

Chip tantalum capacitors

TC Series P Case

●Features (P)

- 1) Vital for all hybrid integrated circuits board application.
- 2) Wide capacitance range.
- 3) Screening by thermal shock.

●Dimensions (Unit : mm)

(Unit : mm)	
Dimensions	P case
L	2.0±0.2
W ₁	1.25±0.2
W ₂	0.9±0.2
H	1.1±0.1
S	0.45±0.3

●Part No. Explanation



① Series name
TC

② Case style
TC..... P

③ Rated voltage

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

④ Nominal capacitance

Nominal capacitance in pF in 3 digits:
2 significant figures followed by the figure
representing the number of 0's.

⑤ Capacitance tolerance

M : ±20% K : ±10%

⑥ Taping

8 : Tape width
R : Positive electrode on the side opposite to sprocket hole

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● Rated table

(μF)	Rated voltage (V)					
	4 0G	6.3 0J	10 1A	16 1C	20 1D	25 1E
1 (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	P			
10 (106)	P	P	P			
15 (156)	P	P				
22 (226)	P	P				
33 (336)						
47 (476)						
68 (686)						

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

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

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

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



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

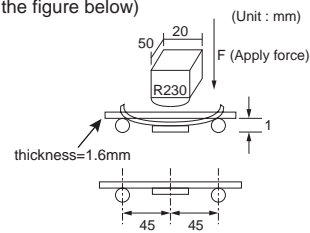
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● Characteristics

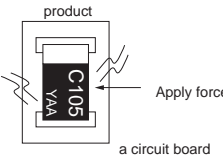
Item		Performance	Test conditions (based on JIS C 5101-1 and JIS C 5101-3)															
Operating Temperature		-55°C to +125°C	Voltage reduction when temperature exceeds +85°C															
Maximum operating temperature with no voltage derating		+85°C																
Rated voltage (VDC)		4 6.3 10 16 20 25	at 85°C															
Category voltage (VDC)		2.5 4 6.3 10 13 16	at 125°C															
Surge voltage (VDC)		5.0 8 13 20 26 32	at 85°C															
DC Leakage current		0.5 μA 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 1min															
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 +1.5 to 2V.DC Measuring circuit : DC Equivalent series circuit															
Tangent of loss angle (Df, tan δ)		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 +1.5 to 2V.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 After the specimens, leave it at room temperature for over 24h and then measure the sample.															
	L.C.	Less than initial limit																
	ΔC / C	TCP0J226□ : Within ±20% of initial value TCP1A106□ : Within ±20% of initial value Others : Within ±10% of initial value																
	Df (tan δ)	Less than 150% of initial limit																
Temperature cycle	Appearance	There should be no significant abnormality. The indications should be clear.	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.	TCP0J226□ : Less than 150% of initial limit Others : Less than initial limit																
	ΔC / C	1 to 10μF : Within ±10% of initial value 15 to 22μF : Within ±20% of initial value TCP1A106□ : Within ±20% of initial value																
	Df (tan δ)	Less than 150% of initial limit																
		<table border="1"> <thead> <tr> <th></th> <th>Temp.</th> <th>Time</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>-55±3°C</td> <td>30±3min.</td> </tr> <tr> <td>2</td> <td>Room temp.</td> <td>3min.or less</td> </tr> <tr> <td>3</td> <td>125±2°C</td> <td>30±3min.</td> </tr> <tr> <td>4</td> <td>Room temp.</td> <td>3min.or less</td> </tr> </tbody> </table>			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
	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																
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 leave it at room temperature for over 24h and then measure the sample.															
	L.C.	TCP0J226□ : Less than 150% of initial limit Others : Less than initial limit																
	ΔC / C	Within ±20% of initial value																
	Df (tan δ)	Less than 150% of initial limit																

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Item	Performance	Test conditions (based on JIS C 5101-1 and JIS C 5101-3)	
Temperature Stability	Temp.	-55°C	As per 4.29 JIS C 5101-1 As per 4.13 JIS C 5101-3
	$\Delta C / C$	Within 0/-15% of initial value	
	Df (tan δ)	Shall be satisfied the voltage on " Standard list "	
	L.C.	-	
	Temp.	+85°C	
	$\Delta C / C$	Within +15/0% of initial value	
	Df (tan δ)	Shall be satisfied the voltage on " Standard list "	
	L.C.	5 μ A or 0.1CV whichever is greater	
	Temp.	+125°C	
	$\Delta C / C$	Within +20/0% of initial value	
	Df (tan δ)	Shall be satisfied the voltage on " Standard list "	
L.C.	6.3 μ A 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 \pm 0.5 min. for 30 \pm 5 s. each time in the atmospheric condition of 85 \pm 2°C. Repeat this procedure 1,000 times. After the specimens, leave it at room temperature for over 24h and then measure the sample.
	L.C.	Shall be satisfied the voltage on " Standard list "	
	$\Delta C / C$	TCP0J226□ : Within \pm 20% of initial value Others : Within \pm 10% of initial value	
	Df (tan δ)	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+36/0 h without discontinuation via the serial resistance of 3 Ω or less at a temperature of 85 \pm 2°C, leave the sample at room temperature / humidity for over 24h and measure the value.
	L.C.	TJP0J226□ : Less than 150% of initial limit Others : Less than initial limit	
	$\Delta C / C$	TJP0J226□ : Within \pm 20% of initial value Others : Within \pm 10% of initial value	
	Df (tan δ)	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.	



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Item		Performance	Test conditions (JIS C 5101-1 and JIS C 5101-3)
Adhesiveness		The terminal should not come off.	<p>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.</p> 
Dimensions		Refer to "External dimensions"	Measure using a caliper of JIS B 7507 Class 2 or higher grade.
Resistance to solvents		The indication should be clear	<p>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.</p>
Solderability		3/4 or more surface area of the solder coated terminal dipped in the soldering bath should be covered with the new solder.	<p>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 1 h. Solder temp. : 245±5°C Duration : 3±0.5s Solder : M705 Flux : Rosin 25% IPA 75%</p>
Vibration	Capacitance	Measure value should not fluctuate during the measurement.	<p>As per 4.17 JIS C 5101-1 Frequency : 10 to 55 to 10Hz/min. Amplitude : 1.5mm</p>
	Appearance	There should be no significant abnormality.	<p>Time : 2h each in X and Y directions Mounting : The terminal is soldered on a print circuit board.</p>

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● Standard products list, TC series A case

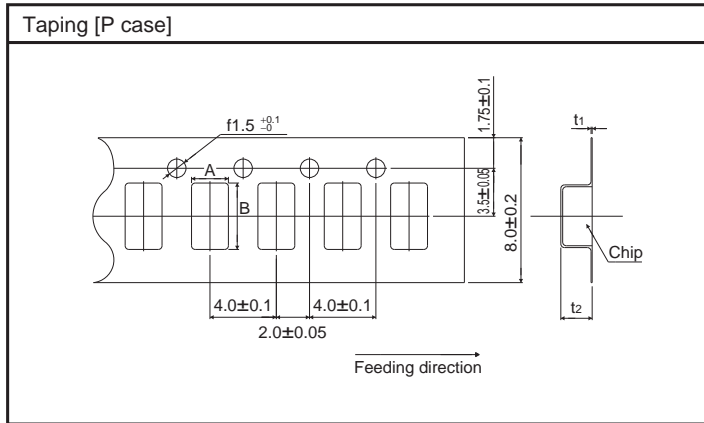
Part No.	Rated voltage 85°C (V)	Category voltage 125°C (V)	Surge voltage 85°C (V)	Cap. 120Hz (μ F)	Tolerance (%)	Leakage current 25°C 1WV.60s (μ A)	Df 120Hz (%)			Impedance 100kHz (Ω)
							-55°C	25°C 85°C	125°C	
TC P 0G 225 □	4	2.5	5	2.2	\pm 20, 10	0.5	15	10	15	17.5
TC P 0G 335 □	4	2.5	5	3.3	\pm 20, 10	0.5	30	20	30	17.5
TC P 0G 475 □	4	2.5	5	4.7	\pm 20, 10	0.5	30	20	30	14.4
TC P 0G 685 □	4	2.5	5	6.8	\pm 20, 10	0.5	30	20	30	11.8
TC P 0G 106 □	4	2.5	5	10	\pm 20, 10	0.5	30	20	30	9.3
TC P 0G 156 □	4	2.5	5	15	\pm 20, 10	0.6	30	20	30	8.3
TC P 0G 226 □	4	2.5	5	22	\pm 20, 10	0.9	30	20	30	7.7
TC P 0J 155 □	6.3	4	8	1.5	\pm 20, 10	0.5	15	10	15	17.5
TC P 0J 225 □	6.3	4	8	2.2	\pm 20, 10	0.5	30	20	30	17.5
TC P 0J 335 □	6.3	4	8	3.3	\pm 20, 10	0.5	30	20	30	14.4
TC P 0J 475 □	6.3	4	8	4.7	\pm 20, 10	0.5	30	20	30	11.8
TC P 0J 685 □	6.3	4	8	6.8	\pm 20, 10	0.5	30	20	30	9.3
TC P 0J 106 □	6.3	4	8	10	\pm 20, 10	0.6	30	20	30	8.3
TC P 0J 156 □	6.3	4	8	15	\pm 20, 10	0.9	30	20	30	7.7
TC P 0J 226 □	6.3	4	8	22	\pm 20, 10	1.4	38	25	38	5.0
TC P 1A 105 □	10	6.3	13	1.0	\pm 20, 10	0.5	15	10	15	17.5
TC P 1A 155 □	10	6.3	13	1.5	\pm 20, 10	0.5	30	20	30	16.1
TC P 1A 225 □	10	6.3	13	2.2	\pm 20, 10	0.5	30	20	30	14.4
TC P 1A 335 □	10	6.3	13	3.3	\pm 20, 10	0.5	30	20	30	11.8
TC P 1A 475 □	10	6.3	13	4.7	\pm 20, 10	0.5	30	20	30	9.3
TC P 1A 685 □	10	6.3	13	6.8	\pm 20, 10	0.7	30	20	30	9.3
TC P 1A 106 □	10	6.3	13	10	\pm 20, 10	1.0	30	20	30	8.3
TC P 1C 105 □	16	10	20	1.0	\pm 20, 10	0.5	15	10	15	16.1
TC P 1D 105 □	20	13	26	1.0	\pm 20, 10	0.5	15	10	15	16.1
TC P 1E 105 □	25	16	32	1.0	\pm 20, 10	0.6	30	20	30	9.3

□=Tolerance (M : \pm 20%, K : \pm 10%)

Tantalum capacitors

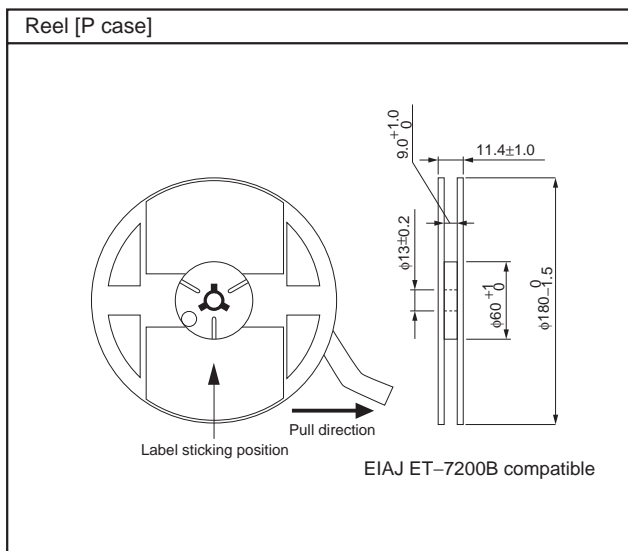
● Packaging specifications

Case code	A±0.1	B±0.1	t ₁ ±0.05	t ₂ ±0.1
P	1.55	2.3	0.25	1.5



● Packaging style

Case code	Packaging	Packaging style		Symbol	Basic ordering units
P case	Taping	plastic taping	φ180mm Reel	R	3,000pcs



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●Recommended condition of reflow soldering

(1) Leakage current-to-voltage ratio

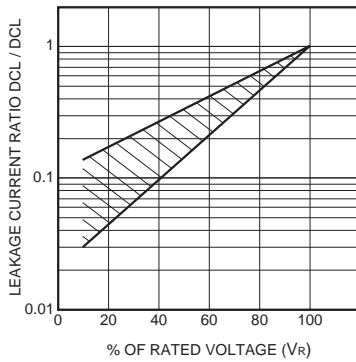


Fig.1

(2) Derating voltage as function of temperature

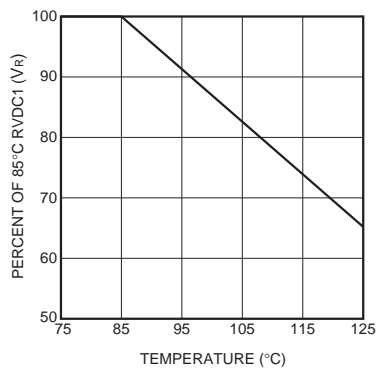


Fig.2

85°C		125°C	
Rated Voltage (V.DC)	Surge Voltage (V.DC)	Category Voltage (V.DC)	Surge Voltage (V.DC)
4	5	2.5	3.2
6.3	8	4	5
10	13	6.3	8
16	20	10	13
20	26	13	16

(3) 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.

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Malfunction rate as function of operating temperature and rated voltage

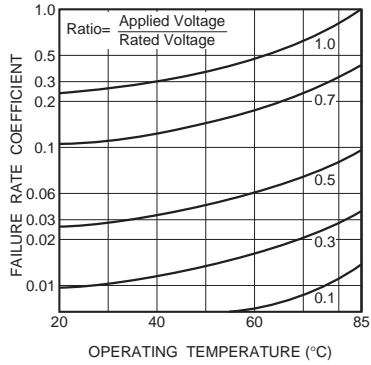


Fig.3

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

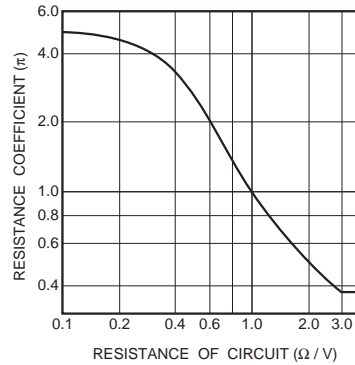


Fig.4

(4) 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 \ Temp.	+25°C	+55°C	+85°C	+125°C
P case (2012)	0.025	0.022	0.020	0.010
A case (3216)	0.070	0.063	0.056	0.028
Max. Temp Rise [°C]	5	5	5	2

Tantalum capacitors

(5) Impedance frequency characteristics

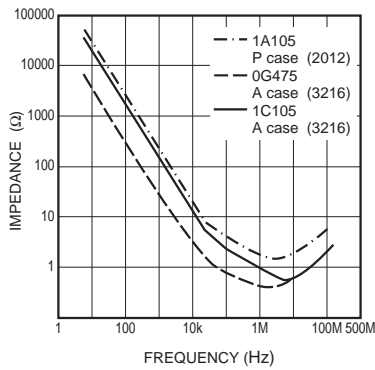


Fig.5

(6) ESR frequency characteristics

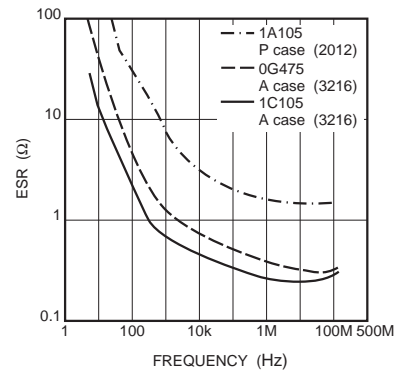


Fig.6

(7) Temperature characteristics

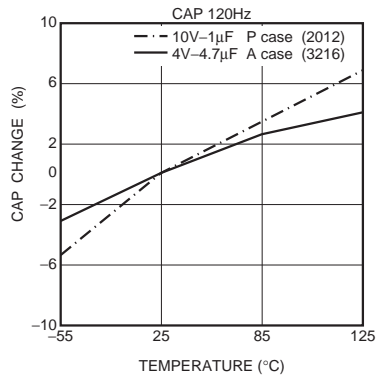


Fig.7

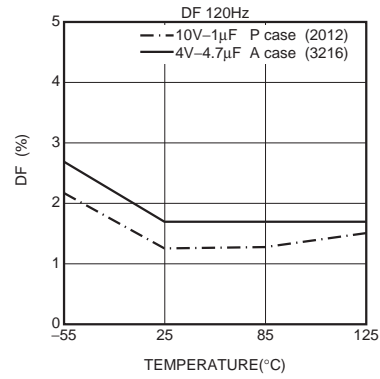


Fig.8

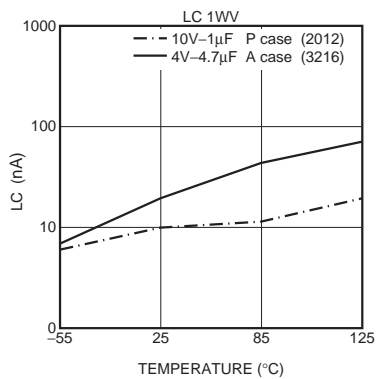


Fig.9

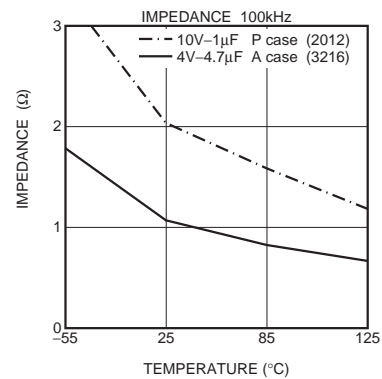


Fig.10

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Rush current

The rush current is in inverse proportion to the ESR.
 The excessive rush current may cause a damage.

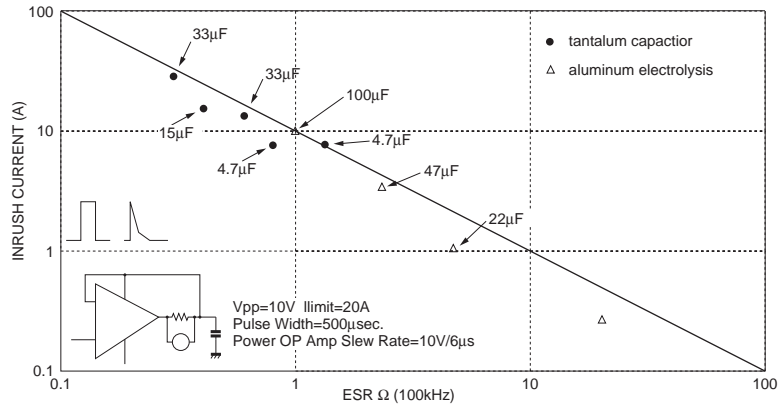


Fig. 11 Max. rush current and ESR

The rush current may be reduced by the protection resistors

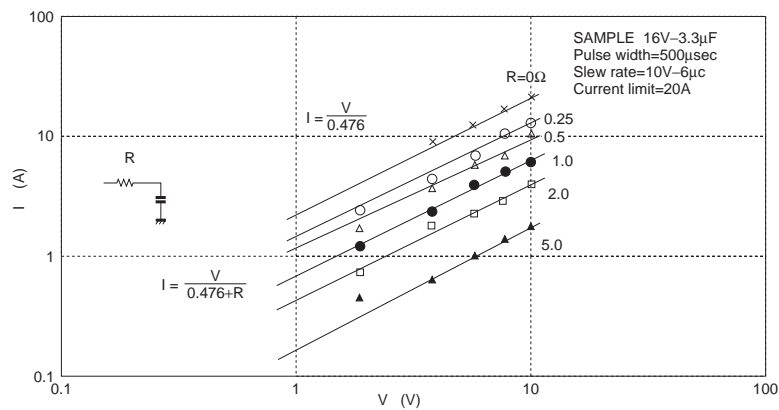


Fig. 12 Change in I max by protection resistors

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