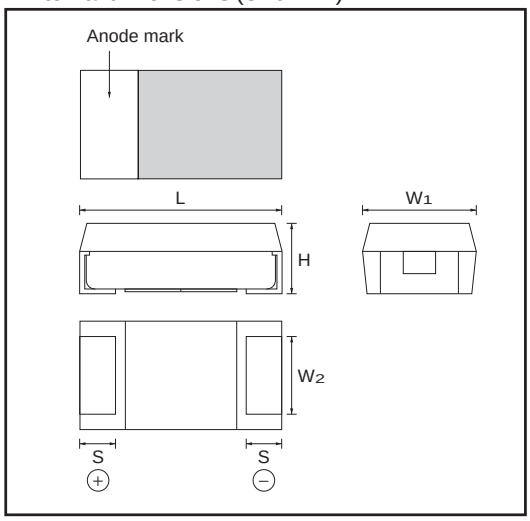
Chip tantalum capacitors with open-function built-in

TCFG series P Case

●**Features**

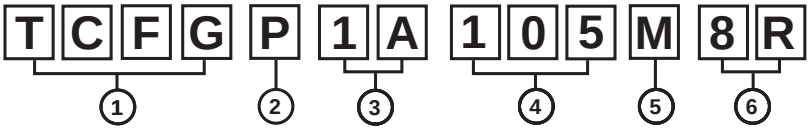
1) Safety design by open function built - in.
2) Wide capacitance range
3) Screening by thermal shock.

●**External dimensions** (Unit : mm)



Case code	L	W_1	W_2	H	S
P (2012)	2.0±0.2	1.25±0.2	0.9±0.2	Max.1.20	0.45±0.3

●**Product designation**



① Series name
TCFG

② Case code
TCFG ····· P

③ Rated Voltage

Rated voltage (V)	4	6.3	10	16	20	25
CODE	0G	0J	1A	1C	1D	1E

④ Capacitance
Nominal capacitance in pF in 3 digits : 2significant figure representing the number of 0's.

⑤ Capacitance tolerance
M : ±20% K : ±10%

⑥ Taping
8 : Tape width (8mm)
R : Positive electrode on the side opposite to sprocket hole

●Capacitance range

TCFG series P Case

(μF)	Rated voltage					
	4 0G	6.3 0J	10 1A	16 1C	20 1D	25 1E
1.0 (105)			P	P	P	P
1.5 (155)		P	P	P		
2.2 (225)	P	P	P	P		
3.3 (335)	P	P	P	P		
4.7 (475)	P	P	P			
6.8 (685)	P	P				
10 (106)	P	P				
15 (156)	P	P				
22 (226)	P					
33 (336)						
47 (476)						
68 (686)						

Remark) Case size codes (P) in the above show each size products line-up.

●Marking

The indications listed below should be given on the surface of a capacitor.

① Polarity : The polarity should be shown by □ bar. (on the anode side)
② Rated DC voltage : Due to the small size of P case, a voltage code is used as shown below.
③ Nominal capacitance

Voltage Code	Rated DC Voltage (V)
g	4
j	6.3
A	10
C	16
D	20
E	25

Capacitance Code	Nominal Capacitance (μF)
A	1.0
E	1.5
J	2.2
N	3.3
S	4.7
W	6.8
a	10
e	15
j	22

Visual typical example (1) voltage code (2) capacitance code

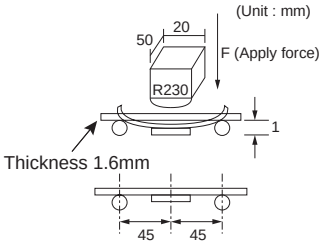
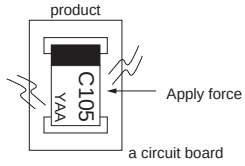
[P Case] note 1) $\frac{j}{(1)}$ $\frac{J}{(2)}$

note 2) voltage code and capacitance code are variable with parts number

●Characteristics

Item		Performance	Test conditions (based on JIS C5101-1 and JIS C5101-3)
Operating Temperature		–55 °C to +125 °C	Voltage reduction when temperature exceeds +85°C
Maximum operating temperature with no voltage derating		+85 °C	
Rated Voltage (V.DC)		4 | 6.3 | 10 | 16 | 20 | 25	at 85°C
Category Voltage (V.DC)		2.5 | 4 | 6.3 | 10 | 13 | 16	at 125°C
Surge Voltage		5.2 | 8 | 13 | 20 | 26 | 32	at 85°C
DC leakage current		0.5μA or 0.01CV whichever is greater (Shown in "Standard list")	As per 4.9 JIS C 5101-1 As per 4.5.1 JIS C 5101-3 Voltage : Rated voltage for 1 min
Capacitance tolerance		Shall be satisfied allowance range. ±10%, ±20%	As per 4.7 JIS C 5101-1 As per 4.5.2 JIS C 5101-3 Measuring frequency : 120±12Hz Measuring voltage : 0.5Vrms, +1.5V.DC Measuring circuit : DC Equivalent series circuit
Tangent of loss angle (Df, tanδ)		Shall be satisfied the voltage on "Standard list"	As per 4.8 JIS C 5101-1 As per 4.5.3 JIS C 5101-3 Measuring frequency : 120±12Hz Measuring voltage : 0.5Vrms, +1.5V.DC Measuring circuit : DC Equivalent series circuit
Impedance		Shall be satisfied the voltage on "Standard list"	As per 4.10 JIS C 5101-1 As per 4.5.4 JIS C 5101-3 Measuring frequency : 100±10kHz Measuring voltage : 0.5Vrms or less Measuring circuit : DC Equivalent series circuit
Resistance to soldering heat	Appearance	There should be no significant abnormality. The indications should be clear.	As per 4.14 JIS C 5101-1 As per 4.6 JIS C 5101-3 Dip in the solder bath Solder temp : 260±5°C Duration : 5±0.5s Repetition : 1
	L.C	Less than initial limit	
	ΔC / C	Within ±10% of initial value	
	tanδ	Less than 150% of initial limit	
Fail-Safe open unit actuation		Within 320°C – 20s	Dip in the solder bath Solder temp : 320±5°C
Temperature cycle	Appearance	There should be no significant abnormality.	As per 4.16 JIS C 5101-1 As per 4.10 JIS C 5101-3 Repetition : 5 cycles (1 cycle : steps 1 to 4) without discontinuation.
	L.C	Less than initial limit	
	ΔC / C	1 to 10μF : within ±10% of initial value 15 to 22μF : within ±20% of initial value	
	tanδ	Less than 150% of initial limit	
Moisture resistance	Appearance	There should be no significant abnormality. The indications should be clear.	As per 4.22 JIS C 5101-1 As per 4.12 JIS C 5101-3 After leaving the sample under such atmospheric condition that the temperature and humidity are 60±2°C and 90 to 95%RH, respectively, for 500±12h level it at room temperature for 1 to 2h and then measure the sample.
	L.C	Less than initial limit	
	ΔC / C	Within ±20% of initial value	
	tanδ	Less than 150% of initial limit	

Step	Temp.	Time
1	–55± 3°C	30±3min
2	Room temp.	3min. or less
3	125± 2°C	30±3min
4	Room temp.	3min. or less

Item		Performance	Test conditions (based on JIS C5101-1 and JIS C5101-3)
Temperature Stability	Temp.	–55°C	As per 4.29 JIS C 5101-1 As per 4.13 JIS C 5101-3
	ΔC / C	Within 0/–15%of initial value	
	tanδ	Shall be satisfied the voltage on "Standard list"	
	L.C	–	
	Temp.	+85°C	
	ΔC / C	Within +15/0%of initial value	
	tanδ	Shall be satisfied the voltage on "Standard list"	
	L.C	5μA or 0.1CV whichever is greater	
	Temp.	+125°C	
	ΔC / C	Within +20/0%of initial value	
	tanδ	Shall be satisfied the voltage on "Standard list"	
	L.C	6.3μA or 0.125CV whichever is greater	
Surge Voltage	Appearance	There should be no significant abnormality.	As per 4.26 JIS C 5101-1 As per 4.14 JIS C 5101-3 Apply the specified surge voltage every 5±0.5min. for 30±5 s. each time in the atmospheric condition of 85±2°C. Repeat this procedure 1,000 times.
	L.C	Shall be satisfied the voltage on "Standard list"	
	ΔC / C	Within ±10%of initial value	
	tanδ	Less than 150% of initial limit	
Loading at High temperature	Appearance	There should be no significant abnormality.	As per 4.23 JIS C 5101-1 As per 4.15 JIS C 5101-3 After applying the rated voltage for 1000+36/0h without discontinuation via the serial resistance of 3Ω or less at a temperature of 85±2°C, leave the sample at room temperature/humidity for 1 to 2h and measure the value.
	L.C	Less than initial limit	
	ΔC / C	Within ±10%of initial value	
	tanδ	Less than 150% of initial limit	
Terminal Strength	Capacitance	The measured value should be stable.	As per 4.35 JIS C 5101-1 As per 4.9 JIS C 5101-3 A force is applied to the terminal until it bends to 1mm and by a prescribed tool maintain the condition for 5s. (See the figure below.) 
	Appearance	There should be no significant abnormality.	
Adhesiveness		The terminal should not come off.	As per 4.34 JIS C 5101-1 As per 4.8 JIS C 5101-3 Apply force of 5N in the two directions shown in the figure below for 10±1s after mounting the terminal on a circuit board. 

Item		Performance	Test conditions (based on JIS C5101-1 and JIS C5101-3)
Dimensions		Be based on "External dimensions"	Measure using a caliper of JIS B 7505 Class 2 or higher grade.
Resistance to solvents		The indication should be clear.	As per 4.32 JIS C 5101-1 As per 4.18 JIS C 5101-3 Dip in the isopropyl alcohol for 30±5s, at room temperature.
Solderability		3/4 or more surface area of the solder coated terminal dipped in the soldering bath should be covered with the new solder.	As per 4.15.2 JIS C 5101-1 As per 4.7 JIS C 5101-3 Dip speed = 25±2.5mm/s Pre-treatment (accelerated aging) : Leave the sample on the boiling distilled water for 1h. Solder temp. : 235±5°C Duration : 2±0.5s Solder : H63A Flux : Rosin 25%, IPA 75%
Vibration	Capacitance	Measure value should not fluctuate during the measurement.	As per 4.17 JIS C 5101-1 Frequency : 10 to 55 to 10Hz/min. Amplitude : 1.5mm Time : 2h each in X and Y directions Mounting : The terminal is soldered on a print circuit board.
	Appearance	There should be no significant abnormality.	

●Table 1 standard list, TCFG series P Case

(P : 2012)

Part No.	Rated Voltage @85°C (V)	Derated Voltage @125°C (V)	Surge Voltage @85°C (V)	Capacitance 120Hz (μF)	Tolerance (%)	Leakage current 25°C 1WV.60s (mA)	DF120Hz (%)			Impedance 100kHz	Case code
							−55°C	25°C 85°C	125°C	(Ω)	
TCFG P 0G 225☐	4	2.5	5.2	2.2	±20,±10	0.5	15	10	15	4.0	P
TCFG P 0G 335☐	4	2.5	5.2	3.3	±20,±10	0.5	30	20	30	17.5	P
TCFG P 0G 475☐	4	2.5	5.2	4.7	±20,±10	0.5	30	20	30	14.4	P
TCFG P 0G 685☐	4	2.5	5.2	6.8	±20,±10	0.5	30	20	30	11.8	P
TCFG P 0G 106☐	4	2.5	5.2	10	±20,±10	0.5	30	20	30	9.3	P
TCFG P 0G 156☐	4	2.5	5.2	15	±20,±10	0.6	30	20	30	8.3	P
TCFG P 0G 226☐	4	2.5	5.2	22	±20,±10	0.9	30	20	30	7.7	P
TCFG P 0J 155 ☐	6.3	4	8	1.5	±20,±10	0.5	15	10	15	17.5	P
TCFG P 0J 225☐	6.3	4	8	2.2	±20,±10	0.5	30	20	30	4.0	P
TCFG P 0J 335☐	6.3	4	8	3.3	±20,±10	0.5	30	20	30	14.4	P
TCFG P 0J 475☐	6.3	4	8	4.7	±20,±10	0.5	30	20	30	11.8	P
TCFG P 0J 685☐	6.3	4	8	6.8	±20,±10	0.5	30	20	30	9.3	P
TCFG P 0J 106☐	6.3	4	8	10	±20,±10	0.6	30	20	30	8.3	P
TCFG P 0J 156☐	6.3	4	8	15	±20,±10	0.9	30	20	30	7.7	P
TCFG P 1A 105☐	10	6.3	13	1.0	±20,±10	0.5	15	10	15	17.5	P
TCFG P 1A 155☐	10	6.3	13	1.5	±20,±10	0.5	30	20	30	16.1	P
TCFG P 1A 225☐	10	6.3	13	2.2	±20,±10	0.5	30	20	30	4.0	P
TCFG P 1A 335☐	10	6.3	13	3.3	±20,±10	0.5	30	20	30	11.8	P
TCFG P 1A 475☐	10	6.3	13	4.7	±20,±10	0.5	30	20	30	6.0	P
TCFG P 1C 105☐	16	10	20	1.0	±20,±10	0.5	15	10	15	16.5	P
TCFG P 1D 105☐	20	13	26	1.0	±20,±10	0.5	15	10	15	16.1	P
TCFG P 1E 105☐	25	16	33	1.0	±20,±10	0.5	15	10	15	16.1	P

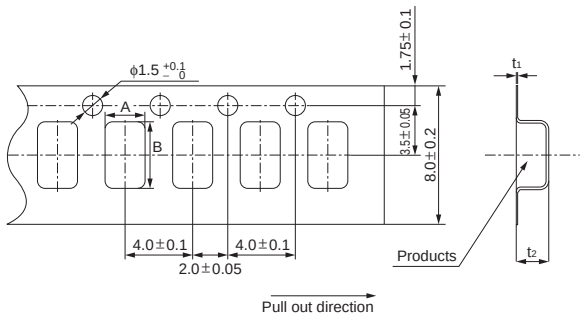
☐=Tolerance (M : ±20%, K : ±10%)

●Packaging specifications

Case code	A±0.1	B±0.1	t_1±0.05	t_2±0.1
P (2012)	1.55	2.3	0.25	1.5

Taping

P Case

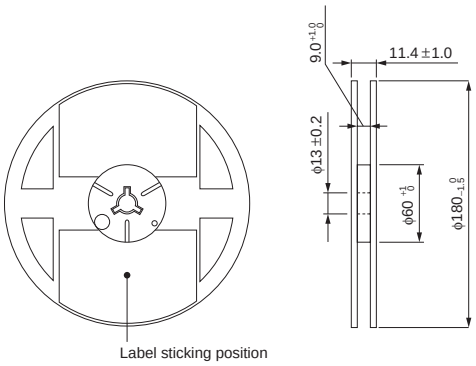


●**Packaging style**

Case size	Packaging	Packaging style		Symbol	Basic ordering unit
P Case	Taping	Plastic taping	ϕ180mm reel	R	2,000

Reel

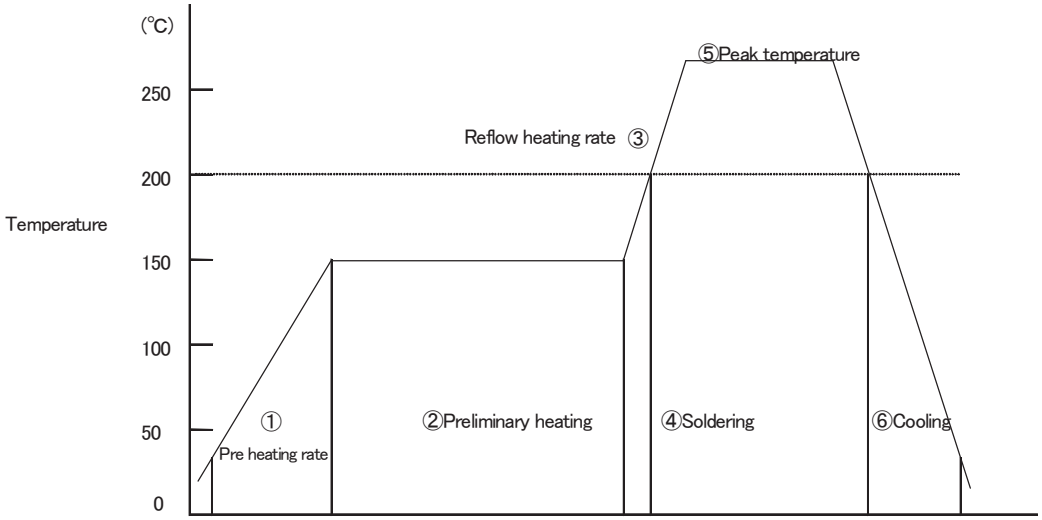
Plastic reel



EIAJ ET - 7200B

● **Recommended condition of reflow soldering**

(1) Soldering Conditions



Recommended condition of reflow soldering

①Pre heating rate	: 1 to 5°C/ s
②Preliminary heating	: 120 to 160°C, 50 to 120s
③Reflow heating rate	: 1 to 5°C / s
④Soldering	: 200°C, 30 to 60s
⑤Peak temperature	: 230 to 260℃ 10s Max.
⑥Cooling	: 60s Min.
⑦Time	: 2times Max.

Recommended condition of hand soldering

①Temperature (30W Max.)	: 300°C Max.
②Time	: 5s Max.

Flow soldering (Dip • Wave soldering)

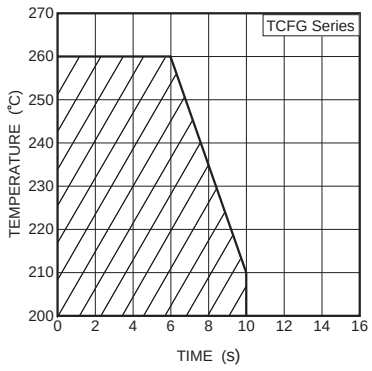


Fig.1

(2) Leakage current-to-voltage ratio

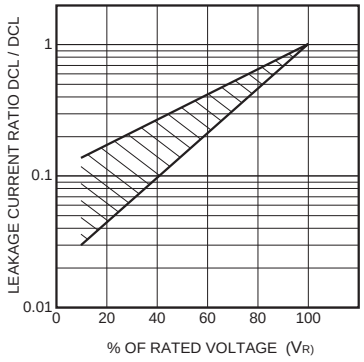


Fig.2

(3) Derating voltage as function of temperature

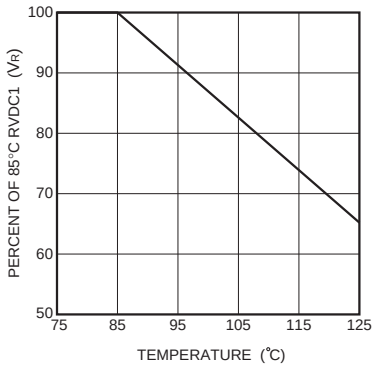


Fig.3

85°C		125°C	
Rated Voltage (V.DC)	Surge Voltage (V.DC)	Category Voltage (V.DC)	Surge Voltage (V.DC)
4	5.0	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

$\lambda p = \lambda b \times (\pi E \times \pi SR \times \pi Q \times \pi CV)$

- λp : Malfunction rate stemming from operation
- λb : Basic malfunction rate
- πE : Environmental factors
- πSR : Series resistance
- πQ : Level of malfunction rate
- πCV : 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

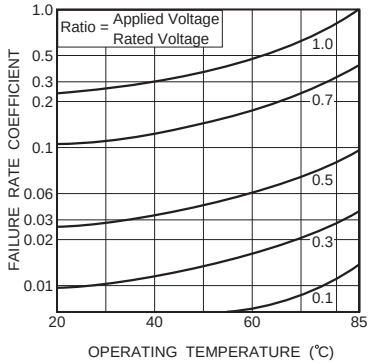


Fig.4

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

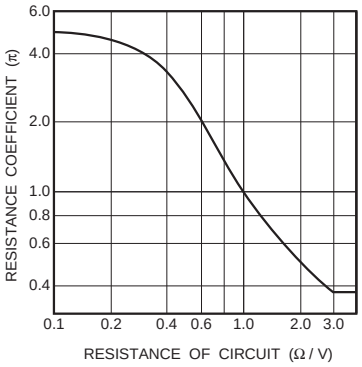


Fig.5

(5) External temperature vs. fuse blowout

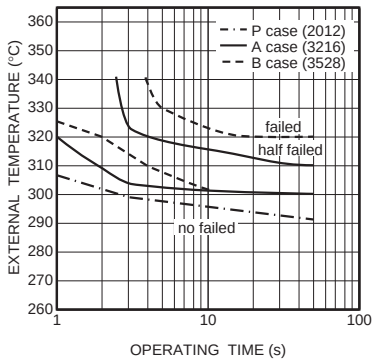


Fig.6

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

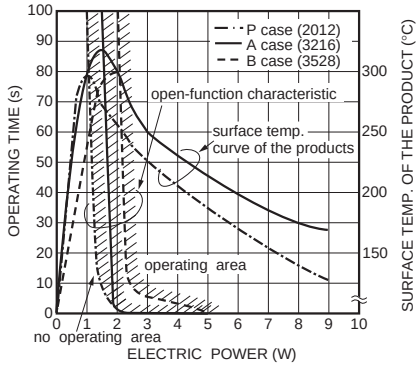


Fig.7

Note: Solder the chip at 300°C or less. If it is soldered using a temperature higher than 300°C, open function built-in may operate.

(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) = $I^2 \cdot R$

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°C	+55°C	+85°C	+125°C
P case (2012)	0.025	0.022	0.020	0.010
Max. Temp Rise (°C)	5	5	5	2

(8) Impedance frequency characteristics

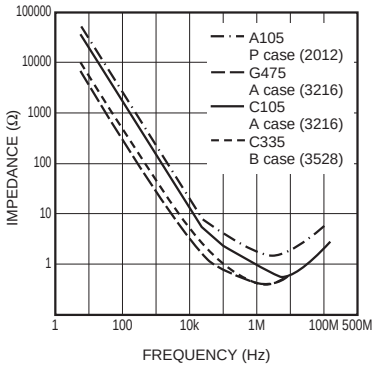


Fig.8

(9) ESR frequency characteristics

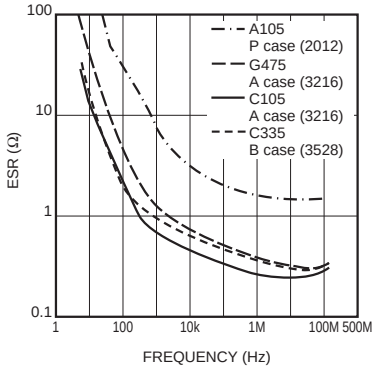


Fig.9

(10) Temperature characteristics

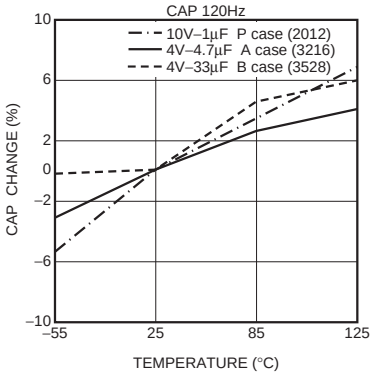


Fig.10

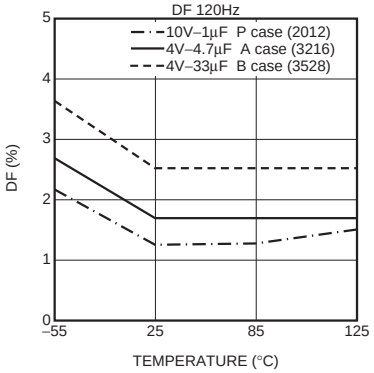


Fig.11

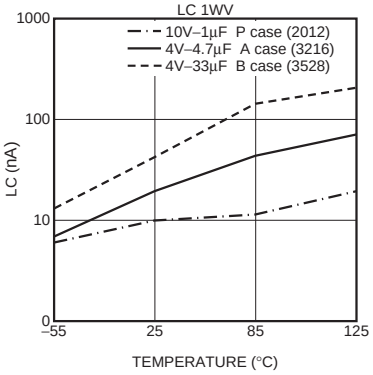


Fig.12

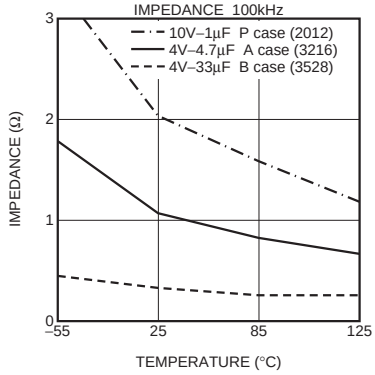


Fig.13

Inrush current

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

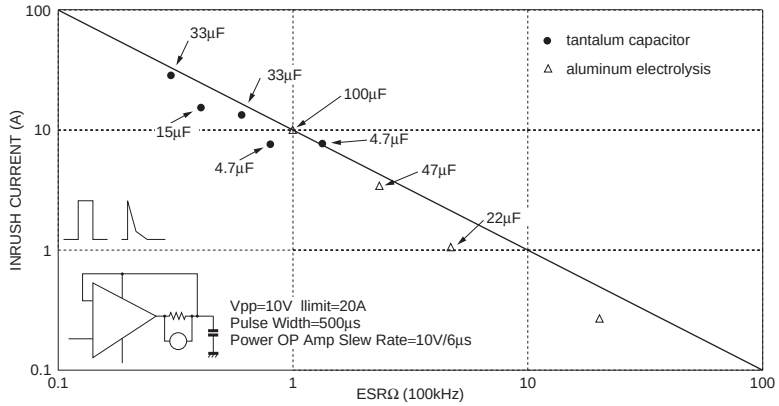


Fig. 14 Maximum inrush current and ESR

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

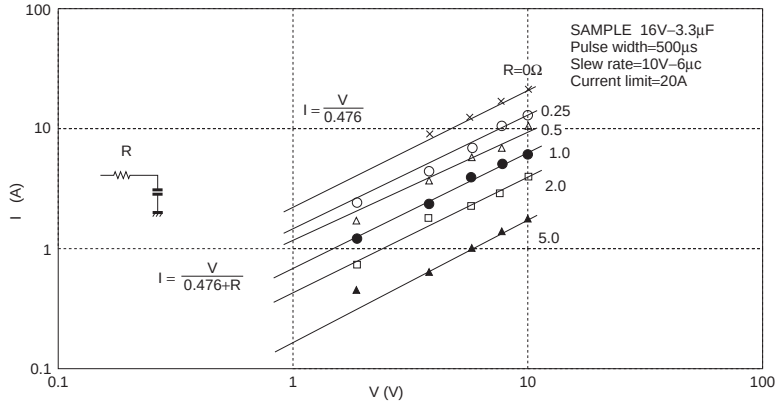


Fig. 15 Imax change due to protective resistor R

(11) Ultrasonic cleaning

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

Example : water
Propagation speed 1500m / s
Solvent density 1g / cm^3

Frequency and wavelength

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

● **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

$$\text{Kin etic energy} = 2 \times \pi \times \text{frequency} \times \sqrt{\frac{2 \times \text{Ultrasonic output}}{\text{propagation} \times \text{speed} \times \text{solvent density}}}$$

Notes

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