Chip tantalum capacitors with built–in open–function

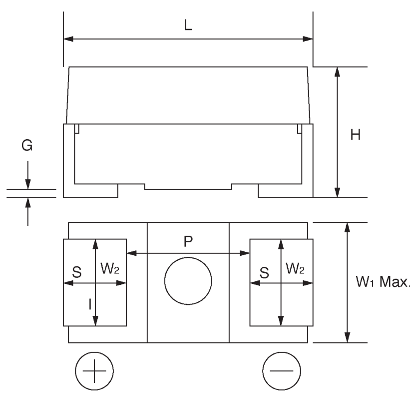
TCFG series

Semiconductor manufacturing technology has been used to include a temperature fuse in TCFG series capacitors. These capacitors feature low impedance and are ideal for digital circuits and low–voltage circuits in portable electronic equipment.

●Features

1) Open–function built into every package.
2) High capacitance in a small package.
3) Low impedance.
4) Use of semiconductor manufacturing technology provides high reliability.
5) Superb solderability.

●External dimensions (mm)



Case code	L	W_1	W_2	H	S	G	P
P (2012)	2.0±0.2	1.25±0.2	0.9±0.2	Max.1.20	0.45±0.3	Max. 0.15	1.3±0.3
A (3216)	3.2±0.2	1.6±0.2	1.2±0.2	1.6±0.2	0.8±0.3	Max. 0.15	1.6±0.3
B (3528)	3.5±0.2	2.8±0.2	1.9±0.2	1.9±0.2	0.8±0.3	Max. 0.15	1.9±0.3

●Product designation

· When ordering, please specify the part No.

· Please check to be sure of what combination of features you wish to order.

· Fill in the blanks from left to right.

TCF G | A | 0 J | 106 | M | 8R

Series name: TCF G

Electrostatic capacitance: 106

Three-digit number indicates the number of picofarads. The first two digits are the significant digits; the last digit gives the number of zeros.

Case type

Symbol	External dimensions		
	L	W	T
P	2.0	1.25	Max.1.20
A	3.2	1.6	1.6
B	3.5	2.8	1.9

Rated voltage

Symbol	Rated voltage (V)
0G	4
0J	6.3
1A	10
1C	16
1D	20

Capacitance tolerance

Symbol	Max. variation
K	±10%
M	±20%

8: Tape width
R: Anode on opposite side from sprocket holes

●Capacitance range

TCFG series

μF	Rated voltage (V. DC)				
	4 0G	6.3 0J	10 1A	16 1C	20 1D
0.68					
1.0			P	P A	A
1.5		P	A	A	
2.2	P	P	A	A	
3.3	P	P A	P A	A B	
4.7	P A	P A	P A B	A B	
6.8	P A	P A	A B	A B	
10	P A	P A B	A B	B	
15	P A B	A B	A B		
22	A B	A B	B		
33	A B	B	B		
47	B	B			
68	B				
100					

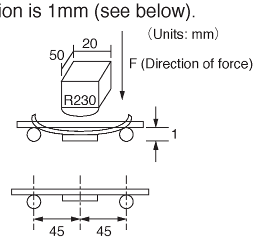
red characters : under the development

●Characteristics

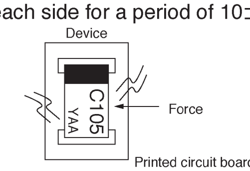
<table>
<tr><th colspan="2">Item</th><th colspan="6">Performance</th><th>Test methods / conditions
(based on JIS C 5102, 5143)</th></tr>
<tr><td colspan="2">Operating temperature</td><td colspan="6">−55℃～+125℃</td><td></td></tr>
<tr><td colspan="2">Max. operating temperature at rated voltage</td><td colspan="6">+85℃</td><td></td></tr>
<tr><td colspan="2">Rated voltage (V. DC)</td><td>4</td><td>6.3</td><td>10</td><td>16</td><td>20</td><td></td><td></td></tr>
<tr><td colspan="2">Derated voltage (V. DC)</td><td>2.5</td><td>4</td><td>6.3</td><td>10</td><td>13</td><td></td><td>at 125℃</td></tr>
<tr><td colspan="2">Surge voltage (V. DC)</td><td>5.2</td><td>8</td><td>13</td><td>20</td><td>26</td><td></td><td></td></tr>
<tr><td colspan="2">Leakage current</td><td colspan="6">Less than or equal to the larger of 0.5 μA or 0.01CV. Details are given in Table 1, "Standard Product List".</td><td>Measured value 60s after application of rated voltage.</td></tr>
<tr><td colspan="2">Capacitance range</td><td colspan="6">1.0～47 μF</td><td>Measured frequency: 120±12Hz
Measured voltage: 0.5Vrms+1.5V. DC
Measured circuit: equivalent series circuit</td></tr>
<tr><td>tan δ</td><td>P case
A case

B case</td><td colspan="6">0.08 max.
1 μF max.: 0.04 max.
1.5 μF to 22 μF max.: 0.06 max.
3.3 μF to 47 μF max.: 0.06 max.</td><td>Measured frequency: 120±12Hz
Measured voltage: 0.5Vrms+1.5V. DC
Measured circuit: equivalent series circuit</td></tr>
<tr><td rowspan="3">Impedance</td><td>P case</td><td colspan="6">27.5Ω max.</td><td rowspan="3">Measured frequency: 100±10Hz
Measured voltage: 0.5Vrms max.
Measured circuit: equivalent series circuit</td></tr>
<tr><td>A case</td><td colspan="6">20.0Ω max.</td></tr>
<tr><td>B case</td><td colspan="6">15.0Ω max.</td></tr>
<tr><td rowspan="4">Resistance to solder heat</td><td>Appearance</td><td colspan="6">No noticeable irregularities, and the markings must be easy to read.</td><td rowspan="4">Direct immersion into solder bath
Solder bath temperature: 260±5℃
Immersion time: 5s
Immersion cycles: 1 time</td></tr>
<tr><td>L.C</td><td colspan="6">Must satisfy the initial specified value.</td></tr>
<tr><td>△C / C</td><td colspan="6">Within ±5%
P case=±10%</td></tr>
<tr><td>tan δ</td><td colspan="6">P case 1.5 times or less or initial specified tolerance.
A·B case must satisfy the initial specified value.</td></tr>
<tr><td>Fuse operation</td><td></td><td colspan="6">320℃ for 20s or less</td><td>Direct immersion into solder bath (320±5℃)</td></tr>
<tr><td rowspan="4">Temperature cycle</td><td>Appearance</td><td colspan="6">No noticeable irregularities, and the markings must be easy to read.</td><td rowspan="4">The four cycles in the table below are repeated five times in succession.
<table><tr><th></th><th>Temperature</th><th>Time</th></tr><tr><td>1</td><td>−55±3℃</td><td>30±3mins.</td></tr><tr><td>2</td><td>Room temperature</td><td>3mins. max.</td></tr><tr><td>3</td><td>125±2℃</td><td>30±3mins.</td></tr><tr><td>4</td><td>Room temperature</td><td>3mins. max.</td></tr></table></td></tr>
<tr><td>L.C</td><td colspan="6">Must satisfy the initial specified value.
P case=Within 150% of initial limit.</td></tr>
<tr><td>△C / C</td><td colspan="6">P case within ±10%
A・B case within ±5%</td></tr>
<tr><td>tan δ</td><td colspan="6">P case 1.5 times or less or initial specified tolerance.
A·B case must satisfy the initial specified value.</td></tr>
<tr><td rowspan="4">Resistance to humidity (steady state)</td><td>Appearance</td><td colspan="6">No noticeable irregularities, and the markings must be easy to read.</td><td rowspan="4">Measured after being left for 500 ±12hrs. at 60±2℃ and 90 to 95% RH, then 1 to 2 hrs. at normal room temperature and humidity.</td></tr>
<tr><td>L.C</td><td colspan="6">Must satisfy the initial specified value.</td></tr>
<tr><td>△C / C</td><td colspan="6">P case within ±20%
A・B case within ±10%</td></tr>
<tr><td>tan δ</td><td colspan="6">P case 1.5 times or less or initial specified tolerance.
A·B case must satisfy the initial specified value.</td></tr>
</table>

Item		Performance	Test methods / conditions (based on JIS C 5102,5143)
Temperature characteristics	Temperature	-55℃	
	△C / C	P case within +0% and -15% of the value before testing. A・B case within +10% and -0% of the value before testing.	
	tan δ	P case within 1.5 times of the value before testing. A・B case must satisfy the initial specified value.	
	L.C	—	
	Temperature	+85℃	
	△C / C	P case within +0% and -15% of the value before testing. A・B case within +10% and -0% of the value before testing.	
	tan δ	Must satisfy the initial specified value.	
	L.C	Less than or equal to the larger of 5 μA or 0.1CV.	
	Temperature	+125℃	
	△C / C	P case within +20% and -0% of the value before testing. A・B case within +15% and -0% of the value before testing.	
	tan δ	P case within 1.5 times of the value before testing. A・B case must satisfy the initial specified value.	
	L.C	Less than or equal to the larger of 6.3 μA or 0.125CV.	
Surge resistance	Appearance	A・B case no noticeable irregularities, and the markings must be easy to read.	Apply the rated surge voltage for 30 ±5s at intervals of 5±.05mins. 1000 times, with the temperature at 85±2℃.
	L.C	Must satisfy the initial specified value.	
	△C / C	P case within ±10% A・B case within ±5%	
	tan δ	P case within 1.5 times of the value before testing. A・B case must satisfy the initial specified value.	
High-temperature load	Appearance	No noticeable irregularities, and the markings must be easy to read.	Apply the rated voltage continuously for 2000 to 2072hrs. via a series resister of 3Ω max., then make the measurement after leaving the device at room temperature and humidity for 1 to 2hrs.
	L. C	Must satisfy the initial specified value.	
	△C / C	Within ±10%	
	tan δ	P case within 1.5 times of the value before testing. A・B case must satisfy the initial specified value.	
Terminal strength	Capacitance	Value must be stable during measurement.	Apply pressure to the device using the specified tool for 5s so that the center deflection is 1mm (see below).
	Appearance	No noticeable irregularities.	



ROHM

<table>
<tr><th colspan="2">Item</th><th>Performance</th><th>Test conditions</th></tr>
<tr><td colspan="2">Adhesion</td><td>Terminals must not detach.</td><td>With the device mounted on the printed circuit board, apply a force of 0.5kg・f from each side for a period of 10±1s.

</td></tr>
<tr><td colspan="2">External dimensions</td><td>Refer to Fig. 1, "External dimensions"</td><td>Measure using slide calipers that meet the requirements of JIS B7507 Class 2.</td></tr>
<tr><td>Markings</td><td>Resistance to solvents</td><td>Marking must be easy to read.</td><td>Immerse in isopropyl alcohol for 30±5s.</td></tr>
<tr><td colspan="2">Solderability
Inspect the solder cover of the terminals using a solder immersion test</td><td>At least 3 / 4 of the surface of the immersed terminals must be covered with new solder.</td><td>Immersion speed: 25±2.5mm / s
Pre-processing (accelerated aging): leave for 1hr over boiling distilled water
Solder temperature: 235±5℃
Immersion time: 2±0.5s
Solder type: H63A
Flux: rosin 25%, IPA 75%</td></tr>
<tr><td rowspan="2">Resistance to vibration</td><td>Capacitance</td><td>Value must be stable during measurement.</td><td rowspan="2">Vibrate in the X / Y axis at frequencies of 10Hz, 55Hz and 10Hz for two hours each, with a total vibration amplitude of 1.5mm.</td></tr>
<tr><td>Appearance</td><td>No noticeable irregularities.</td></tr>
<tr><td rowspan="4">Reverse polarity withstanding voltage</td><td>Appearance</td><td>No noticeable irregularities, and the markings must be easy to read.</td><td rowspan="4">Apply either 0.1 times the rated voltage, or 3V, whichever is smaller, via a series resister of 3Ω max. and 0.1Ω min. at a temperature of 85±2℃.</td></tr>
<tr><td>L.C</td><td>Must be less than or equal to twice the initial specified value.</td></tr>
<tr><td>△C / C</td><td>Within ±10% of the value before the test.</td></tr>
<tr><td>tan δ</td><td>Must be less than or equal to 1.5 times the initial specified value.</td></tr>
</table>

●Table 1 Standard parts list, TCFG series

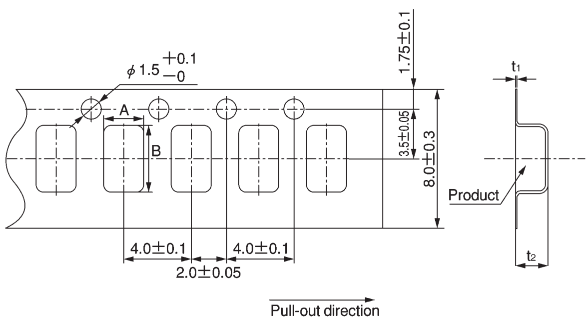
Part No.	Rated voltage at 85℃ (V)	Derated voltage at 125℃ (V)	Surge voltage at 85℃ (V)	Capacitance (μF)	Tolerance (%)	Leakage current at 25℃ 1WV.60s (μA)	DF 120Hz 25℃ (%)
TCF GP 0G 225_	4	2.5	5.2	2.2	±20,10	0.5	8
TCF GP 0G 335_	4	2.5	5.2	3.3	±20,10	0.5	8
TCF GP 0G 475_	4	2.5	5.2	4.7	±20,10	0.5	6
TCF GA 0G 685_	4	2.5	5.2	6.8	±20,10	0.5	6
TCF GA 0G 106_	4	2.5	5.2	10	±20,10	0.5	6
TCF GA 0G 156_	4	2.5	5.2	15	±20,10	0.6	6
TCF GB 0G 156_	4	2.5	5.2	15	±20,10	0.6	6
TCF GA 0G 226_	4	2.5	5.2	22	±20,10	0.9	6
TCF GB 0G 226_	4	2.5	5.2	22	±20,10	0.9	6
TCF GB 0G 336_	4	2.5	5.2	33	±20,10	1.3	6
TCF GB 0G 476_	4	2.5	5.2	47	±20,10	1.9	6
TCF GP 0J 155_	6.3	4	8	1.5	±20,10	0.5	6
TCF GP 0J 225_	6.3	4	8	2.2	±20,10	0.5	6
TCF GA 0J 335_	6.3	4	8	3.3	±20,10	0.5	6
TCF GA 0J 475_	6.3	4	8	4.7	±20,10	0.5	6
TCF GA 0J 685_	6.3	4	8	6.8	±20,10	0.5	6
TCF GA 0J 106_	6.3	4	8	10	±20,10	0.6	6
TCF GA 0J 156_	6.3	4	8	15	±20,10	0.9	6
TCF GB 0J 106_	6.3	4	8	10	±20,10	0.6	6
TCF GB 0J 156_	6.3	4	8	15	±20,10	0.8	6
TCF GB 0J 226_	6.3	4	8	22	±20,10	1.4	6
TCF GB 0J 336_	6.3	4	8	33	±20,10	2.1	6
TCF GP 1A 105_	10	6.3	13	1.0	±20,10	0.5	8
TCF GA 1A 225_	10	6.3	13	2.2	±20,10	0.5	6
TCF GA 1A 335_	10	6.3	13	3.3	±20,10	0.5	6
TCF GA 1A 475_	10	6.3	13	4.7	±20,10	0.5	6
TCF GB 1A 475_	10	6.3	13	4.7	±20,10	0.5	6
TCF GA 1A 685_	10	6.3	13	6.8	±20,10	0.7	6
TCF GB 1A 685_	10	6.3	13	6.8	±20,10	0.7	6
TCF GA 1A 106_	10	6.3	13	10	±20,10	1.0	6
TCF GB 1A 106_	10	6.3	13	10	±20,10	1.0	6
TCF GB 1A 156_	10	6.3	13	15	±20,10	1.5	6
TCF GA 1C 105_	16	10	20	1.0	±20,10	0.5	4
TCF GA 1C 155_	16	10	20	1.5	±20,10	0.5	6
TCF GA 1C 225_	16	10	20	2.2	±20,10	0.5	6

Part No.	Rated voltage at 85℃ (V)	Derated voltage at 125℃ (V)	Surge voltage at 85℃ (V)	Capacitance (μF)	Tolerance (%)	Leakage current at 25℃ 1WV.60s (μA)	DF 120Hz 25℃ (%)
TCF GA 1C 335_	16	10	20	3.3	±20,10	0.5	6
TCF GB 1C 335_	16	10	20	3.3	±20,10	0.5	6
TCF GB 1C 475_	16	10	20	4.7	±20,10	0.8	6
TCF GB 1C 685_	16	10	20	6.8	±20,10	1.1	6
TCF GB 1C 106_	16	10	20	10	±20,10	1.6	6
TCF GA 1D 105_	20	16	26	1.0	±20,10	0.5	4

●Packaging specifications

Taping

TCFG / TCFP

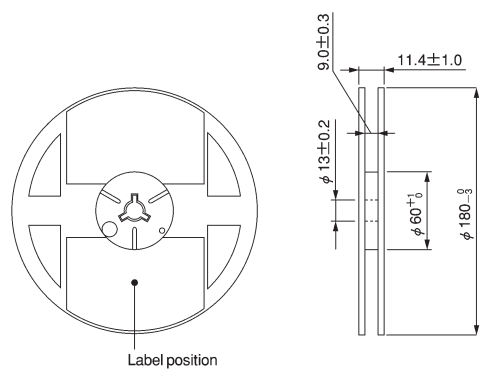


Case code	A±0.1	B±0.1	t_1±0.05	t_2±0.2
P（2012）	1.55	2.3	0.25	1.5
A（3216）	1.9	3.5	0.25	1.9
B（3528）	3.3	3.8	0.25	2.2

Some emboss tapes have the center hole on its bottom.

Reel

Plastic reel



EIAJ ETX - 7001compliant

●Packaging style

Part no.	Package type	Packaging style		Symbol	Basic ordering unit (pcs)
TCFG	Taping	Plastic taping	φ180 mm reel	R	2,000
TCFP	Taping	Plastic taping	φ180 mm reel	R	2,000

●Electrical characteristics and operation notes

(1) Soldering conditions (soldering temperature and soldering time)

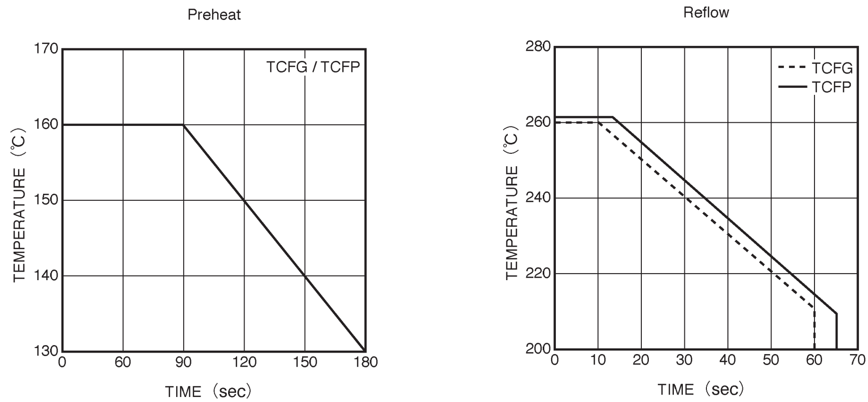


Fig.1 Reflow (Infrared Ray, Hot Plate, Hot Air)

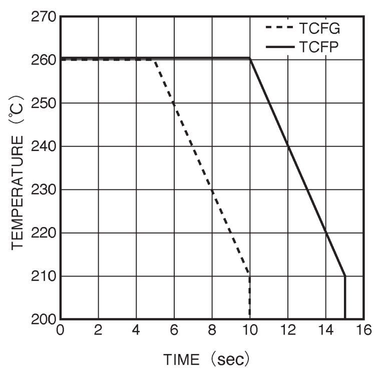


Fig.2 Flow (Dipping wave soldering)

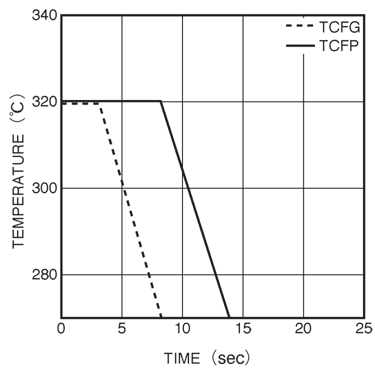


Fig.3 Hand soldering (soldering gun output: 30W or less)

(2) Leakage current–to–voltage ratio

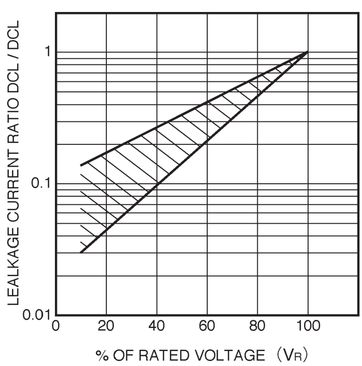


Fig.4

(3) Derating voltage as function of temperature

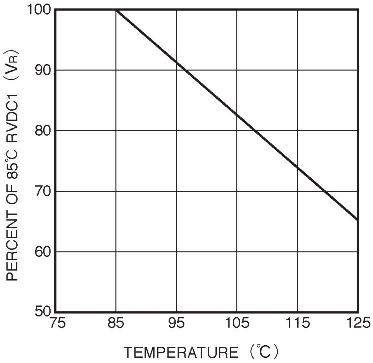


Fig.5

85°C		125°C	
Rated Voltage (V.DC)	Surge Voltage (V.DC)	Category Voltage (V.DC)	Surge Voltage (V.DC)
4	5.2	2.5	3.4
6.3	8	4	5
10	13	6.3	9
16	20	10	12
20	26	13	16

(4) Reliability

The malfunction rate of tantalum solid state electrolytic capacitors varies considerably depending on the conditions of usage (ambient temperature, applied voltage, circuit resistance).

Formula for calculating malfunction rate

$$\lambda_p = \lambda_b \times (\pi_E \times \pi_{SR} \times \pi_Q \times \pi_{CV})$$

- λ_p : Malfunction rate stemming from operation
- λ_b : Basic malfunction rate
- π_E : Environmental factors
- π_{SR} : Series resistance
- π_Q : Level of malfunction rate
- π_{CV} : Capacitance

For details on how to calculate the malfunction rate stemming from operation, see the tantalum solid state electrolytic capacitors column in MIL–HDBK–217.

Malfunction rate as function of operating temperature and rated voltage

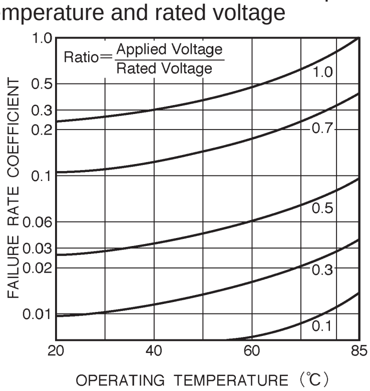


Fig.6

Malfunction rate as function of circuit resistance (Ω/V)

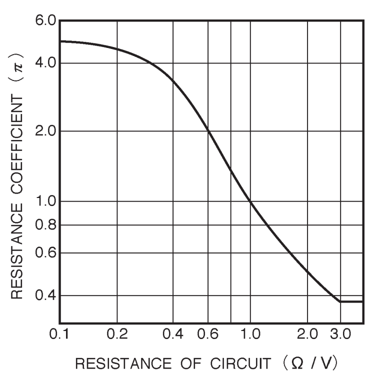


Fig.7

(5) External temperature vs. fuse blowout

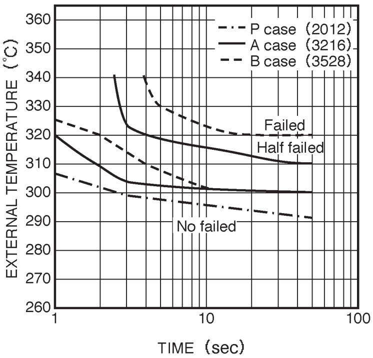


Fig.8

Note: Solder the chip at 300°C or less. If it is soldered using a temperature higher than 300°C, the built–in temperature fuse may blow out.

(6) Power vs. fuse blowout characteristics / Product surface temperature

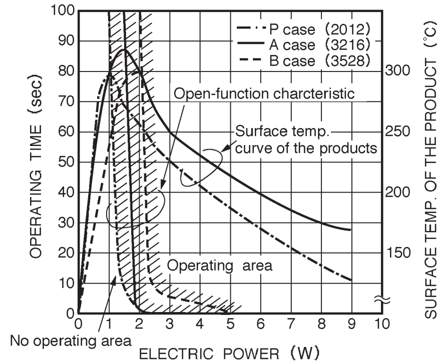


Fig.9

(7) Maximum power dissipation

Warming of the capacitor due to ripple voltage balances with warming caused by Joule heating and by radiated heat. Maximum allowable warming of the capacitor is to 5°C above ambient temperature. When warming exceeds 5°C, it can damage the dielectric and cause a short circuit.

Power dissipation (P) = I^2 ▪ R

Ripple current

P: As shown in table at right

R: Equivalent series resistance

Notes:

1. Please be aware that when case size is changed, maximum allowable power dissipation is reduced.
2. Maximum power dissipation varies depending on the package. Be sure to use a case which will keep warming within the limits shown in the table below.

Allowable power dissipation (W) and maximum temperature rising

Case \ Ambient temp.	+25℃	+55℃	+85℃	+125℃
P case (2012)	0.025	0.022	0.020	0.010
A case (3216)	0.070	0.063	0.056	0.028
B case (3528)	0.080	0.072	0.064	0.032
Max. temp rise	5	5	5	2

(8) Impedance frequency characteristics

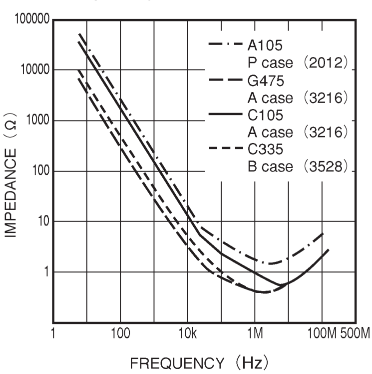


Fig.10

(9) ESR frequency characteristics

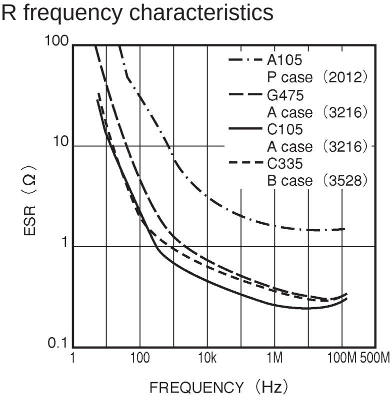


Fig.11

(10) Temperature characteristics

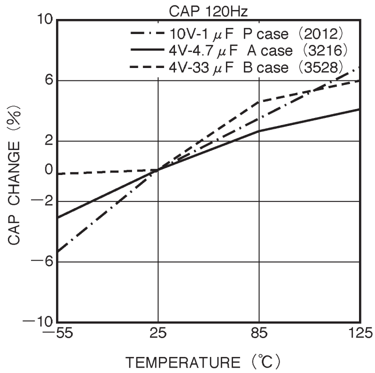


Fig.12

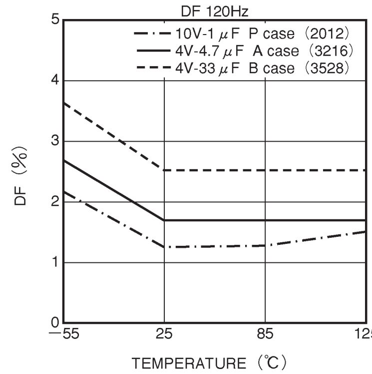


Fig.13

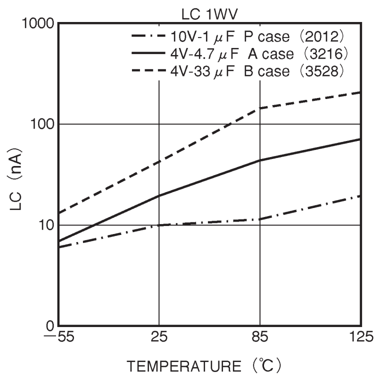


Fig.14

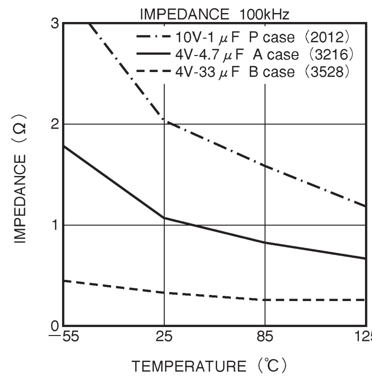


Fig.15

Inrush current

Beware of inrush current.
Inrush currents are inversely proportional to ESR. Large inrush currents can cause component failure.

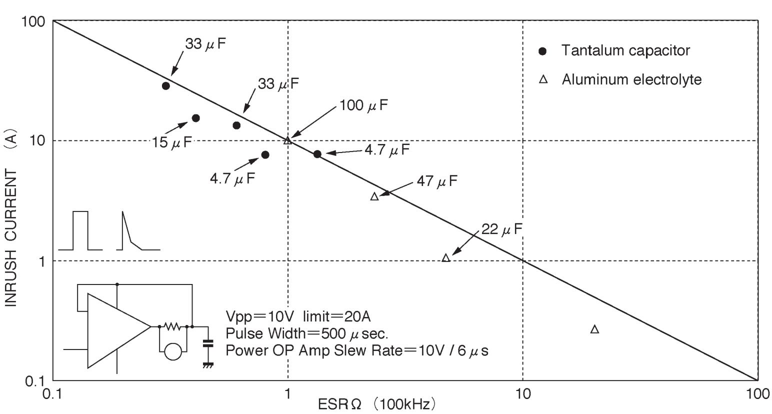


Fig.16 Maximum inrush current and ESR

Inrush current can be limited by means of a protective resistor.

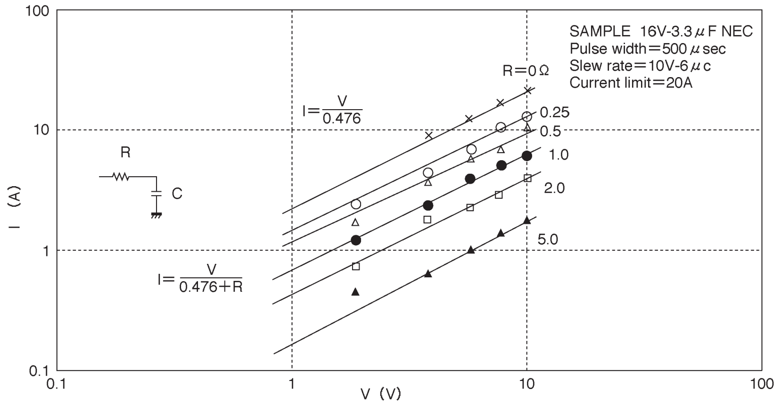


Fig.17 Imax change due to protective resistor R

(11) Ultrasonic cleaning

Carry out cleaning under the mildest conditions possible. The internal element of a tantalum capacitor are larger than those of a transistor or diode, so it is not as resistant to ultrasonic waves.

Example: water

Propagation speed 1500 m/s

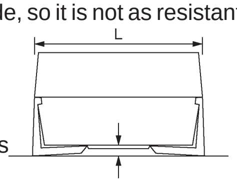
Solvent density 1g/cm^3

Frequency and wavelength

Frequency	Wavelength
20kHz	7.5cm
28kHz	5.3cm
50kHz	3.0cm

Design

G dimension : 150µm or less



G dimension : 150 µm or less

Precautions

1) Do not allow solvent to come to a boil (kinetic energy increases).
   - Ultrasonic output 0.5W/cm^2 or less
   - Use a solvent with a high boiling point.
   - Lower solvent temperature.
2) Ultrasonic cleaning frequency
   28 kHz or less
3) Keep cleaning time as short as possible.
4) Move item being cleaned.
   Standing waves caused by the ultrasonic waves can cause stress to build up in part of the item being cleaned.

Reference

$$\text{Kinetic energy} = 2 \times \pi \times \text{frequency} \times \sqrt{\frac{2 \times \text{ultrasonic output}}{\text{propagation speed} \times \text{solvent density}}}$$