

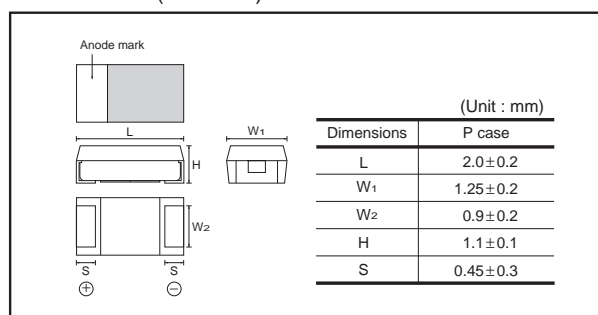
# Chip tantalum capacitors

## TC Series P Case

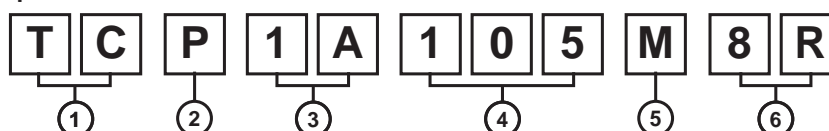
### ●Features (P)

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

### ●Dimensions (Unit : mm)



### ●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

## Tantalum capacitors

## ● 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

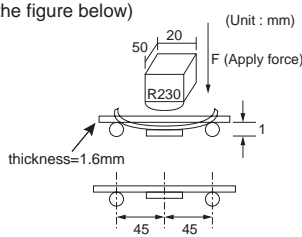
## Tantalum capacitors

## ● Characteristics

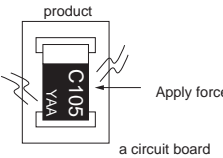
Item		Performance	Test conditions (based on JIS C 5101-1 and JIS C 5101-3)
Operating Temperature		-55°C to +125°C	Voltage reduction when temperature exceeds +85°C
Maximum operating temperature with no voltage derating		+85°C	
Rated voltage (VDC)		4 6.3 10 16 20 25	at 85°C
Category voltage (VDC)		2.5 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 $\mu$ A 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. $\pm 10\%$ , $\pm 20\%$	As per 4.7 JIS C 5101-1 As per 4.5.2 JIS C 5101-3 Measuring frequency : 120 $\pm$ 12Hz Measuring voltage : 0.5Vrms +1.5 to 2V.DC Measuring circuit : DC Equivalent series circuit
Tangent of loss angle (Df, tan $\delta$ )		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 $\pm$ 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 $\pm$ 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 $\pm$ 5°C Duration : 5 $\pm$ 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	
	$\Delta C / C$	TCP0J226□ : Within $\pm 20\%$ of initial value TCP1A106□ : Within $\pm 20\%$ of initial value Others : Within $\pm 10\%$ of initial value	
	Df (tan $\delta$ )	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	
	$\Delta C / C$	1 to 10 $\mu$ F : Within $\pm 10\%$ of initial value 15 to 22 $\mu$ F : Within $\pm 20\%$ of initial value TCP1A106□ : Within $\pm 20\%$ of initial value	
	Df (tan $\delta$ )	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 $\pm$ 2°C and 90 to 95% RH, respectively, for 500 $\pm$ 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	
	$\Delta C / C$	Within $\pm 20\%$ of initial value	
	Df (tan $\delta$ )	Less than 150% of initial limit	

	Temp.	Time
1	-55 $\pm$ 3°C	30 $\pm$ 3min.
2	Room temp.	3min.or less
3	125 $\pm$ 2°C	30 $\pm$ 3min.
4	Room temp.	3min.or less

## Tantalum capacitors

Item	Performance	Test conditions (based on JIS C 5101-1 and JIS C 5101-3)
Temperature Stability	Temp.	-55°C
	$\Delta C / C$	Within 0/-15% of initial value
	Df (tan $\delta$ )	Shall be satisfied the voltage on " Standard list "
	L.C.	—
	Temp.	+85°C
	$\Delta C / C$	Within +15/0% of initial value
	Df (tan $\delta$ )	Shall be satisfied the voltage on " Standard list "
	L.C.	5 $\mu$ A or 0.1CV whichever is greater
	Temp.	+125°C
	$\Delta C / C$	Within +20/0% of initial value
	Df (tan $\delta$ )	Shall be satisfied the voltage on " Standard list "
	L.C.	6.3 $\mu$ A or 0.125CV whichever is greater
Surge voltage	Appearance	There should be no significant abnormality.
	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 $\delta$ )	Less than 150% of initial limit
Loading at High temperature	Appearance	There should be no significant abnormality.
	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 $\delta$ )	Less than 150% of initial limit
Terminal strength	Capacitance	The measured value should be stable.
	Appearance	There should be no significant abnormality.
		<p>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)</p>  <p>(Unit : mm)</p> <p>thickness=1.6mm</p> <p>45 45</p>

## Tantalum capacitors

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>

# TC Series P Case

## Tantalum capacitors

### ● Standard products list, TC series A case

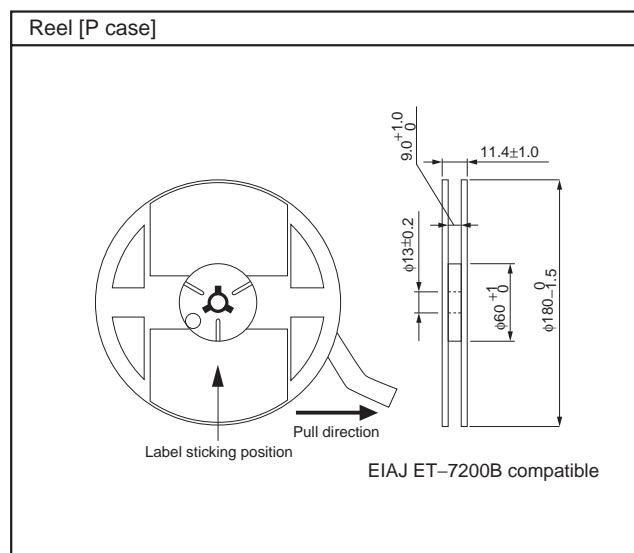
Part No.	Rated voltage 85°C (V)	Category voltage 125°C (V)	Surge voltage 85°C (V)	Cap. 120Hz (μF)	Tolerance (%)	Leakage current 25°C 1WV.60s (μA)	Df 120Hz (%)			Impedance 100kHz (Ω)
							-55°C	25°C 85°C	125°C	
TC P 0G 225 □	4	2.5	5	2.2	±20, 10	0.5	15	10	15	17.5
TC P 0G 335 □	4	2.5	5	3.3	±20, 10	0.5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

□=Tolerance (M : ±20%, K : ±10%)

Case code	A $\pm$ 0.1	B $\pm$ 0.1	t <sub>1</sub> $\pm$ 0.05	t <sub>2</sub> $\pm$ 0.1
P	1.55	2.3	0.25	1.5



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



## Tantalum capacitors

## ●Recommended condition of reflow soldering

## (1) Leakage current-to-voltage ratio

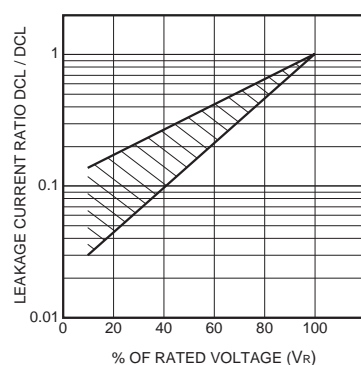


Fig.1

## (2) Derating voltage as function of temperature

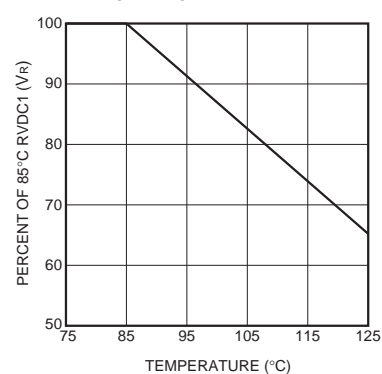


Fig.2

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

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

$\lambda_p$  : Malfunction rate stemming from operation

$\lambda_b$  : Basic malfunction rate

$\pi_E$  : Environmental factors

$\pi_{SR}$  : Series resistance

$\pi_Q$  : Level of malfunction rate

$\pi_{CV}$  : 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.



## Tantalum capacitors

Malfunction rate as function of operating temperature and rated voltage

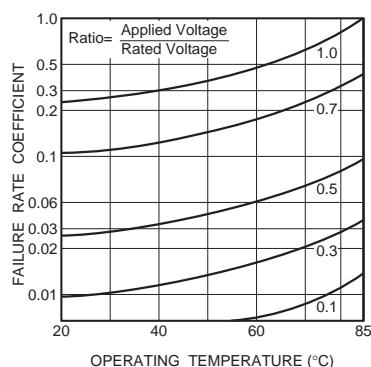


Fig.3

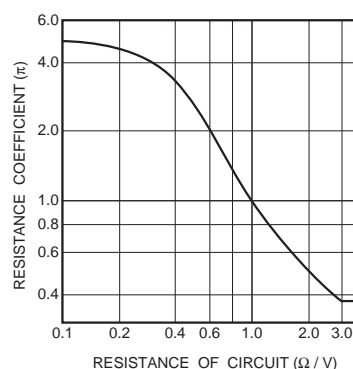
Malfunction rate as function of circuit resistance ( $\Omega/V$ )

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.

$$\text{Power dissipation (P)} = I^2 \cdot R$$

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

Temp.	+25°C	+55°C	+85°C	+125°C
Case				
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

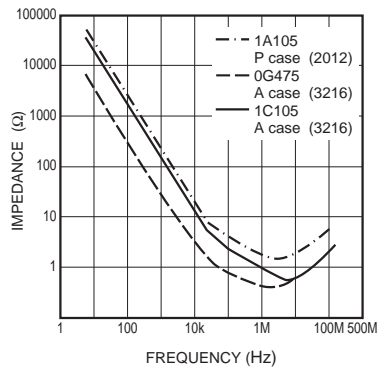


Fig.5

(6) ESR frequency characteristics

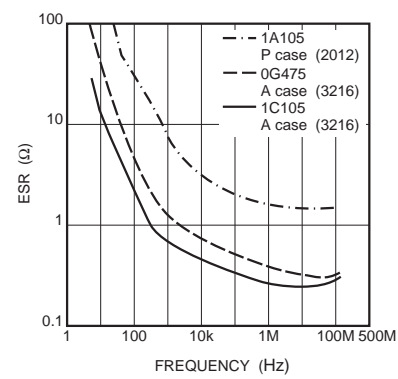


Fig.6

(7) Temperature characteristics

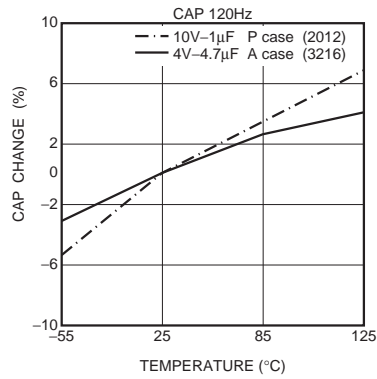


Fig.7

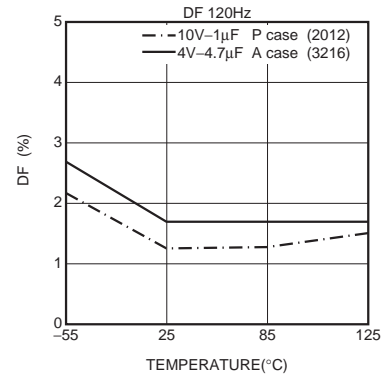


Fig.8

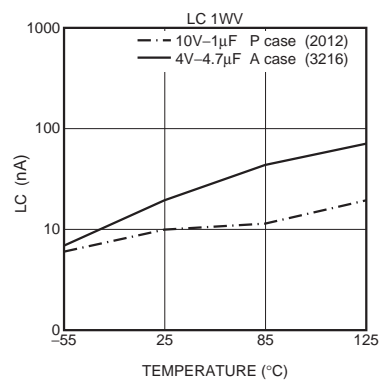


Fig.9

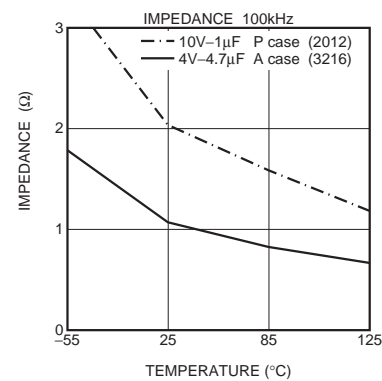


Fig.10

# Tantalum capacitors

## Rush current

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

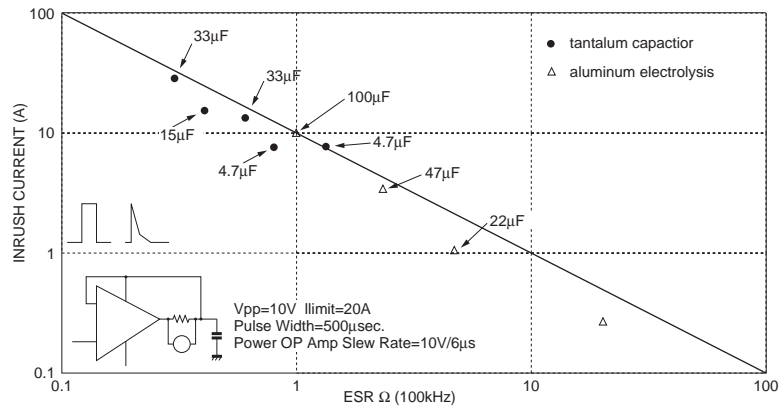


Fig. 11 Max. rush current and ESR

The rush current may be reduced by the protection resistors

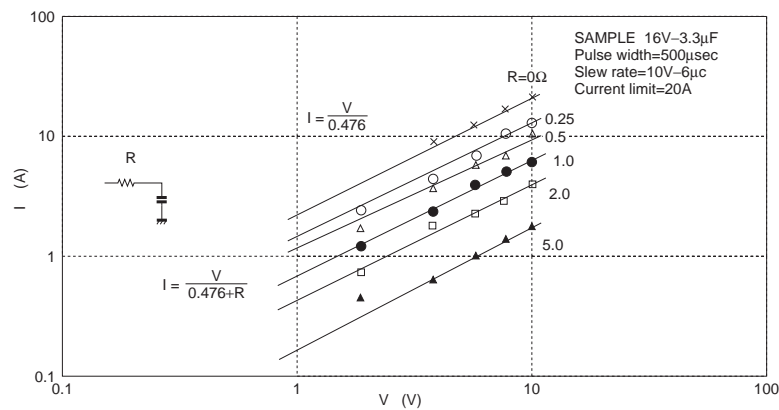


Fig. 12 Change in I max by protection resistors

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