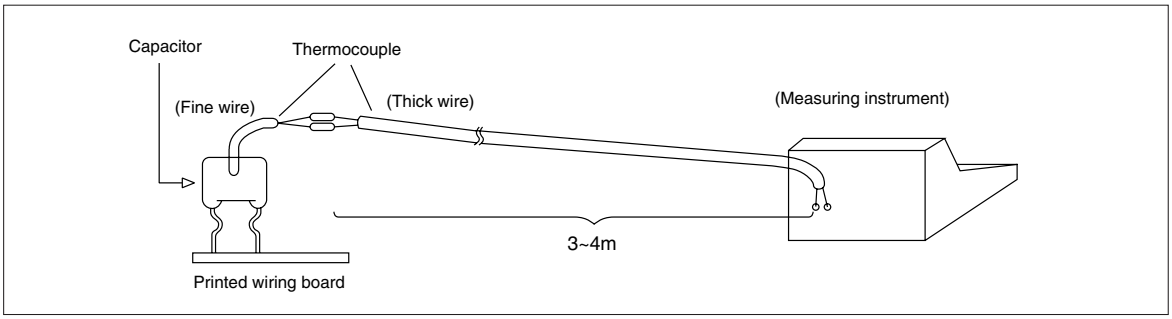
4.1 Lead type

<Preparation of measuring sample>

Open a hole of about ø0.3 to 0.8mm in the top of the capacitor to the middle of the element, and insert thermocouple (ø0.1T wire), and fix with adhesive.

<Measurement of temperature profile>

As shown below, connect a thermocouple (3 to 4m) of same type as the thermocouple attached to the capacitor, to the thermocouple of the capacitor as shown below. Mount the sample on the mounting printed wiring board, and pass into the soldering and mounting process, and measure the temperature profile.



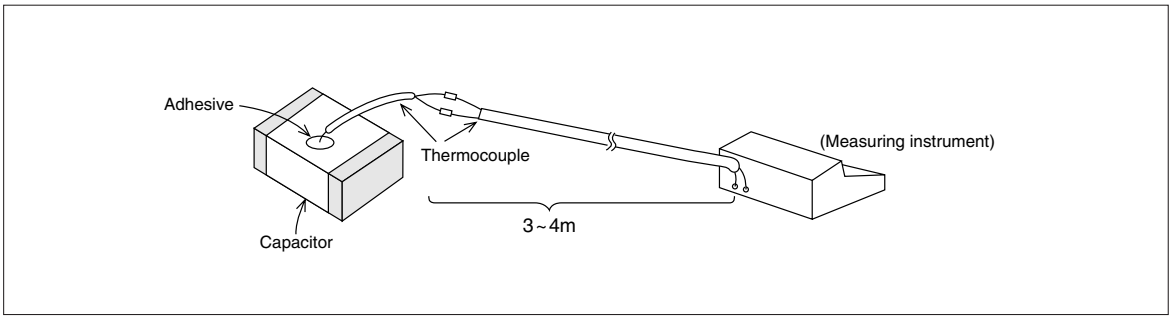
4.2. Chip type

<Preparation of measuring sample>

Fix thermocouple (ø0.1T wire) to the top of the capacitor with adhesive.

<Measurement of temperature profile>

As shown below, connect a thermocouple (3 to 4m) of same type as the thermocouple to the capacitor, to the thermocouple of the capacitor as shown below. Mount the sample on the mounting printer wiring boad, and pass into the soldering and mounting process, and measure the temperature profile.



■Other Cautions

1. Changes in capacitance value over time

●The capacitor characteristics change depending on its ambient conditions and environmental conditions. In natural conditions, there is a certain capacitance change due to permeation of humidity in the air. The degree of such capacitance changes varies with the dielectric material, coating material, and structure. Therefore, we ship considering these changes, but we only guarantee capacitance value until delivery (without other arrangements.)

●For use in a circuit where time constant and capacitance precision are required, use the products of polypropylene film (ECQP, ECQF types) or pps film(ECHS,ECHU types) which vary less with time.

2. Hum (Buzz)

●Hum produced by capacitors due to mechanical vibration of the film is caused by the coulomb force which exists between electrodes of opposite polarity. A louder hum is produced when the applied voltage waveform has distortion, and/or a higher frequency component, etc., although hum does not spoil characteristics of capacitors.

3. Storing method, storing conditions

3.1 It must be noted that the solderability of the external electrode may deteriorate when stored in an atmosphere filled with moisture, dust, or a reactive oxidizing gas (hydrogen chloride, hydrogen sulfide, sulfuric acid).

3.2 Avoid location with particularly high temperature and high humidity, and store in conditions not exceeding 35℃ and 85% RH.

4. Operating Environment

4.1 Prolonged exposure to, moisture may deteriorate the capacitors performance by lowering its insulation resistance and/or oxidizing the metallized film element.

4.2 The capacitor should not be used under the following conditions:

a) in the presence of hydrogen chloride, hydrogen sulfide, sufuric acid, ammonia, etc.

b) direct or indirect exposure to water, frost formation oils or sunlight

c) exposure to ozone, radioactive or ultraviolet rays.

The conditions mentioned above deteriorate the overall performance of the capacitor.

4.3 The capacitor shall be used in a dust free environment. The presence of dust on the capacitor may cause electrical leakage.

5. Handling Precautions

5.1 Sudden charging or discharging may cause deterioration of the capacitor such as shorting and opening due to charging or discharging current. When charging or discharging, pass through a resistance of 20 to 1000Ω/V or more.

5.2 When connecting multiple film capacitors in parallel for withstand voltage test or life test, connect a resistance of 20 to 1000Ω/V or more in series to each capacitor.

5.3 Be careful not to scratch the capacitor surface with sharp edges (such as screwdriver, soldering iron, pincers, chassis). Don't apply excessive load to the lead wire (at the time of re-processing of lead wire, etc.).

5.4 If the capacitor is dropped by accident, its characteristics may be damaged. Don't use it in such a case. (If reusing, check the quality sufficiently.)

5.5 In the case of leaded type capacitor, be careful not to apply excessive force to the lead wire root area, which may cause cracking or separation in the coating resin near the root area.

5.6. Dust or water should not be permitted to remain on the surface of capacitor terminals as this may cause electrical leakage or corrosion.

5.7. When used for noise suppression between lines and between line to earth when voltage is more than 30VAC and more than 45VDC, covering peripheral components with a flame retardant material or flame retardant case (for avoiding fire) is recommended.

5.8. Chip type capacitor is developed assuming normal use of surface mounting parts. Abnormal use (ex: piling up two capacitors, mounting capacitor in upright position, etc.) should not be permitted. Please consult us in advance if using in a way different from normal.

6. Additional Points

- Product specifications, materials and other points mentioned in the catalog may change without notice.
- For further information regarding usage please contact:

Engineering section
Electronic Circuit Capacitor Division
Matsushita Electric Industrial Co., Ltd.
369,Nogi-Fukutomi,Matsue,C.,Shimane.690-8527
Japan
Tel : (81) 852--32-3219 Fax : (81) 852-25-5180

■ Points to be noted when ordering

When placing an order, please specify the following:

1. Working voltage
2. Capacitance value
3. Capacitance tolerance
4. Application products: fluorescent lamp, mercury lamp, motor, electromagnetic cooker, microwave oven, etc.
5. Capacitor function; resonance, motor running, power factor correction etc.
6. Condition of operation: pulse, frequency, wave-form, current.
7. Operating temperature.
8. Dimensions: body size, lead-space, etc.
9. Shape: enclosure (dip, case, etc.), terminal (lead wire, fast-on terminal,etc.)
10. Safety: Infuence on other components when the capacitor gets short-circuited or opens. Influence on capacitor when other components or the circuit work irregularly.
11. Others:

※ Product specifications, materials and other items mentioned in the catalog may change without notification.

■ General Precautions

For correct usage, please note the following points

1. Rated voltage

The rated voltage of capacitors for electrical equipment is usually specified as AC, except special types.

1) Selection of rated voltage

In addition to the normally operated terminal voltage, it is necessary to pay attention to rated frequency, load fluctuation and voltage change caused by a connection with other electrical parts.

Typical Rated Voltage (AC)
125V,180V,200V,220V,240V,250V,290V,430V,480V

2) Permissible overvoltage

Permissible continuous overvoltage, including changes in the source voltage, is less than 110% of the rated voltage. If supply voltage fluctuation exceeds + 10%, the rated voltage should be raised.

2. Permissible overcurrent

Permissible overcurrent caused by high frequency, permissible overvoltage etc.is less than 130% of the rated current ($2\pi \times$rated frequency$\times$rated capacitance$\times$rated voltage$\times 10^{-6}$).

3. Permissible VA

Less than 135% of the rated VA (rated voltage$\times$ rated current).

4. Operating temperature range

1) Maximum Permissible Temperature

Capacitors should be used within the maximum permissible temperature.

(The temperature defined by the highest capacitor surface temperature, i.e. the sum of the inherent temperature rise and the ambient temperature). The ambient temperature upper limit value according to the conditions such as heat transmission and radiation from nearby heat-generating sources or little air convection.

Maximum Permissible Temperature
60℃, 70℃

2) Minimum permissible temperature

The minimum permissible temperature is −25℃. Capacitors should be used at ambient temperature above this figure.

5.Hum (Buzz)

Hum produced by capacitor is due to mechanical vibration of the film caused by the coulomb force between electrodes of opposite polarity. A louder hum may be produced when applied voltage wave has distortion and or higher frequency.

However, hum does not spoil characteristics of capacitors.

6.Voltage applied duration shows guidelines for a rational design appropriate to the operating duration of the equipment.

When using capacitors, please select proper types of capacitors which are suitable for your applications.

	Life time classification
Motor use	25,000
Discharge lamp use	40,000

Please consult with us about the use other than the above life time classification.

- Short duration designing is available for capacitors used for 30 minutes at a time or for 1 hour in a day. Please contact with usage conditions for engineering assistance.

7.Other points to be noted

1) In case capacitors are used at frequencies other than the rated frequencies (50/60 Hz), please contact our engineering section.

Even within the rated voltage and current ranges, appropriate precautions are necessary if steep voltage rises or high frequencies are applied.

2) When capacitors are fixed by screws, please note the following.
   a) Tighten the screws with a torque of less than 2N•m.
   b) Use M4 truss screws with washers.
   c) On burring process, care should be taken to keep the correct tap-hole angle, and not to have a foreign matter intrusion and flash under the fastening terminal of the capacitor.
3) No dust or water should be permitted to remain on the surface of capacitor terminals as this may cause electrical leakage or corrosion.

For complete engineering assisstance to insure achieving optimum performance of the capacitors in your particular application, please contact to the following :

Engineering section
Electronic Circuit Capacitor Division
Matsushita Electric Industrial Co.,Ltd.
369,Nogi-Fukutomi,Matsue,C.,Shimane.690-8527
Japan
Tel : (81) 852--32-3219 Fax : (81) 852-25-5180

1. What are capacitors with a safety mechanism

Capacitors for electrical equipment are widely used for power factor correction in discharge lamp ballasts, and for motor running in home electrical equiment. Althought it is rare for capacitors to emit smoke or to catch fire in such equipment, accidents do occasionally occur, and the requirement to maintain safety up to the end of a capacitor's life is of great importance.

Customarily, in order to maintain safety, the equipment itself has been provided with some form of safety device, or capacitors in the equipment have been fitted with built-in safety devices such as the pressure type, current fuse type, thermal type, etc.

However, these capacitors with built-in safety devices have a complicated structure and are expensive, and bulky. For this reason, there has been a strong demand for the development of a capacitor which has high safety and reliabitity as well as a simple structure.

We have first developed a capacitor with a safety mechanism in which the conventional winding type capacitor element itself maintains the safety mechanism.

If any defect occurs in the capacitor, only the defect site is isolated from the source, thus preventing capacitors from accidents such as smoke emission and catching fire.

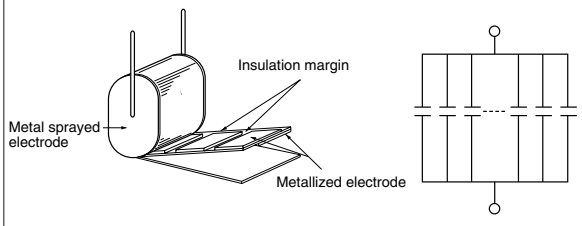
2. Structure and operation (working) principles of capacitors with a safety mechanism.

The capacitor basically has a conventional winding structure, however it has unique segmented metallized electrodes, which form a parallel connection of many small-capacitance capacitors referred as to capacitor units here.

If a dielectric breakdown should occur in this capacitor owing to overvoltage, etc., only the fault capacitor unit is disconnected, thus preventing the whole capacitor from being burnt out (smoke emission, catching fire).

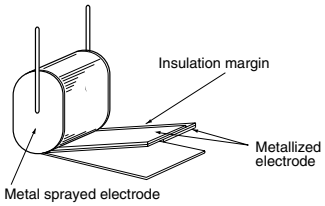
In this case, the normal function of the capacitor will be kept with only a slight reduction of capacitance. Since the basic structure consists of the conventional winding structure, this capacitor shows the compatibility with customary capacitors and the same excellent features and quality as the conventional capacitors for electrical equipment.

Structure of element with a safety mechanism and equivalent circuit	Structure of conventional element and equivalent circuit



(Element structure)

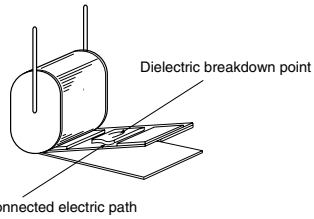
(Equivalent circuit)



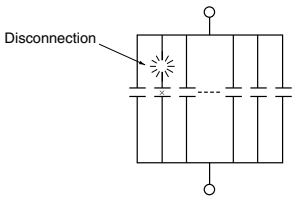
(Element structure)

(Equivalent circuit)

Protective action in capacitor with a safety mechanism and equivalent circuit



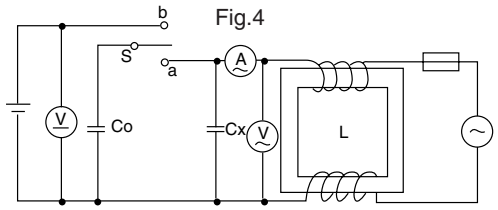
(Element structure)



(Equivalent circuit)

3. Safety Test Procedure and Mechanism

Fig.4



: direct current power source
: alternating current power source
: direct current voltmeter
: alternating current voltmeter
S : change-over switch
: alternating current ammmeter
Co : discharging capacitor
L : choke coil
Cx : capacitor
: fuse

In carrying out the safety test of capacitor with safety mechanism, the capacitor shall be put in the thermostatic oven which is able to maintain control at the highest ambient temperature, and after the capacitor has reached that temperature, the test shall be conducted with the circuit on Fig.4 using the following procedure.

(1) Switch S shall be at open position and the capacitor Cx shall be applied with alternating current voltage of 1.3 times the rated voltage.

(2)Then, S shall be put in the position "b" and the discharging capacitor Co shall be applied with the direct voltage of, at maximum, 7 times the rated voltage and the maximum capacitance of Co shall be twice of Cx.

(3) After Co has reached the specified value of direct voltage, S shall be put in the position "a" and the charge of Co shall be discharged through Cx which is applied with a voltage of 1.3 times of the rated voltage.

(4)After discharge, S shall be put back in position "b" and the procedures described above shall be repeated. During this time, discharge shall be repeated every 15 sec.

(5)The ammeter A shall record the value of the current and when the current corresponding to Cx has become about zero, the test shall be ended.

4. Example of Capacitor Current Decrease due to Protective Action