SAMXON®

SAMXON BRAND ALUMINUM ELECTROLYTIC CAPACITORS

PRODUCT SPECIFICATION
規格書

CUSTOMER : **(客戶) :**	**DATE :** **(日期) :**

CATEGORY (品名) : ALUMINUM ELECTROLYTIC CAPACITORS

DESCRIPTION (型号) : GT SERIES

VERSION (版本) : 01

Customer P/N :

SUPPLIER :

SUPPLIER		CUSTOMER	
PREPARED （拟定）	**CHECKED （审核）**	**APPROVAL （批准）**	**SIGNATURE （签名）**
毛彩林	刘渭清		

SPECIFICATION					ALTERNATION HISTORY RECORDS		
GT SERIES							
Rev.	Date	Mark	Page	Contents	Purpose	Drafter	Approver

C O N T E N T S

1. Application

This specification applies to polar aluminum electrolytic capacitor (foil type) used in electronic equipment. Designed capacitor's quality meets IEC60384.

2. Part Number System

E GT 477 M 1A F 12 TC □□ □

E GT 477 M 1A F 12 TC □□ P

- P — Sleeve Material (2.7)
- TC — Type (2.3)
- 12 — Case Length (2.6)
- F — Diameter (2.5)
- 1A — Voltage (2.2)
- M — Tolerance (2.4)
- 477 — Capacitance (2.1)
- GT — Series
- E — E-CAP

2.1 Capacitance code

Code	**474**	**475**	**476**	**477**	**478**	**479**
Capacitance (μF)	0.47	4.7	47	470	4700	47000

2.2 Rated voltage code

Code	**0J**	**1A**	**1C**	**1E**	**1V**	**1H**	**1J**	**2A**
Rate voltage (V.DC)	6.3	10	16	25	35	50	63	100

2.3 Type

Code	**RR**	**TU**	**TV**	**TC**	**TE**	**CE**	**HE**	**KD**	**FD**
Reference	Bulk	Taping Spec.				Forming Spec.			

2.4 Capacitance tolerance

"M" stands for -20% ~ +20%

2.5 Diameter

Code	**E**	**F**	**G**	**I**	**K**	**L**
Diameter	6.3	8	10	12.5	16	18

2.6 Length

"11" stands for 11mm "1B" stands for 12.5mm

"25" stands for 25mm "35" stands for 35mm

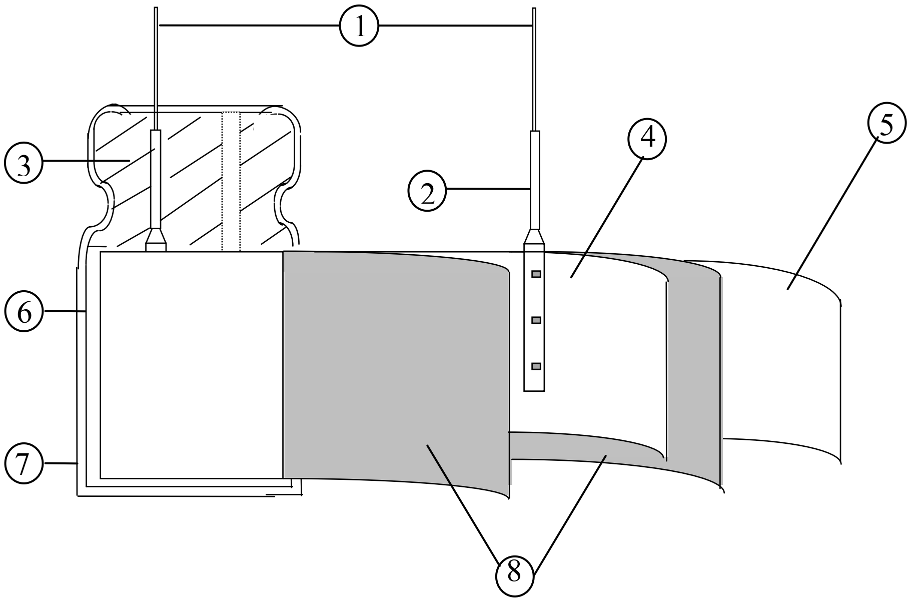
2.7 Sleeve material

Code	**P**	**Blank**
Sleeve material	PET	PVC

Remark: The " □ " in fifteenth and sixteenth digits is used for the product lines, and the " □ " in the seventeenth digit is used to indicate that the sleeve is the PVC material.

3.Construction

Single ended type to be produced to fix the terminals to anode and cathode foil, and wind together with paper, and then wound element to be impregnated with electrolyte will be enclosed in an aluminum case. Finally sealed up tightly with end seal rubber, then finished by putting on the vinyl sleeve.



No	Component	Material
1	Lead Line	Tinned CP wire (Pb Free)
2	Terminal	Aluminum wire
3	Rubber seal	Rubber
4	Al-Foil (+)	Formed aluminum foil
5	Al-Foil (-)	Etched aluminum foil or formed aluminum foil
6	Case	Aluminum case
7	Sleeve	PVC/PET
8	Separator	Electrolyte paper

4. Characteristics

Standard atmospheric conditions

Unless otherwise specified, the standard range of atmospheric conditions for making measurements and tests is as follows:

Ambient temperature	:15°C to 35°C
Relative humidity	: 45% to 85%
Air pressure	: 86kPa to 106kPa

If there is any doubt about the results, measurement shall be made within the following conditions:

Ambient temperature	: 20°C ± 2°C
Relative humidity	: 60% to 70%
Air pressure	: 86kPa to 106kPa

Operating temperature range

The ambient temperature range at which the capacitor can be operated continuously at rated voltage is -40°C to 105°C.

As to the detailed information, please refer to table 1.

Table 1

<table>
<tr><th colspan="2">ITEM</th><th>PERFORMANCE</th></tr>
<tr><td>4.1</td><td>Rated voltage (WV)

Surge voltage (SV)</td><td>
<table>
<tr><td>WV (V.DC)</td><td>6.3</td><td>10</td><td>16</td><td>25</td><td>35</td><td>50</td><td>63</td><td>100</td></tr>
<tr><td>SV (V.DC)</td><td>8</td><td>13</td><td>20</td><td>32</td><td>44</td><td>63</td><td>79</td><td>125</td></tr>
</table>
</td></tr>
<tr><td>4.2</td><td>Nominal capacitance (Tolerance)</td><td><Condition>
Measuring frequency : 120Hz±12Hz
Measuring voltage : Not more than 0.5Vrms
Measuring temperature : 20±2℃
<Criteria>
Shall be within the specified capacitance tolerance.</td></tr>
<tr><td>4.3</td><td>Leakage current</td><td><Condition>
Connecting the capacitor with a protective resistor (1kΩ±10Ω) in series for 2 minutes, and then, measure Leakage Current.
<Criteria>
I (μA)≤0.01CV or 3 (μA) whichever is greater.

I: Leakage current (μA)
C: Capacitance (μF)
V: Rated DC working voltage (V)</td></tr>
<tr><td>4.4</td><td>Tan δ</td><td><Condition>
See 4.2, Norm capacitance, for measuring frequency, voltage and temperature.
<Criteria>
<table>
<tr><td>Working voltage (v)</td><td>6.3</td><td>10</td><td>16</td><td>25</td><td>35</td><td>50</td><td>63</td><td>100</td></tr>
<tr><td>Tan δ (max.)</td><td>0.22</td><td>0.19</td><td>0.16</td><td>0.14</td><td>0.12</td><td>0.10</td><td>0.09</td><td>0.08</td></tr>
</table>
For capacitance value >1000μF, add 0.02 per another 1000μF.</td></tr>
<tr><td>4.5</td><td>Impedance</td><td><Condition>
Measuring frequency:100kHz; Measuring temperature:20±2℃
Measuring point: 2mm max from the surface of a sealing rubber on the lead wire.

<Criteria>
(20℃)Less than the initial limit(See page 14~17).</td></tr>
</table>

4.6	Terminal strength	**<Condition>** Tensile strength of terminals Fixed the capacitor, applied force to the terminal in lead out direction for 10±1 seconds. Bending strength of terminals. Fixed the capacitor, applied force to bent the terminal (1~4 mm from the rubber) for 90° within 2~3 seconds, and then bent it for 90° to its original position within 2~3 seconds.

Diameter of lead wire	Tensile force N (kgf)	Bending force N (kgf)
0.5mm and less	5 (0.51)	2.5 (0.25)
Over 0.5mm to 0.8mm	10 (1.0)	5 (0.51)

<Criteria>
No noticeable changes shall be found, no breakage or looseness at the terminal.

4.7 Temperature characteristics

<Condition>

STEP	Testing temperature(℃)	Time
1	20±2	Time to reach thermal equilibrium
2	-40 (-25) ±3	Time to reach thermal equilibrium
3	20±2	Time to reach thermal equilibrium
4	105±2	Time to reach thermal equilibrium
5	20±2	Time to reach thermal equilibrium

<Criteria>

a. At +105℃, capacitance measured at +20℃ shall be within ±20% of its original value.
Tan δ shall be within the limit of Item 4.4
The leakage current measured shall not more than 8 times of its specified value.

b. In step 5, Tan δ shall be within the limit of Item 4.4
The leakage current shall not more than the specified value.

4.7		c. At-40℃ (-25℃), impedance (Z) ratio shall not exceed the value of the following table. <table><tr><td>Working Voltage (V)</td><td>6.3</td><td>10</td><td>16</td><td>25</td><td>35</td><td>50</td><td>63</td><td>100</td></tr><tr><td>Z-25℃/Z+20℃</td><td>4</td><td>3</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td></tr><tr><td>Z-40℃/Z+20℃</td><td>8</td><td>6</td><td>4</td><td>3</td><td>3</td><td>3</td><td>3</td><td>3</td></tr></table>Capacitance, Tan δ , and impedance shall be measured at 120Hz.
4.8	Load life test	**<Condition>** According to IEC60384-4No.4.13 methods, The capacitor is stored at a temperature of 105 ±2 °C with DC bias voltage plus the rated ripple current for 6.3~10WV: 4000+48/0(Φ 5~ Φ 6.3) hours,6000 +48/0(Φ 8~ Φ 10) hours,8000+48/0(Φ 12.5) hours; 16~100WV: 5000 +48/0(Φ 5~ Φ 6.3) hours,7000 +48/0(Φ 8~ Φ 10) hours,10000 +48/0(Φ 12.5)hours. (The sum of DC and ripple peak voltage shall not exceed the rated working voltage) Then the product should be tested after 16 hours recovering time at atmospheric conditions. The result should meet the following table: **<Criteria>** The characteristic shall meet the following requirements. <table><tr><td>Leakage current</td><td>Value in 4.3 shall be satisfied</td></tr><tr><td>Capacitance Change</td><td>Within ±25% of initial value.</td></tr><tr><td>Tan δ</td><td>Not more than 200%of the specified value.</td></tr><tr><td>Appearance</td><td>There shall be no leakage of electrolyte.</td></tr></table>
4.9	Shelf life test	**<Condition>** The capacitors are then stored with no voltage applied at a temperature of 105±2 ℃ for 1000+48/0 hours. Following this period the capacitors shall be removed from the test chamber and be allowed to stabilized at room temperature for 4~8 hours. Next they shall be connected to a series limiting resistor(1k±100Ω) with D.C. rated voltage applied for 30min. After which the capacitors shall be discharged, and then, tested the characteristics. **<Criteria>** The characteristic shall meet the following requirements. <table><tr><td>Leakage current</td><td>Value in 4.3 shall be satisfied</td></tr><tr><td>Capacitance Change</td><td>Within ±25% of initial value.</td></tr><tr><td>Tan δ</td><td>Not more than 200%of the specified value.</td></tr><tr><td>Appearance</td><td>There shall be no leakage of electrolyte.</td></tr></table>Remark: If the capacitors are stored more than 1 year, the leakage current may increase. Please apply voltage through about 1 kΩ resistor, if necessary.

4.10 Surge test

<Condition>

Applied a surge voltage to the capacitor connected with a (100 ±50)/C_R (kΩ) resistor.

The capacitor shall be submitted to 1000 cycles, each consisting of charge of 30 ±5s, followed discharge of 5 min 30s.

The test temperature shall be 15~35℃.

C_R :Nominal Capacitance (μ F)

<Criteria>

Leakage current	Not more than the specified value.
Capacitance Change	Within ±15% of initial value.
tan δ	Not more than the specified value.
Appearance	There shall be no leakage of electrolyte.

Attention:

This test simulates over voltage at abnormal situation only. It is not applicable to such over voltage as often applied.

4.11 Vibration test

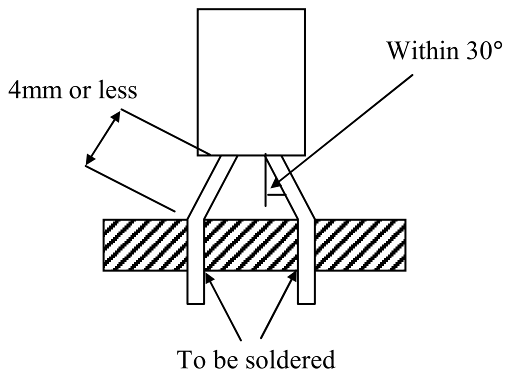
<Condition>

The following conditions shall be applied for 2 hours in each 3 mutually perpendicular directions.

Vibration frequency range : 10Hz ~ 55Hz
Peak to peak amplitude : 1.5mm
Sweep rate : 10Hz ~ 55Hz ~ 10Hz in about 1 minute

Mounting method:

The capacitor with diameter greater than 12.5mm or longer than 25mm must be fixed in place with a bracket.



<table>
<tr><td></td><td></td><td>

<Criteria>

After the test, the following items shall be tested:

Inner construction	No intermittent contacts, open or short circuiting. No damage of tab terminals or electrodes.
Appearance	No mechanical damage in terminal. No leakage of electrolyte or swelling of the case. The markings shall be legible.

</td></tr>
<tr><td>4.12</td><td>Solderability test</td><td>

<Condition>

The capacitor shall be tested under the following conditions:

Soldering temperature : 245±3°C
Dipping depth : 2mm
Dipping speed : 25±2.5mm/s
Dipping time : 3±0.5s

<Criteria>

Coating quality	A minimum of 95% of the surface being immersed

</td></tr>
<tr><td>4.13</td><td>Resistance to solder heat test</td><td>

<Condition>

Terminals of the capacitor shall be immersed into solder bath at 260±5℃ for 10±1 seconds or 400±10℃ for 3^{+1}_{-0} seconds to 1.5~2.0mm from the body of capacitor.

Then the capacitor shall be left under the normal temperature and normal humidity for 1~2 hours before measurement.

<Criteria>

Leakage current	Not more than the specified value.
Capacitance Change	Within ±10% of initial value.
Tan δ	Not more than the specified value.
Appearance	There shall be no leakage of electrolyte.

</td></tr>
</table>

4.14	Change of temperature test	**<Condition>** Temperature Cycle: According to IEC60384-4No.4.7 methods, capacitor shall be placed in an oven, the condition according as below: <table><tr><th>Temperature</th><th>Time</th></tr><tr><td>(1)+20℃</td><td>≦3 Minutes</td></tr><tr><td>(2)Rated low temperature (-40℃) (-25℃)</td><td>30±2 Minutes</td></tr><tr><td>(3)Rated high temperature (+105℃)</td><td>30±2 Minutes</td></tr><tr><td colspan="2">(1) to (3)=1 cycle, total 5 cycle</td></tr></table> **<Criteria>** The characteristic shall meet the following requirement. <table><tr><td>Leakage current</td><td>Not more than the specified value.</td></tr><tr><td>Tan δ</td><td>Not more than the specified value.</td></tr><tr><td>Appearance</td><td>There shall be no leakage of electrolyte.</td></tr></table>
4.15	Damp heat test	**<Condition>** Humidity Test: According to IEC60384-4No.4.12methods, capacitor shall be exposed for 500 ±8 hours in an atmosphere of 90~95%R H. at 40±2℃, the characteristic change shall meet the following requirement. **<Criteria>** <table><tr><td>Leakage current</td><td>Not more than the specified value.</td></tr><tr><td>Capacitance Change</td><td>Within ±20% of initial value.</td></tr><tr><td>Tan δ</td><td>Not more than 120% of the specified value.</td></tr><tr><td>Appearance</td><td>There shall be no leakage of electrolyte.</td></tr></table>

4.16	Vent test	**<Condition>** The following test only apply to those products with vent products at diameter ≥Ø6.3 with vent. D.C. test The capacitor is connected with its polarity reversed to a DC power source. Then a current selected from Table 2 is applied. <Table 2> Diameter (mm): 22.4 or less — DC Current (A): 1 **<Criteria>** The vent shall operate with no dangerous conditions such as flames or dispersion of pieces of the capacitor and/or case.
4.17	Maximum permissible (ripple current, temperature coefficient)	**<Condition>** The maximum permissible ripple current is the maximum A.C current at 100kHz and can be applied at maximum operating temperature Table-3 The combined value of D.C voltage and the peak A.C voltage shall not exceed the rated voltage and shall not reverse voltage.

<Table 2>

Diameter (mm)	DC Current (A)
22.4 or less	1

Frequency Multipliers:

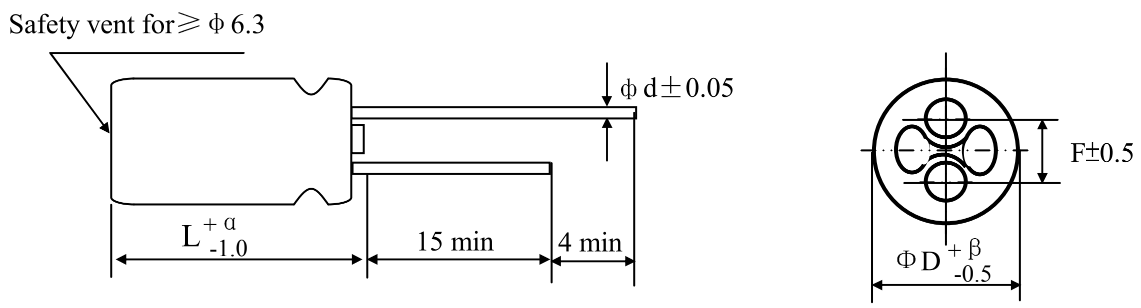
Coefficient / Freq. (Hz) / Cap. (μF)	50	120	300	1k	100k
15~33	0.45	0.55	0.70	0.90	1.00
39~330	0.60	0.70	0.85	0.95	1.00
390~1000	0.65	0.75	0.90	0.98	1.00
1200~3900	0.75	0.80	0.95	1.00	1.00

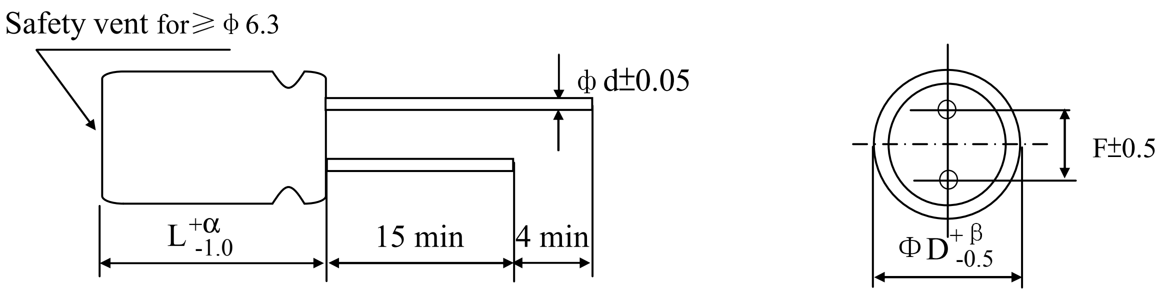
Temperature Coefficient:

Temperature (°C)	85	95	105
Factor	1.73	1.41	1.00

5. Product Dimensions, Impedance & Maximum Permissible Ripple Current

Unit: mm





ΦD	6.3	8	10	12.5
F	2.5	3.5	5.0	5.0
Φd	0.5	L<20:0.5, L⩾20:0.6	0.6	
α	L<20 : α=1.5; L⩾20 : α=2.0			
β	D＜20 : β =0.5; D⩾20 : β =1.0			

Table-3

Voltage (Code)		6.3V(0J)			10V(1A)		
Cap. (μF)	Code	Case size ΦD×L(mm)	Impedance (Ω)	Ripple Current (mA rms)	Case size ΦD×L(mm)	Impedance (Ω)	Ripple Current (mA rms)
220	227				6.3x11	0.220	340
330	337	6.3x11	0.220	340			
470	477				8x12	0.130	640
680	687	8x12	0.130	640	8x16	0.087	840
					10x12.5	0.080	865
820	827	10x12.5	0.080	865			
1000	108	8x16	0.087	840	⚠8x16	0.087	840
					8x20	0.069	1050
					10x16	0.060	1210
1200	128	8x20	0.069	1050	10x20	0.046	1400
		10x16	0.060	1210			
1500	158	10x20	0.046	1400	10x25	0.042	1650
2200	228	10x25	0.042	1650	10x30	0.031	1910
					12.5x20	0.035	1900
2700	278	10x30	0.031	1910			
3300	338	12.5x20	0.035	1900	12.5x25	0.030	2124
3900	398	12.5x25	0.030	2124			

Maximum Allowable Ripple Current (mA rms) at 105℃100kHz Case Size ΦDxL(mm)

Maximum Impedance(Ω) at 20℃100kHz

Voltage (Code)		16V(1C)			25V(1E)		
Cap. (µF)	Code	Case size ΦD×L(mm)	Impedance (Ω)	Ripple Current (mA rms)	Case size ΦD×L(mm)	Impedance (Ω)	Ripple Current (mA rms)
100	107				6.3x11	0.220	340
120	127	6.3x11	0.220	340			
150	157						
220	227				8x12	0.130	640
330	337	8x12	0.130	640	8x16	0.087	840
					10x12.5	0.080	865
470	477	8x16	0.087	840	8x20	0.069	1050
		10x12.5	0.080	865	10x16	0.060	1210
680	687	8x20	0.069	1050	10x20	0.046	1400
		10x16	0.060	1210			
820	827				10x25	0.042	1650
1000	108	10x20	0.046	1400	⚠10x20	0.046	1400
					10x30	0.031	1910
					12.5x20	0.035	1900
1200	128	10x25	0.042	1650			
1500	158	10x30	0.031	1910	12.5x25	0.030	2124
		12.5x20	0.035	1900			
2200	228	12.5x25	0.030	2124			

Maximum Allowable Ripple Current (mA rms) at 105℃100kHz　　Case Size ΦDxL(mm)

Maximum Impedance(Ω) at 20℃100kHz

Voltage (Code)		35V(1V)			50V(1H)		
Cap. (μF)	Code	Case size ΦD×L(mm)	Impedance (Ω)	Ripple Current (mA rms)	Case size ΦD×L(mm)	Impedance (Ω)	Ripple Current (mA rms)
56	566	6.3x11	0.220	340	6.3x11	0.300	295
100	107				8x12	0.170	555
120	127				8x16	0.120	730
150	157	8x12	0.130	640	10x12.5	0.120	760
220	227	8x16	0.087	840	10x16	0.084	1050
		10x12.5	0.080	865			
330	337	10x16	0.060	1210	10x25	0.055	1440
470	477	10x20	0.046	1400	10x30	0.043	1690
					12.5x20	0.045	1660
560	567	10x25	0.042	1650	12.5x25	0.034	1950
680	687	10x30	0.031	1910			
		12.5x20	0.035	1900			
1000	108	12.5x25	0.030	2124			

Maximum Allowable Ripple Current (mA rms) at 105℃100kHz　　Case Size ΦDxL(mm)

Maximum Impedance(Ω) at 20℃100kHz

Voltage (Code)		63V(1J)			100V(2A)		
Cap. (μF)	Code	Case size ΦD×L(mm)	Impedance (Ω)	Ripple Current (mA rms)	Case size ΦD×L(mm)	Impedance (Ω)	Ripple Current (mA rms)
15	156				6.3x11	0.960	115
27	276				8x12	0.504	232
33	336	6.3x11	0.960	115			
39	396				8x16	0.360	300
47	476				10x12.5	0.344	314
56	566	8x12	0.504	232	8x20	0.264	362
68	686				10x16	0.248	357
82	826	8x16	0.360	300	10x20	0.168	466
		10x12.5	0.344	314			
100	107				10x25	0.160	531
120	127	8x20	0.264	362	10x30	0.120	663
		10x16	0.248	357	12.5x20	0.128	690
180	187	10x20	0.168	466	12.5x25	0.096	922
220	227	10x25	0.160	531			
270	277	10x30	0.120	663			
		12.5x20	0.128	690			
330	337	12.5x25	0.096	922			

Maximum Allowable Ripple Current (mA rms) at 105℃100kHz　　Case Size ΦDxL(mm)

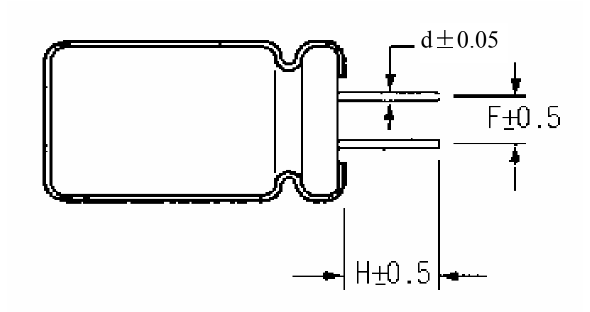
Maximum Impedance(Ω) at 20℃100kHz

6. Forming Dimension

Unit: mm

Shape Code	φ D	φ 5	φ 6.3	φ 8	φ 10	φ 12.5	φ 16	φ 18
CE	F	2.0	2.5	3.5	5.0	5.0	7.5	7.5
	H	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	d	0.5	0.5	0.5/0.6	0.6	0.6	0.8	0.8
HE	F	5.0	5.0	5.0	-----	-----	-----	-----
	H	5.0	5.0	5.0	-----	-----	-----	-----
	d	0.5	0.5	0.5/0.6	-----	-----	-----	-----
FD	F	5.0	5.0	5.0	-----	-----	-----	-----
	H1	4.5	4.5	4.5	-----	-----	-----	-----
	H2	2.0	2.0	2.0	-----	-----	-----	-----
	d	0.5	0.5	0.5/0.6	-----	-----	-----	-----
KD	F	-----	-----	-----	5.0	5.0	7.5	7.5
	H1	-----	-----	-----	4.5	4.5	4.5	4.5
	H2	-----	-----	-----	2.0	2.0	2.0	2.0
	d	-----	-----	-----	0.6	0.6	0.8	0.8

CE Type



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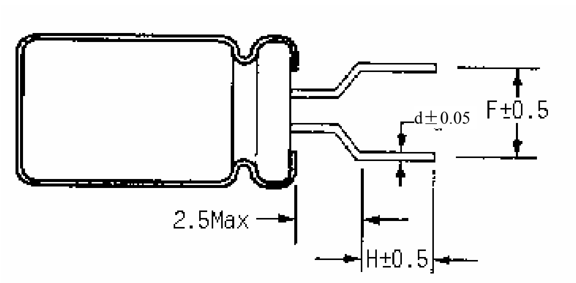
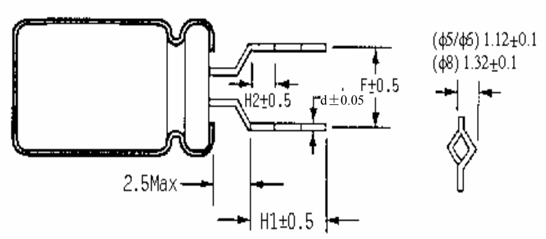
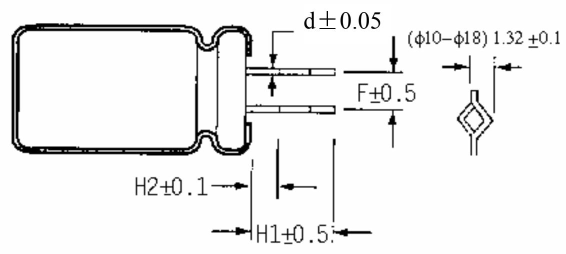


FD Type

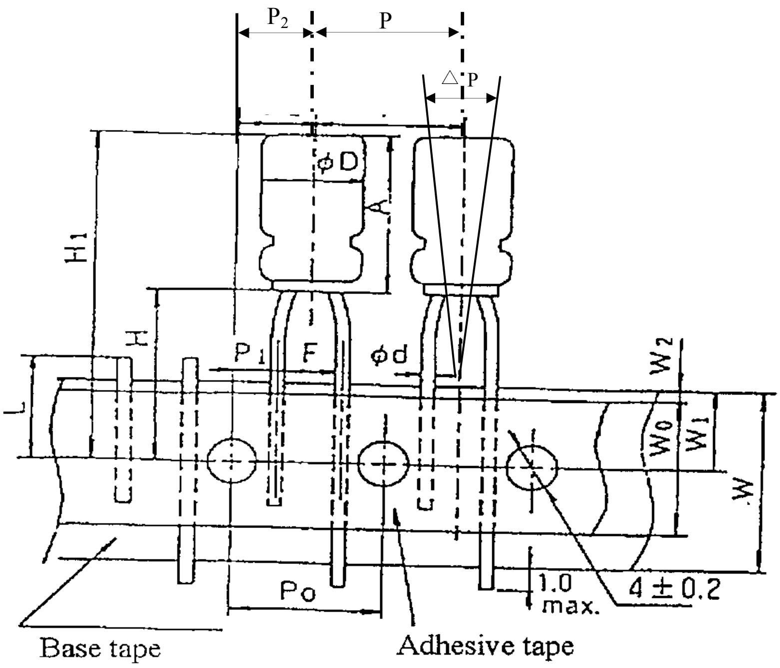


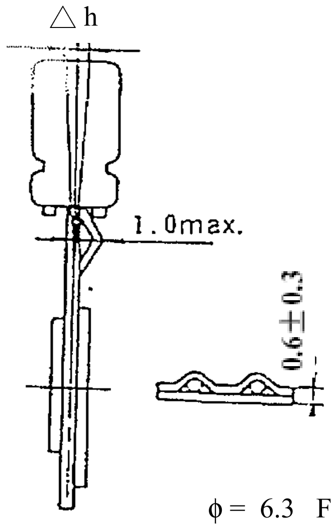
KD Type



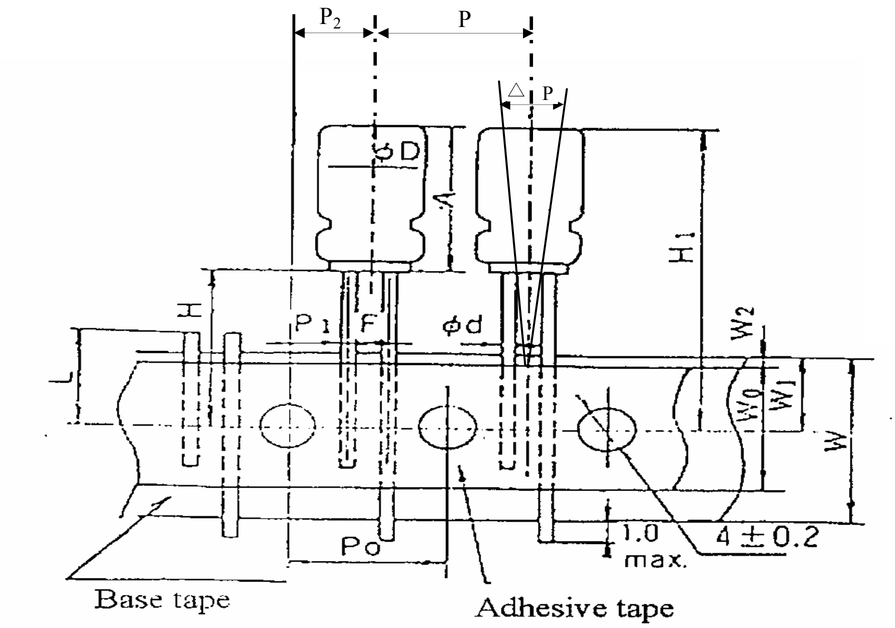
7.Taping Specification

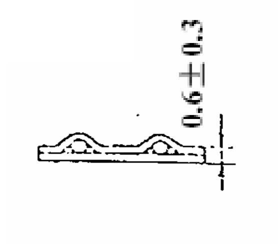
Φ = 5
F=2.5
TU Type Taping





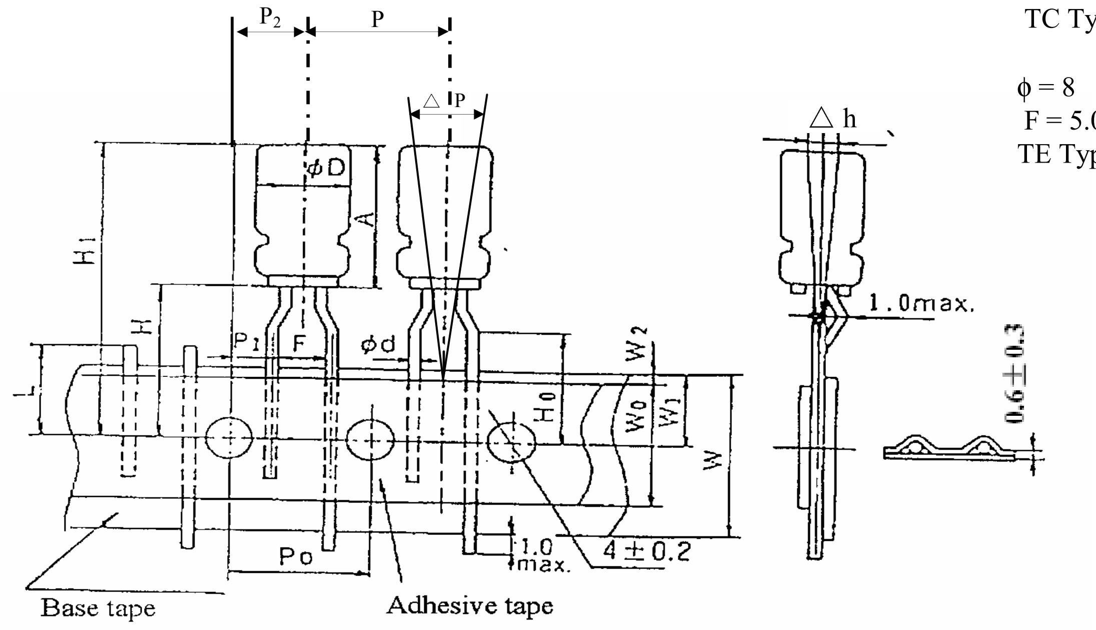
ϕ = 6.3 F = 2.5
TU Type Taping
ϕ = 8 F = 3.5
TV Type Taping
ϕ = 10~12.5 F = 5.0
TC Type Taping





φ = 5 ~ 8
F = 5.0
TC Type Taping

φ = 8
F = 5.0
TE Type Taping



Remark: Maximum Taping Dimension: 18mm Diameter Unit: mm

Item \ Code		TU		TV	TC				TE
Diameter	D	5	6.3	8	5 / 6.3	8	10	12.5	8
Height	A	9~15	9~15	10~20	9~15	10~20	9~30	15~35	10~20
Lead Diameter	d±0.05	0.5	0.5	0.5/0.6	0.5	0.5/0.6	0.6	0.6	0.5/0.6
Component Spacing	P±1.0	12.7	12.7	12.7	12.7	12.7	12.7	15	12.7
Pitch of sprocket holes	P_0±0.2	12.7	12.7	12.7	12.7	12.7	12.7	15	12.7
Distance between centers of terminal	P_1±0.5	5.1	5.1	4.6	3.85	3.85	3.85	5.0	3.85
Feed hole center to component center	P_2±1.0	6.35						7.5	6.35
Distance between centers of component leads	$F^{+0.8}_{-0.2}$	2.5	2.5	3.5	5.0	5.0	5.0	5.0	5.0
Carrier tape width	$W^{+1}_{-0.5}$	18	18	18	18	18	18	18	18
Hold down tape width	W_0	7min						15min	7min
Distance between the center of upper edge of carrier tape and sprocket hole	W_1±0.5	9	9	9	9	9	9	9	9
Distance between the upper edges of the carrier tape and the hold down tape	W_2	3max							
Distance between the abscissa and the bottom of the components body	$H^{+0.75}_{-0.5}$	18.5	18.5	18.5	18.5	20.0	18.5	18.5	18.5
Distance between the abscissa and the reference plane of the components with crimped leads	H_0±0.5	----	-----	-----	16	16	-----	-----	16
Cut off position of defectives	L	11 max							
Max. lateral deviation of the component body vertical to the tape plane	△h	2 max							
Max. deviation of the component body in the tape plane	△P	1.3 max							

8. List of “Environment-related Substances to be Controlled (‘Controlled Substances’)”

The latest version of <Substances Prohibited as per Sony-SS-00259>

Substances	
Heavy metals	Cadmium and cadmium compounds
	Lead and lead compounds
	Mercury and mercury compounds
	Hexavalent chromium compounds
Chloinated organic compounds	Polychlorinated biphenyls (PCB) Polychlorinated naphthalenes (PCN) Polychlorinated terphenyls (PCT)
	Short-chain chlorinated paraffins(SCCP)
	Other chlorinated organic compounds
Brominated organic compounds	Polybrominated biphenyls (PBB)
	Polybrominated diphenylethers(PBDE) (including decabromodiphenyl ether[DecaBDE])
	Other brominated organic compounds
Tributyltin compounds(TBT) Triphenyltin compounds(TPT)	
Asbestos	
Specific azo compounds	
Formaldehyde	
Beryllium oxide	
Beryllium copper	
Specific phthalates (DEHP,DBP,BBP,DINP,DIDP,DNOP,DNHP)	
Hydrofluorocarbon (HFC), Perfluorocarbon (PFC)	
Perfluorooctane sulfonates (PFOS)	
Specific Benzotriazole	

Attachment: Application Guidelines

1.Circuit Design

1.1 Operating Temperature and Frequency

Electrolytic capacitor electrical parameters are normally specified at 20℃ temperature and 120Hz frequency. These parameters vary with changes in temperature and frequency. Circuit designers should take these changes into consideration.

(1) Effects of operating temperature on electrical parameters

a) At higher temperatures, leakage current and capacitance increase while equivalent series resistance (ESR) decreases.

b) At lower temperatures, leakage current and capacitance decrease while equivalent series resistance (ESR) increases.

(2) Effects of frequency on electrical parameters

a) At higher frequencies capacitance and impedance decrease while tan δ increases.

b) At lower frequencies, ripple current generated heat will rise due to an increase in equivalent series resistance (ESR).

1.2 Operating Temperature and Life Expectancy

See the file: Life calculation of aluminum electrolytic capacitor

1.3 Common Application Conditions to Avoid

The following misapplication load conditions will cause rapid deterioration to capacitor electrical parameters. In addition, rapid heating and gas generation within the capacitor can occur causing the pressure relief vent to operate and resultant leakage of electrolyte. Under Leaking electrolyte is combustible and electrically conductive.

(1) Reverse Voltage

DC capacitors have polarity. Verify correct polarity before insertion. For circuits with changing or uncertain polarity, use DC bipolar capacitors. DC bipolar capacitors are not suitable for use in AC circuits.

(2) Charge / Discharge Applications

Standard capacitors are not suitable for use in repeating charge / discharge applications. For charge / discharge applications consult us and advise actual conditions.

(3) Over voltage

Do not apply voltages exceeding the maximum specified rated voltage. Voltages up to the surge voltage rating are acceptable for short periods of time. Ensure that the sum of the DC voltage and the superimposed AC ripple voltage does not exceed the rated voltage.

(4) Ripple Current

Do not apply ripple currents exceeding the maximum specified value. For high ripple current applications, use a capacitor designed for high ripple currents or contact us with your requirements.

Ensure that allowable ripple currents superimposed on low DC bias voltages do not cause reverse voltage conditions.

1.4 Using Two or More Capacitors in Series or Parallel

(1) Capacitors Connected in Parallel

The circuit resistance can closely approximate the series resistance of the capacitor causing an imbalance of ripple current loads within the capacitors. Careful design of wiring methods can minimize the possibility of excessive ripple currents applied to a capacitor.

(2) Capacitors Connected in Series

Normal DC leakage current differences among capacitors can cause voltage imbalances. The use of voltage divider shunt resistors with consideration to leakage current can prevent capacitor voltage imbalances.

1.5 Capacitor Mounting Considerations

(1) Double Sided Circuit Boards

Avoid wiring pattern runs, which pass between the mounted capacitor and the circuit board.

When dipping into a solder bath, excess solder may collect under the capacitor by capillary action and short circuit the anode and cathode terminals.

(2)Circuit Board Hole Positioning

The vinyl sleeve of the capacitor can be damaged if solder passes through a lead hole for subsequently processed parts. Special care when locating hole positions in proximity to capacitors is recommended.

(3)Circuit Board Hole Spacing

The circuit board holes spacing should match the capacitor lead wire spacing within the specified tolerances. Incorrect spacing can cause excessive lead wire stress during the insertion process. This may result in premature capacitor failure due to short or open circuit, increased leakage current, or electrolyte leakage.

(4) Clearance for Case Mounted Pressure Relief vents

Capacitors with case mounted pressure relief vents require sufficient clearance to allow for proper vent operation. The minimum clearances are dependent on capacitor diameters as proper vent operation. The minimum clearances are dependent on capacitor diameters as follows.

Φ6.3~Φ16mm:2mm minimum, Φ18~Φ35mm:3mm minimum, Φ40mm or greater:5mm minimum.

(5) Clearance for Seal Mounted Pressure Relief Vents

A hole in the circuit board directly under the seal vent location is required to allow proper release of pressure.

(6) Wiring Near the Pressure Relief Vent

Avoid locating high voltage or high current wiring or circuit board paths above the pressure relief vent. Flammable, high temperature gas exceeding 100℃ may be released which could dissolve the wire insulation and ignite.

(7) Circuit Board patterns Under the Capacitor

Avoid circuit board runs under the capacitor as electrolyte leakage could cause an electrical short.

(8) Screw Terminal Capacitor Mounting

Do not orient the capacitor with the screw terminal side of the capacitor facing downwards.

Tighten the terminal and mounting bracket screws within the torque range specified in the specification.

1.6 Electrical Isolation of the Capacitor

Completely isolate the capacitor as follows.

(1) Between the cathode and the case (except for axially leaded B types) and between the anode terminal and other circuit paths

(2) Between the extra mounting terminals (on T types) and the anode terminal, cathode terminal, and other circuit paths.

1.7 The Product endurance should take the sample as the standard.

1.8 If conduct the load or shelf life test, must be collect date code within 6 months products of sampling.

1.9 Capacitor Sleeve

The vinyl sleeve or laminate coating is intended for marking and identification purposes and is not meant to electrically insulate the capacitor.

The sleeve may split or crack if immersed into solvents such as toluene or xylene, and then exposed to high temperatures.

CAUTION!

Always consider safety when designing equipment and circuits. Plan for worst case failure modes such as short circuits and open circuits which could occur during use.

(1) Provide protection circuits and protection devices to allow safe failure modes.

(2) Design redundant or secondary circuits where possible to assure continued operation in case of main circuit failure.

2.Capacitor Handling Techniques

2.1 Considerations Before Using

(1) Capacitors have a finite life. Do not reuse or recycle capacitors from used equipment.
(2) Transient recovery voltage may be generated in the capacitor due to dielectric absorption. If required, this voltage can be discharged with a resistor with a value of about 1kΩ.
(3) Capacitors stored for long periods of time may exhibit an increase in leakage current. This can be corrected by gradually applying rated voltage in series with a resistor of approximately 1kΩ.
(4) If capacitors are dropped, they can be damaged mechanically or electrically. Avoid using dropped capacitors.
(5) Dented or crushed capacitors should not be used. The seal integrity can be compromised and loss of electrolyte / shortened life can result.

2.2 Capacitor Insertion

* (1) Verify the correct capacitance and rated voltage of the capacitor.
* (2) Verify the correct polarity of the capacitor before inserting.
* (3) Verify the correct hole spacing before insertion (land pattern size on chip type) to avoid stress on the terminals.

(4) Ensure that the auto insertion equipment lead clinching operation does not stress the capacitor leads where they enter the seal of the capacitor.

<u>For chip type capacitors, excessive mounting pressure can cause high leakage current, short circuit, or disconnection.</u>

2.3 Manual Soldering

(1) Observe temperature and time soldering specifications or do not exceed temperatures of 400 ℃ for 3 seconds or less.
(2) If lead wires must be formed to meet terminal board hole spacing, avoid stress on the lead wire where it enters the capacitor seal.
(3) If a soldered capacitor must be removed and reinserted, avoid excessive stress to the capacitor leads.
(4) Avoid touching the tip of the soldering iron to the capacitor, to prevent melting of the vinyl sleeve.

2.4 Flow Soldering

(1) Do not immerse the capacitor body into the solder bath as excessive internal pressure could result.
(2) Observe proper soldering conditions (temperature, time, etc.) Do not exceed the specified limits.
(3) Do not allow other parts or components to touch the capacitor during soldering.

2.5 Other Soldering Considerations

Rapid temperature rises during the preheat operation and resin bonding operation can cause cracking of the capacitor vinyl sleeve.

For heat curing, do not exceed 150℃ for a maximum time of 2 minutes.

2.6 Capacitor Handling after Solder

(1). Avoid movement of the capacitor after soldering to prevent excessive stress on the lead wires where they enter the seal.
(2). Do not use capacitor as a handle when moving the circuit board assembly.
(3). Avoid striking the capacitor after assembly to prevent failure due to excessive shock.

2.7 Circuit Board Cleaning

* (1) Circuit boards can be immersed or ultrasonically cleaned using suitable cleaning solvents for up 5 minutes and up to 60℃ maximum temperatures. The boards should be thoroughly rinsed and dried.
The use of ozone depleting cleaning agents is not recommended in the interest of protecting the environment.

* (2) Avoid using the following solvent groups unless specifically allowed for in the specification;

. Halogenated cleaning solvents: except for solvent resistant capacitor types, halogenated solvents can permeate the seal and cause internal capacitor corrosion and failure. For solvent resistant capacitors, carefully follow the temperature and time requirements of the specification. 1-1-1 trichloroethane should never be used on any aluminum electrolytic capacitor.

. Alkali solvents : could attack and dissolve the aluminum case.

. Petroleum based solvents: deterioration of the rubber seal could result.

. Xylene : deterioration of the rubber seal could result.

. Acetone : removal of the ink markings on the vinyl sleeve could result.

* (3) A thorough drying after cleaning is required to remove residual cleaning solvents which may be trapped between the capacitor and the circuit board. Avoid drying temperatures, which exceed the maximum rated temperature of the capacitor.

* (4) Monitor the contamination levels of the cleaning solvents during use by electrical conductivity, pH, specific gravity, or water content. Chlorine levels can rise with contamination and adversely affect the performance of the capacitor.
Please consult us for additional information about acceptable cleaning solvents or cleaning methods.

2.8 Mounting Adhesives and Coating Agents

When using mounting adhesives or coating agents to control humidity, avoid using materials containing halogenated solvents. Also, avoid the use of chloroprene based polymers.
After applying adhesives or coatings, dry thoroughly to prevent residual solvents from being trapped between the capacitor and the circuit board.

3. Precautions for using capacitors

3.1 Environmental Conditions

Capacitors should not be stored or used in the following environments.

* (1) Temperature exposure above the maximum rated or below the minimum rated temperature of the capacitor.

* (2) Direct contact with water, salt water, or oil.

* (3) High humidity conditions where water could condense on the capacitor.

* (4) Exposure to toxic gases such as hydrogen sulfide, sulfuric acid, nitric acid chlorine, or ammonia.
* (5) Exposure to ozone, radiation, or ultraviolet rays.
* (6) Vibration and shock conditions exceeding specified requirements.

3.2 Electrical Precautions

(1) Avoid touching the terminals of the capacitor as possible electric shock could result. The exposed aluminum case is not insulated and could also cause electric shock if touched.

(2) Avoid short circuit the area between the capacitor terminals with conductive materials including liquids such as acids or alkaline solutions.

4. Emergency Procedures

(1) If the pressure relief vent of the capacitor operates, immediately turn off the equipment and disconnect form the power source. This will minimize additional damage caused by the vaporizing electrolyte.

(2) Avoid contact with the escaping electrolyte gas which can exceed 100℃ temperatures.
If electrolyte or gas enters the eye, immediately flush the eyes with large amounts of water.
If electrolyte or gas is ingested by month, gargle with water.
If electrolyte contacts the skin, wash with soap and water.

5. Long Term Storage

Leakage current of a capacitor increases with long storage times. The aluminum oxide film deteriorates as a function of temperature and time. If used without reconditioning, an abnormally high current will be required to restore the oxide film. This current surge could cause the circuit or the capacitor to fail.
After one year, a capacitor should be reconditioned by applying rated voltage in series with a 1000Ω,current limiting resistor for a time period of 30 minutes .
If the expired date of products date code is over eighteen months, the products should be return to confirmation.

5.1 Environmental Conditions

The capacitor shall be not use in the following condition:

(1) Temperature exposure above the maximum rated or below the minimum rated temperature of the capacitor.
(2) Direct contact with water, salt water, or oil.
(3) High humidity conditions where water could condense on the capacitor.
(4) Exposure to toxic gases such as hydrogen sulfide, sulfuric acid, nitric acid, chlorine, or ammonia.
(5) Exposure to ozone, radiation, or ultraviolet rays.
(6) Vibration and shock conditions exceeding specified requirements.

6. Capacitor Disposal

When disposing of capacitors, use one of the following methods.

* Incinerate after crushing the capacitor or puncturing the can wall (to prevent explosion due to internal pressure rise). Capacitors should be incinerated at high temperatures to prevent the release of toxic gases such as chlorine from the polyvinyl chloride sleeve, etc.
* Dispose of as solid waste.

NOTE: Local laws may have specific disposal requirements, which must be followed.