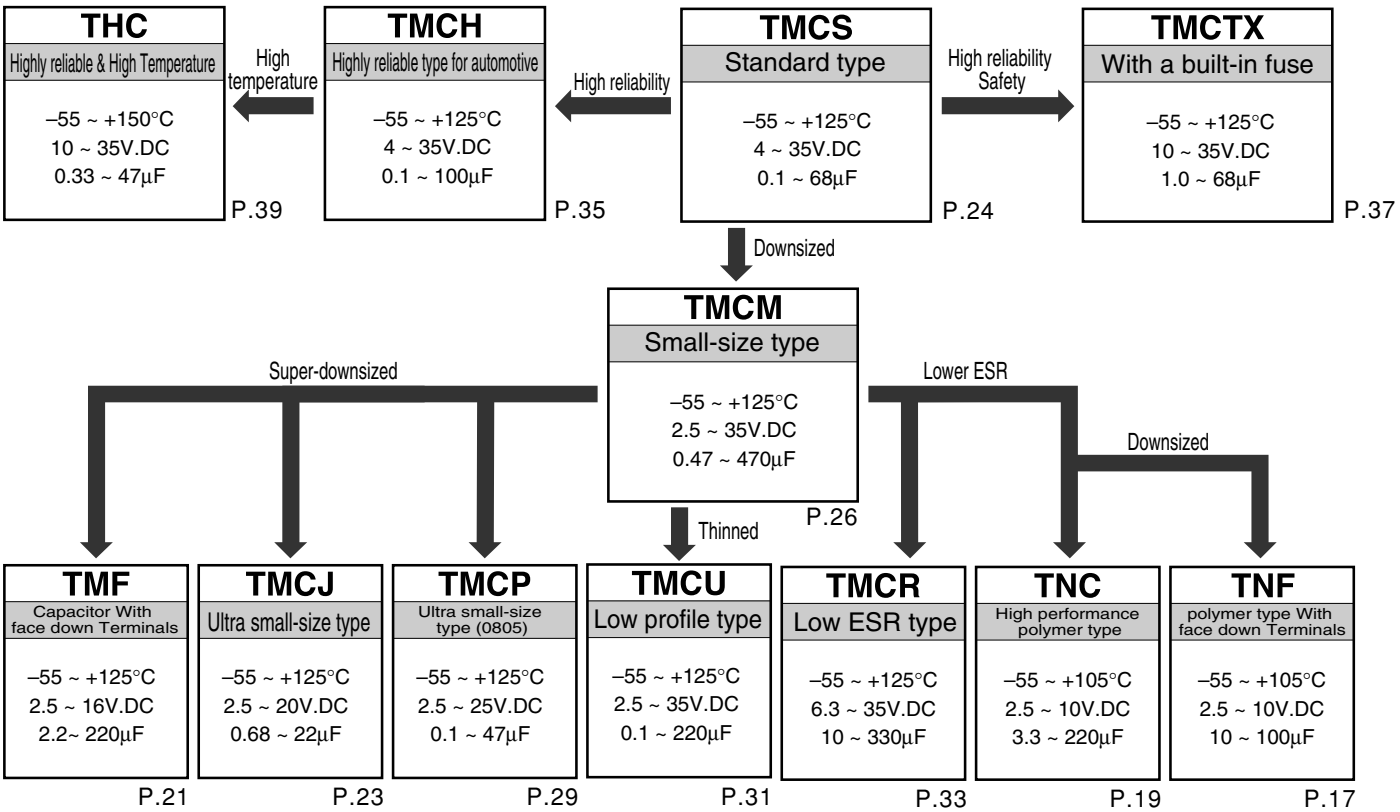
Product Table

List of tantalum electrolytic capacitor products

Series	Description	Operating temperature range	Standard type	Small-size type	Highly reliable type	Thin type	Low ESR type	Operating voltage V.DC	Capacitance range µF	See page:
TNF	Resin mold chip, polymer type with face down terminals	–55 ~ +105°C		○			○	2.5 ~ 10	10 ~ 100	17
TNC	Resin mold chip, high performance polymer type	–55 ~ +105°C					○	2.5 ~ 10	3.3 ~ 330	19
TMF	Resin mold chip, capacitor with face down terminals	–55 ~ +125°C		○				2.5 ~ 16	2.2 ~ 220	21
TMCJ	Resin mold chip, ultra small-size type (0603)	–55 ~ +125°C		○				2.5 ~ 20	0.68 ~ 22	23
TMCS	Resin mold chip, standard type	–55 ~ +125°C	○					4 ~ 35	0.1 ~ 68	24
TMCM	Resin mold chip, small-size type	–55 ~ +125°C		○				2.5 ~ 35	0.47 ~ 470	26
TMCP	Resin mold chip, ultra small-size type (0805)	–55 ~ +125°C		○				2.5 ~ 25	0.1 ~ 47	29
TMCU	Resin mold chip, low profile type	–55 ~ +125°C				○		2.5 ~ 35	0.1 ~ 220	31
TMCR	Resin mold chip, low ESR type	–55 ~ +125°C					○	6.3 ~ 35	10 ~ 330	33
TMCH	Resin mold chip, highly reliable type	–55 ~ +125°C			○			4 ~ 35	0.1 ~ 100	35
TMCTX	Resin mold chip, with a built-in fuse	–55 ~ +125°C			○			10 ~ 35	1.0 ~ 68	37
THC	Resin mold chip, high relaible, high temperature	–55 ~ +150°C			○			10 ~ 35	0.33 ~ 47	39

Chip type

• VCR cameras, headphones, and other electronic equipment • Cameras • HIC • Automotive electrical equipment
• Personal computers • Cellular communications equipment • DC-DC converters • Others



Planning to change over to Sn100 plating for all series.

Precautions in using Tantalum Capacitors

The major conditions to be considered in relation to the use of the tantalum capacitors are as follows:

1) Electrical conditions
2) Climatic conditions
3) Conditions for mounting on equipment and circuit boards
4) Mechanical vibration, shock, and storage conditions

If the tantalum capacitors are used without satisfying any one of these conditions, the probability of short-circuiting, leakage current increase or other problems to occur. To avoid such problems, observe the following precautions when using the tantalum capacitors.

1. Operating Voltage

(1) The voltage derating factor should be as great as possible. Under normal conditions, the operating voltage should be reduced to 50% or less of the rated. It is recommended that the operating voltage be 30% or less of the rated, particularly when the tantalum capacitors are used in a low-impedance circuit (see Figs. 1, 2, and 3).

(2) For circuits in which a switching, charging, discharging, or other momentary current flows, it is recommended that the operating voltage be 30% or less of the rated, with a resistor connected in series to limit the current to 300 mA or less (see section 4 for details).

(3) When the tantalum capacitors are to be used at an ambient temperature of higher than 85°C, the recommended operating range shown in Fig. 3 should not be exceeded.

• Low-impedance circuits

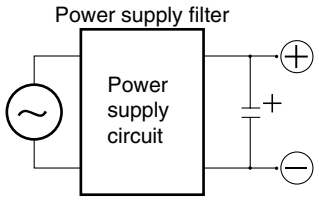


Fig. 1

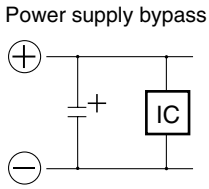


Fig. 2

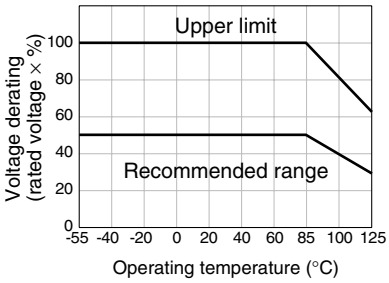


Fig. 3

2. Ripple

If an excessive ripple voltage is applied to the tantalum capacitors, their internal temperature rises due to Joule heat, resulting in the detriment of their reliability. The maximum permissible ripple voltage and current are related to the ratings or case size. Please consult us for detail information.

2.1 Ripple Current

The maximum permissible ripple current, I_{MAX}, is calculated as follows:

$$I_{MAX} = \sqrt{\frac{P_{MAX}}{ESR\ (D)}}$$

where:

I_{MAX}: Maximum permissible capacitor ripple current (Arms).
P_{MAX}: Maximum permissible capacitor power loss (W). Varies with the ambient temperature and case size. Calculated according to Table 1.
ESR (D): Capacitor equivalent series resistance (Ω).

Since the ESR(D) value varies with the ripple frequency, however, the following correction must be made in accordance with the operating frequency (see Table 2 and Fig. 4).

ESR (D)=K • ESR (120)

K: Coefficient for the operating frequency (Table 2 and Fig. 4).

$$\textbf{ESR (120)} = \tan\delta \cdot Xc = \frac{\tan\delta}{2\pi fC}$$

where:

ESR (120): Equivalent series resistance at 120 Hz (Ω).
Xc : Capacitive reactance at 120 Hz (Ω).
C : Electrostatic capacitance at 120 Hz (μF).
f : Operating frequency (Hz).

Table 1 Maximum permissible power loss values (P_{MAX}) by case size

Ambient temperature (°C)	P_{MAX} (W)						
	LM,J	LP,P	LA,UA,A	UB,B	C	E	F
25	0.050	0.064	0.078	0.096	0.100	0.120	0.160
55	0.032	0.045	0.051	0.062	0.065	0.078	0.104
85	0.018	0.023	0.029	0.035	0.037	0.044	0.059

Table 2

Frequency f	K
120	1.0
400	0.8
1k	0.65
10k	0.50
20k	0.45
40k	0.43
100k	0.40
1M	0.35

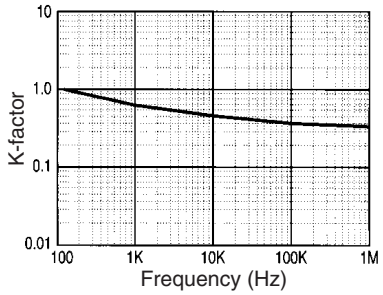


Fig. 4 Correction coefficient (K)

2.2 Ripple Voltage

(1) The tantalum capacitors must be used in such a conditions that the sum of the working voltage and ripple voltage peak values does not exceed the rated voltage (Fig. 5)

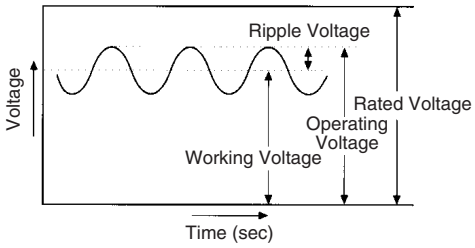


Fig. 5

(2) Ensure that an reverse voltage due to superimposed voltages is not applied to the capacitors.

(3) The maximum permissible ripple voltage varies with the rated voltage. Ensure that ripple voltage does not exceed the values shown in Figs. 6 and 7. If, however, the capacitors are used at a high temperature, the maximum permissible ripple voltage must be calculated as follows:

Vrms (at 55°C) = 0.8 × Vrms (at 25°C)
Vrms (at 85°C) = 0.6 × Vrms (at 25°C)
Vrms (at 125°C) = 0.4 × Vrms (at 25°C)

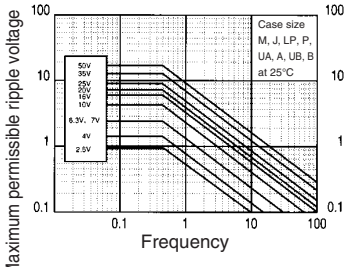


Fig. 6 Maximum permissible ripple voltage (LM, J, LP, P, UA,LA, A, UB, B)

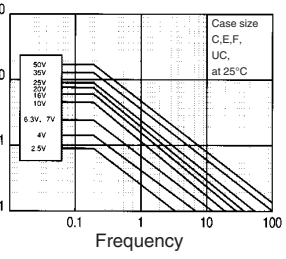


Fig. 7 Maximum permissible ripple voltage (C, E, F)

3. Reverse Voltage

(1) The tantalum capacitors must not be operated and charged in reverse mode. And also the capacitors must not be used in an pure AC circuit.

(2) The tantalum capacitor dielectric has a rectifying characteristics. Therefore, when a reverse voltage is applied to it, a large current flows even at a low reverse voltage. As a result, it may spontaneously generate heat and lead to shorting.

(3) Make sure that the polarity and voltage is correct when applying a multimeter or similar testing instrument to the capacitors because a reverse voltage or overvoltage can be accidentally applied.

(4) When using the capacitors in a circuit in which a reverse voltage is applied, consult your local Hitachi AIC agent. If the application of an reverse voltage is unavoidable, it must not exceed the following values:
At 25°C: 10% of the rated voltage or 1 V, whichever smaller.
At 85°C: 5% of the rated voltage or 0.5 V, whichever smaller.
Further, the reverse voltage application time must be no longer than 240 hours, with the power supply impedance maintained at 33Ω or more.
*These limits are reference value.

4. Reliability of Tantalum Capacitors

4.1 General

The failure rate of the tantalum capacitor varies with the derating ratio, ambient temperature, circuit resistance, circuit application, etc. Therefore, when proper selections are made so as to afford additional margins, higher reliabilities can be derived from the tantalum capacitors. Some examples of actual failure rates are presented below for your reference.

4.2 Failure Rate Calculation Formula

The tantalum capacitors are designed to work at their basic failure rates shown in Table 3 that prevail when the rated voltage is applied for 1000 hours at 85°C.

Table 3 Basic failure rate

Type	Classification	Basic failure rate
TMCR	Low ESR type	1%/1000hrs
TMF	Face down terminals	
TMCJ	Ultra small-size type (0603)	
TMCP	Ultra small-size type (0805)	
TMCU	Low profile type	
TMCM	Small type	
TMCS	Standard type	
TMCTX	Fuse-incorporated type	
TMCH	High-reliability type	0.5%/1000hrs
TNC	High performance polymer type	1%/1000hrs

A capacitor failure rate can be calculated from the formula shown below. Note that a capacitor failure rate can be lowered by giving margins to the circuit temperature, applied voltage ratio (derating factor), and circuit resistance selected for the basic failure rate.

• Failure rate calculation formula

λ use = λ 85 × K_V × K_R

λ use: Estimated capacitor failure rate under the operating conditions.
λ 85: Basic failure rate (Table 3)
K_V: Failure rate correction coefficient by the ambient temperature and derating factor.
K_R: Failure rate correction coefficient by the circuit resistance, which is the series-connected resistance divided by the voltage applied to the capacitor. This resistance is connected in series when the power supply side is viewed from the capacitor side. The K_V and K_R values must be determined according to Figs. 8 and 9.

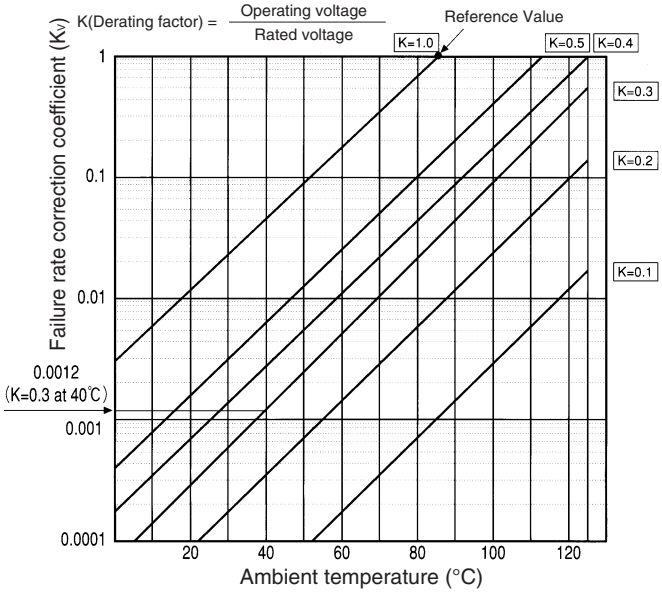


Fig. 8 Ambient temperature and derating-dependent failure rate correction coefficient (K_V)

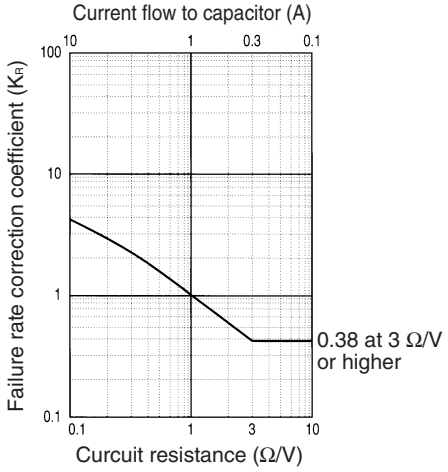


Fig. 9 Circuit resistance-dependent failure rate correction coefficient (K_R)

4.3 Example of Capacitor Failure Rate Calculation

• Operating conditions

Type:	TMCM type
Rating:	10 V, 10 µF (B case)
Operating temperature:	40°C
Derating factor:	0.3 [K=operating voltage / rated voltage=3 V/10 V=0.3]
Circuit resistance:	3Ω / V
λ85:	1%/1000 hours (from Table 3)
K_V:	0.0012 (from Fig. 8)
K_R:	0.38 (from Fig. 9)

$\lambda_{use}=\lambda_{85}\times K_V\times K_R=1\%/1000h\times 0.0012\times 0.38$
$=1\times 10^{-5}\times 0.0012\times 0.38$
$=4.56\times 10^{-9}$
$=0.000456\%/1000h$
$=4.56Fit$
} Estimated failure rate

5. Mounting Precautions

5.1 Limit Pressure on Capacitor Installation with Mounter

Pressure must not exceed 4.9 N with a tool end diameter of 1.5 mm when applied to the capacitors using an absorber, centering tweezers, or the like (maximum permitted pressurization time: 5 seconds). An excessively low absorber setting position would result in not only the application of undue force to the capacitors but capacitor and other component scattering, circuit board wiring breakage, and/or cracking as well, particularly when the capacitors are mounted together with other chips having a height of 1 mm or less.

5.2 Flux Selection

(1) Select a flux that contains a minimum of chlorine and amine.
(2) After flux use, the chlorine and amine in the flux remain must be removed.

5.3 Recommended Soldering Pattern Dimensions

The recommended chip soldering pattern dimensions are as shown in Table 4 and Fig. 10. Note, however, that they are affected by such factors as reflow conditions, solder type, and circuit board size.

If the pattern area is significantly larger than the capacitor terminal area, the capacitor in place may be displaced when the solder melts.

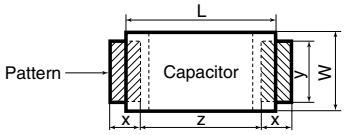


Fig. 10

Table 4 Recommended soldering pattern dimensions (mm)

Dimensions / Case	Capacitor size		Pattern dimensions		
	L	W	x	y	z
LM	1.6	0.8	0.5^{MIN}	0.65^{MIN}	0.65^{MAX}
J	1.6	0.8	0.9	1.0	0.7
LP	2.0	1.25	0.5^{MIN}	0.8^{MIN}	1.05^{MAX}
P	2.0	1.25	1.2	1.1	0.8
LA	3.2	1.6	0.8^{MIN}	1.2^{MIN}	1.65^{MAX}
LA,UA,A	3.2	1.6	1.6	1.2	1.2
UB,B	3.5	2.8	1.6	2.2	1.4
C	5.8	3.2	2.3	2.4	2.4
E	7.3	4.3	2.3	2.6	3.8
F	7.3	5.8	2.3	3.8	3.8

5.4 Chip Soldering Temperature and Time

For the capacitor body, the chip soldering temperature and time must be as shown below.

(1) Reflow soldering (infrared, hot air, hot plate)
Capacitor body temperature: 260°C or lower(TNC:240°C or lower)
Time: 10 sec. max.
Permitted temperature/time range: See Fig. 11.

NOTE 1: When upward heating is provided by infrared, the capacitor body temperature rises above the circuit board surface temperature.

When a high-power hot blast stove or the like is used, a sudden temperature rise occurs.

Therefore, a 130-160°C, 1-minute preheating zone should be provided to ensure that the difference from the reflow maximum temperature is not greater than 100°C (see Fig. 12).

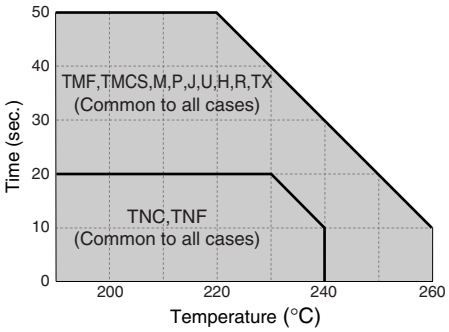


Fig. 11 Reflow soldering permitted temperature / time range

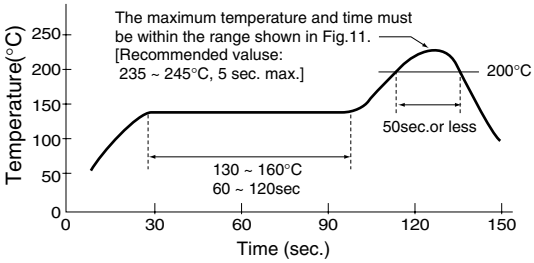


Fig. 12 Recommended temperature profile

(2) Flow soldering (not available for TNC type)
Solder bath temperature: 260°C or lower
Time: LM, J, LP, P, UA, LA,A, UB, or B case, 10 sec max. C, E, F case, 5 sec max.
Permitted temperature and time range: See Fig. 13.

NOTE 1: To avoid sudden heating, conduct preheating. 130-160°C, 1-minute preheating zone should be provided (see Fig. 14).

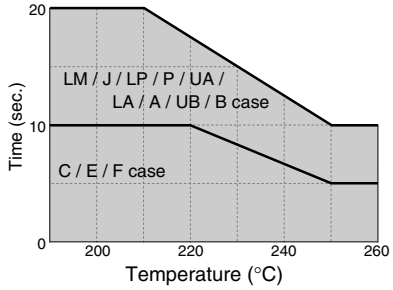


Fig. 13 Flow soldering permitted temperature / time range

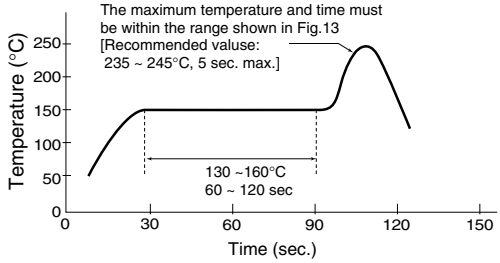


Fig. 14 Recommended temperature profile

(3) Soldering with a soldering iron
The use of a soldering iron should be avoided wherever possible. If it is unavoidable, follow the instructions set forth in Table 5. The time of soldering with an iron should be one.

Table 5

Type	TMCR,TMCS,TMCM,TMCP,TMCJ,TMCU,TMCH	TMCTX *
Soldering-iron tip temperature	$350°C_{MAX}$	290°C MAX
Time	3 sec MAX	3 sec MAX
Soldering-iron power	30 W MAX	30 W MAX

*If a soldering iron is used at a high temperature for the TMCTX type which incorporates a thermal fuse, the fuse opens. Due care must be used to avoid such a trouble.

*If a soldering iron needs to be used for TMF and/or TNC type, please contact us for information.

(4) Repetition of soldering
The soldering conditions for soldering operations (1) through (3) above are established on the presumption that only one type of soldering operation is conducted.
When repeating a reflow soldering or a combined flow-and-reflow soldering operation, comply with the following conditions:

i) Once the capacitor is mounted, it must not be removed for reuse.
ii) Any type of soldering operation may be performed to the capacitor only twice.
iii) The second performance of a type of soldering operation must not be initiated until a 2-hour or longer heat dissipation period has elapsed after completion of the first performance.
iv) Cleaning must be conducted upon completion of the second performance.

*Soldering conditions (temperature, time) of Sn 100 terminal products are same as the above.

5.5 Cleaning after Mounting

The following solvents are usable when cleaning the capacitors after mounting. Never use a highly active solvent.

- Halogen organic solvent (HCFC225, etc.)
- Alcoholic solvent (IPA, ethanol, etc.)
- Petroleum solvent, alkali saponifying agent, water, etc.

Circuit board cleaning must be conducted at a temperature of not higher than 50°C and for an immersion time of not longer than 30 minutes. When an ultrasonic cleaning method is used, cleaning must be conducted at a frequency of 48 kHz or lower, at an vibrator output of 0.02 W/cm³, at a temperature of not higher than 40°C, and for a time of 5 minutes or shorter.

NOTE 1: Care must be exercised in cleaning process so that the mounted capacitor will not come into contact with any cleaned object or the like or will not get rubbed by a stiff brush or the like. If such precautions are not taken particularly when the ultrasonic cleaning method is employed, terminal breakage may occur.

NOTE 2: When performing ultrasonic cleaning under conditions other than stated above, conduct adequate advance checkout.

6. Long-term Stock

The capacitors which has been storaged for more than 1 years, please contact us before use.

7. Others

(1) For further details, refer to EIAJ RCR-2368B, Precautions and Guidelines for Using Electronic Device Tantalum Capacitors.

(2) If you have any questions, feel free to contact your local Hitachi AIC agent.

TAPING AND TERMINAL PLATING SPECIFICATION FOR TMC TYPE CAPACITORS (INCLUDING TMF AND TNC TYPES)

1. Product Symbol

Example:TMCM Series A case 4V 10μF ±20%
(Tape delivery, insertion direction, feed hole side cathode)

TMCM A 0G 106 M T R F

- Terminal code
- Packing polarity code
- Packing method code (T:carrier tape)
- Capacitance tolerance code
- Capacitance code
- Rated voltage code
- Case size code

Type of series

2. Tape Materials

Transparent or half-transparent plastic covering tape is stuck by heat press.

3. Tape Size

See Fig. 1 and Table 1.

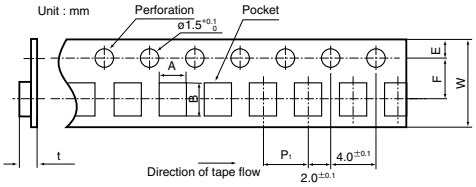


Fig. 1

Table 1 (Unit : mm)

Capacitor dimensions	A±0.1	B±0.1	W±0.1	F±0.1	E±0.1	P1±0.1	tMAX	Quantity per reel
P	1.5	2.2	8.0	3.5	1.75	4.0	1.6	3000pcs
UA	1.9	3.5	8.0	3.5	1.75	4.0	1.7	3000pcs
UB	3.1	3.9	8.0	3.5	1.75	4.0	1.7	3000pcs
A	1.9	3.5	8.0	3.5	1.75	4.0	2.5	2000pcs
B	3.1	3.9	8.0	3.5	1.75	4.0	2.5	2000pcs
C	3.7	6.3	12.0	5.5	1.75	8.0	3.0	500pcs
E	4.8	7.7	12.0	5.5	1.75	8.0	3.4	500pcs
F	6.3	7.5	12.0	5.5	1.75	8.0	4.1	500pcs
LM,J	1.0±0.2	1.8±0.2	8.0	3.5	1.75	4.0	1.3	4000pcs
LP	1.5	2.3	8.0	3.5	1.75	4.0	1.5	3000pcs
LA	1.9	3.5	8.0	3.5	1.75	4.0	1.5	3000pcs

4. Inserting Direction

Capacitors are packed with their cathodes on perforation side and with their electrodes faced with the bottoms of the pockets. (See Fig. 3.)

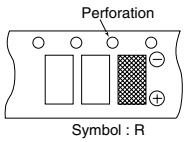


Fig. 2

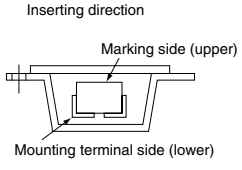


Fig. 3

5. Adhesion Strength of Cover at Peeling off

When cover tape is peeled off in such manner as Fig. 4 adhesion strength F must be with the range of 0.3±0.2N.

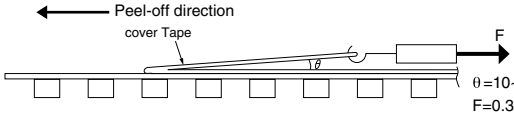


Fig. 4

6. Reel Drawings and Dimensions

As indicated in Fig. 5.

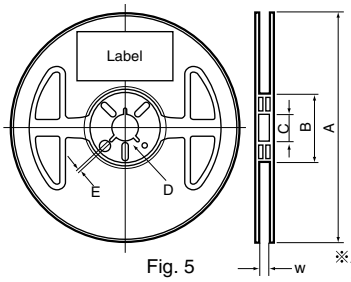


Fig. 5

(Unit:mm)

Tape width	8	12
A −0 −3	ø180	←
B +1 0	ø60	←
C ±0.2	ø13	←
D ±0.5	ø21	←
E ±0.5	2.0	←
W ±0.3	9.0	13.0

※A tape reel diameter of 330 mm is aiso applicable.

7. Quantity Packed in Reel and Description

The standard number of capacitors to be accommodated by one reel is as indicated in Table 1.

One side surface of a reel is basically marked with the following items of information.

(1) Name of capacitor or product identification
(2) Rated voltage
(3) Capacitance value
(4) Capacitance tolerance value
(5) Quantity
(6) Lot number for production month / year
(7) Manufacturer's name or symbol.

8. Part Number Discrimination of terminal plating

No.	Part Number Descrimation	Plating Materials
1	TMCM✻ △△□□□○○○F	Sn100

*As regards TNC, TMF and TMCJ types, their terminals are plated only with Sn100.

9. Packing and Storage

The capacitors are packed in such a manner that they will not possibly be damaged during transit or storage. As far as they are stored at normal temperature with normal humidity (5 to 35°C, below 75% RH), they are warranted for a period of 1 years from the date of manufacture. TNC series are moisture sensitive. The storage condition recommends JEDEC level 4. The maximum storage is within 1 year. Once Dry Pak is opend parts must be stored at less than 60%RH and 5~30°C and must be Reflow Soldered within 72 hour.

Please pay attention, because a soldering faulty sometimes occurs, in the case that it came off an above strage carlition.

10. Other Specification

The JIS C 0806 Standard, EIAJ EXT-7001 Standard, and relevant agreements are complied with.

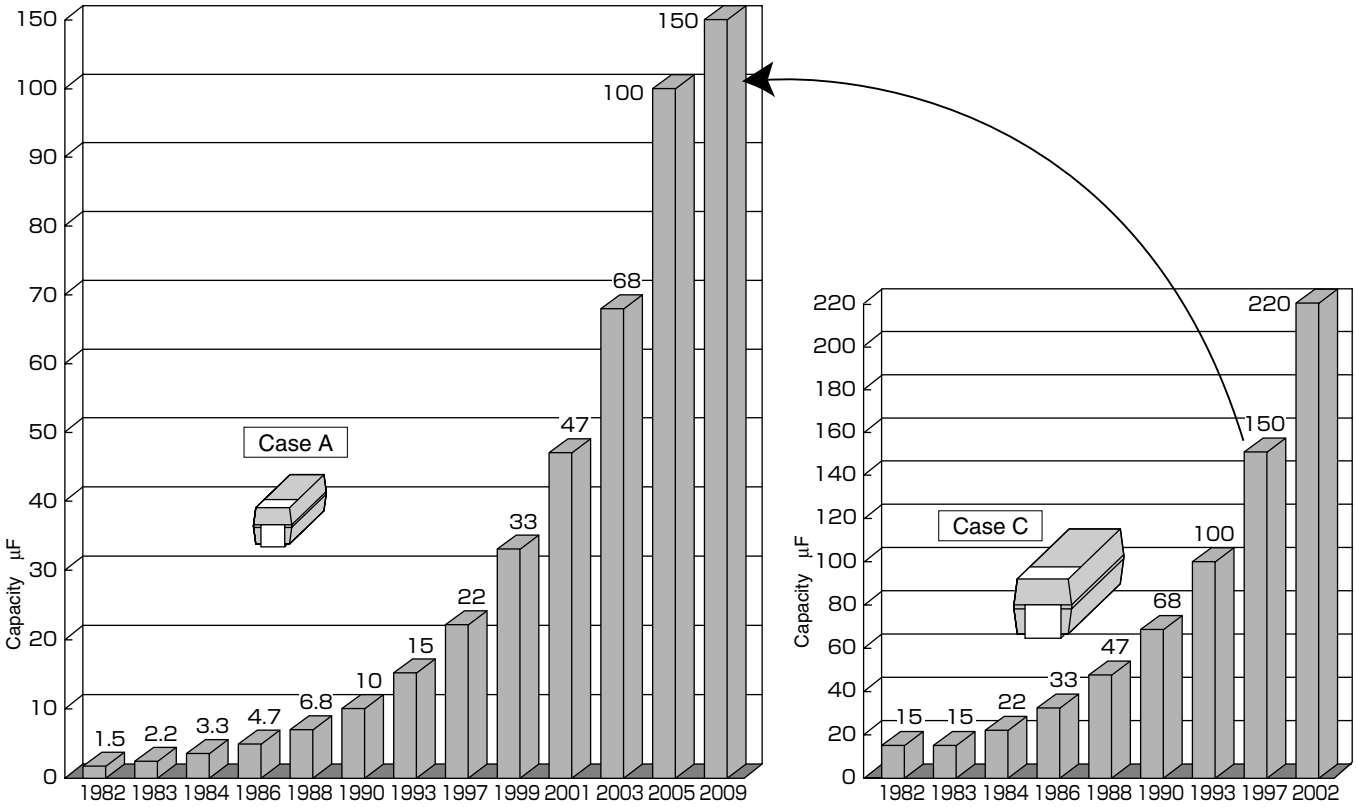
About downsizing (upgrading)

To meet the recent needs for electronic products smaller in size and lighter in weight, chip type tantalum capacitor manufacturers have been downsized their products by various methods. Of these methods, the method of ensuring a required capacity by thinning the dielectric film greatly reduces the withstand voltage characteristics. The most common method is therefore by using fine tantalum powder to enlarge the surface area of the anode per unit area.

The TMC type has been enlarged in capacity and reduced in size by taking full advantage of fine powder (hereinafter referred to as "high-CV powder"). In recent years, however, technical advances have been remarkable in downsizing and capacity expansion in the industry of multilayer ceramic capacitors. The advantage of TMCs is therefore being challenged. To keep the advantage in competing with ceramic capacitors today, it is imperative to use high-CV powder to upgrade the TMCs.

Hitachi AIC is planning to make yet another family of products.

(1) Development of products with a larger capacity than the TMCM type
(2) Development of products with a larger capacity than the TMCP type (0805 inch)
(3) Development of products with a larger capacity than the TMCU type (thin type, a low-height version of the TMCM type).
(4) Development of products TMCJ type (0603 inch)
(5) Development of products Niobium solid Electrolytic Capacitors.
(6) Development of products with a larger capacity than the TMF type (Face down terminals type).



History of capacity expansion in 6.3-V(7V) models

Pb free chip tantalum Capacitor (TMC serise)

•Tin-based Solder for Terminal Plating – Heat-resistant at up to 260°C

Lead alloy solder mounting

No need to change existing mounting conditions (for conventional – with lead – production lines)

Lead-free solder mounting

For lead-free solder of any base materials (For lead-free production lines)

Hitachi AIC has developed a tantalum capacitor containing no lead at the terminal, which went into mass production in April 2001.

Lead alloy has long been used in electrical and electronic equipment for solderings. Lead is, however, known to be harmful. The European Union has announced that it would ban the use of lead and other hazardous substances from 2006.
In the interest of preserving the global environment, Hitachi AIC has been studying a way to eliminate the use of lead in terminal plating.

The new plating method is based on tin, the main ingredient in joint solder. It can therefore be used in both lead alloy and lead-free soldering.

We ensure this product's high degree of heat-resistance (260°C ; up to 10 seconds) to provide strong support in the move to lead-free production lines.

Specifications Table

	TNF	TNC	TMF	TMCJ	TMCS	Test conditions JIS C5101-1:1998
Specifications Table	-55℃～+105℃	-55℃～+105℃	-55℃～+125℃	-55℃～+125℃	-55℃～+125℃	
Rated voltage	DC2.5～10V	DC2.5～10V	DC2.5～16V	DC2.5～20V	DC4～35V	85℃
Surge voltage	DC3～13V	DC3～13V	DC3.2～20V	DC3.2～26V	DC5～45V	85℃
Derated voltage	DC1.6～6.3V	DC1.6～6.3V（105℃）	DC1.6～10V	DC1.6～13V	DC2.5～22V	125℃（TNC:105℃, THC:150℃）
Capacitance	10～100 μF	3.3～330 μF	2.2～220 μF	0.68～22 μF	0.1～68 μF	
Capacitance tolerance	±20%	±20%	±20%	±20%	±10% or 20%	Paragraph 4.7, 120 Hz
Leakage current	Refer to standard product table	Refer to standard product table	0.01CV or 0.5 μA, whichever is larger or less.	Refer to standard product table	0.01CV or 0.5 μA, whichever is larger or less.	Paragraph 4.9, in 5 minutes after the rated voltage is applied.
tan δ	0.1 or less	0.1 or less	0.3 or less	0.2 or less	0.1～1.0 0.04 or less 1.5～68 0.06 or less	Paragraph 4.8, 120 Hz
ESR	LP case 200mΩ,500mΩ MAX LA case 200mΩ,500mΩ MAX	—	—	—	—	—
Surge withstanding voltage	△C/C ±20% or less tan δ Specified initial value or less LC 300% or less Specified initial value or less	△C/C ±20% or less tan δ Specified initial value or less LC ≦0.1CV or ≦0.3CV	△C/C ±20% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±20% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±5% or less tan δ Specified initial value or less LC Specified initial value or less	Paragraph 4.26
Temperature characteristics	Specified initial value / -55 / 105 △C/C — / -20～0% / 0～+30% tan δ 0.10 / 0.14 / — Value shown table or less LC Refer to standard product table / — / 1CV or 30μA or less	Specified initial value / -55 / 105 △C/C — / -20～0% / 0～+30% tan δ 0.10 / 0.14 / — Value shown table or less LC Refer to standard product table / — / 1CV or 30μA or less	Specified initial value / -55 / 85 / 125 △C/C — / -20～+20% / 0～+20% / 0～+20% tan δ 0.30 / 0.60 / 0.30 / 0.40 Value shown table or less LC Refer to standard product table / — / 1000% or less specified initial value or less / 1250% or less specified initial value or less	Specified initial value / -55 / 85 / 125 △C/C — / -20～0% / 0～+20% / 0～+20% tan δ 0.2 / 0.3 / 0.2 / 0.3 Value shown table or less LC Refer to standard product table / — / 1000% or less specified initial value or less / 1250% or less specified initial value or less	Specified initial value / -55 / 85 / 125 △C/C — / -10～0% / 0～+10% / 0～+12% tan δ 0.04 / 0.04 / 0.05 / 0.05 Value shown table or less 0.06 / 0.06 / 0.07 / 0.07 LC 0.01CV or 0.5μA or less / — / 0.1CV or 5μA or less / 0.125CV or 6.25μA or less	Paragraph 4.24
Solder heat resistance	△C/C ±20% or less tan δ Specified initial value or less LC 300% or less Specified initial value or less	△C/C ±20% or less tan δ Specified initial value or less LC ≦0.1CV or ≦0.3CV	△C/C ±20% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±20% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±5% or less tan δ Specified initial value or less LC Specified initial value or less	Solder Dip 260±5℃ LM,J,LP,P,LA, UA,A,UB,B case C,E,F case 10±1 sec. 5±0.5 sec. Reflow 260℃ 10±1 sec.
Moisture resistance no load	△C/C +30% ～ -20% or less tan δ Specified initial value or less LC 300% or less Specified initial value or less	△C/C +30% ～ -20% or less tan δ Specified initial value or less LC 300% or less Specified initial value or less	△C/C ±20% or less tan δ 150% or less Specified initial value or less LC Specified initial value or less	△C/C ±20% or less tan δ 150% or less Specified initial value or less LC Specified initial value or less	△C/C ±5% or less tan δ Specified initial value or less LC Specified initial value or less	Paragraph 4.22 40℃ 90 ～ 95%RH, 500hours （TMCH,THC:85℃, 85%RH, 1000hours）
High-temperature load	△C/C ±20% or less tan δ Specified initial value or less LC 300% or less Specified initial value or less	△C/C ±20% or less tan δ Specified initial value or less LC 300% or less Specified initial value or less	△C/C ±20% or less tan δ Specified initial value or less LC 200% or less Specified initial value or less	△C/C ±20% or less tan δ Specified initial value or less LC 200% or less Specified initial value or less	△C/C ±10% or less tan δ Specified initial value or less LC 125% or less Specified initial value or less	Paragraph 4.23 85℃ The rated voltage is applied for 2000 hours. (TMCH:Derated voltage in 125℃, THC:Derated voltage in 150℃)
Thermal shock	△C/C ±20% or less tan δ Specified initial value or less LC 300% or less Specified initial value or less	△C/C ±20% or less tan δ Specified initial value or less LC ≦0.1CV or ≦0.3CV	△C/C ±20% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±20% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±5% or less tan δ Specified initial value or less LC Specified initial value or less	Leave at -55℃, normal temperature, 125℃, and normal temperature for 30 min., 3 min., 30 min., and 3 min. Repeat this operation 5 cycles running. TMCS,TMCTX:20 cycles TMCH,THC:1000 cycles
Moisture resistance load	—	—	—	—	△C/C ±10% or less tan δ 150% or less Specified initial value or less LC 125% or less Specified initial value or less	40℃, humidity 90 to 95%RH The rated voltage is applied for 500 hours. （TMCH,THC:65℃）
Failure rate	1%／1000hrs	1%／1000hrs	The same as shown at left	The same as shown at left	The same as shown at left	85℃. The rated voltage is applied (through a protective resistor of 1Ω/V).

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	TMCM	TMCP	TMCU	TMCR	Test conditions JIS C5101-1:1998
Specifications Table	-55℃～+125℃	The same as shown at left	The same as shown at left	The same as shown at left	
Rated voltage	DC2.5～35V	DC2.5～25V	DC2.5～35V	DC6.3～35V	85℃
Surge voltage	DC3.2～45V	DC3.2～32V	DC3.2～45V	DC8～45V	85℃
Derated voltage	DC1.6～22V	DC1.6～16V	DC1.6～22V	DC4～22V	125℃ (TNC:105℃, THC:150℃)
Capacitance	0.47～470 μF	0.1～47 μF	0.1～220 μF	10～330 μF	
Capacitance tolerance	±10% or 20%	The same as shown at left	The same as shown at left	The same as shown at left	Paragraph 4.7, 120 Hz
Leakage current	Refer to standard product table	Refer to standard product table	Refer to standard product table	0.01CV or less	Paragraph 4.9, in 5 minutes after the rated voltage is applied.
tanδ	Refer to standard product table	Refer to standard product table	Refer to standard product table	10～68 0.06 or less 100～150 0.08 or less 220 0.1 or less 330 0.15 or less	Paragraph 4.8, 120 Hz
Surge withstanding voltage	△C/C ±5% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±20% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±5% or less tand Specified initial value or less LC Specified initial value or less	The same as shown at left	Paragraph 4.26
Temperature characteristics	See table below	See table below	See table below	See table below	Paragraph 4.24
Solder heat resistance	△C/C ±5% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±20% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±5% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±10% or less tan δ Specified initial value or less LC Specified initial value or less	Solder Dip 260±5℃ LM,J,LP,P,LA, C,E,F case UA,A,UB,B case 10±1 sec. 5±0.5 sec. Reflow 260℃ 10±1 sec.
Moisture resistance no load	△C/C ±10% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±20% or less tan δ 150% or less Specified initial value or less LC Specified initial value or less	△C/C ±10% or less tan δ Specified initial value or less LC Specified initial value or less	The same as shown at left	Paragraph 4.22 40℃ 90 ～ 95%RH, 500hours (TMCH,THC:85℃,85%RH, 1000hours)
High-temperature load	△C/C ±10% or less tan δ Specified initial value or less LC 125% or less Specified initial value or less	△C/C ±20% or less tan δ Specified initial value or less LC 200% or less Specified initial value or less	△C/C ±10% or less tan δ Specified initial value or less LC 125% or less Specified initial value or less	△C/C ±10% or less tan δ Specified initial value or less LC Specified initial value or less	Paragraph 4.23 85℃ The rated voltage is applied for 2000 hours. (TMCH:Derated voltage in 125℃, THC:Derated voltage in 150℃)
Thermal shock	△C/C ±10% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±20% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±5% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±10% or less tan δ Specified initial value or less LC Specified initial value or less	Leave at -55℃, normal temperature, 125℃, and normal temperature for 30 min., 3 min., 30 min., and 3 min. Repeat this operation 5 cycles running. TMCS,TMCTX:20 cycles TMCH,THC:1000 cycles
Moisture resistance load	△C/C ±10% or less tan δ 150% or less Specified initial value or less LC 200% or less Specified initial value or less	△C/C ±20% or less tan δ 150% or less Specified initial value or less LC 200% or less Specified initial value or less	△C/C ±10% or less tan δ 150% or less Specified initial value or less LC 200% or less Specified initial value or less	△C/C ±10% or less tan δ Specified initial value or less LC Specified initial value or less	40℃, humidity 90 to 95%RH The rated voltage is applied for 500 hours. (TMCH,THC:65℃)
Failure rate	1%／1000hrs	The same as shown at left	The same as shown at left	The same as shown at left	85℃. The rated voltage is applied (through a protective resistor of 1Ω/V).

Temperature characteristics

	Specified initial value	-55	85	125
△C/C	—	-10～0%	0～+10%	0～+12%
tan δ Value shown table or less	0.04	0.09	0.07	0.09
	0.06	0.1	0.08	0.1
	0.08	0.12	0.1	0.12
	0.1	0.14	0.12	0.14
	0.12	0.16	0.14	0.16
	0.16	0.20	0.18	0.20
	0.18	0.34	0.20	0.22
	0.20	0.36	0.22	0.24
	0.30	0.60	0.30	0.40
LC	Refer to standard product table	—	1000% or less specified initial value or less	1250% or less specified initial value or less

	Specified initial value	-55	85	125
△C/C	—	-20～0%	0～+20%	0～+20%
tan δ Value shown table or less	0.06	0.1	0.08	0.1
	0.08	0.12	0.1	0.12
	0.1	0.14	0.12	0.14
	0.12	0.16	0.14	0.16
	0.20	0.24	0.22	0.24
	0.30	0.60	0.30	0.40
LC	Refer to standard product table	—	1000% or less specified initial value or less	1250% or less specified initial value or less

	Specified initial value	-55	85	125
△C/C	—	-10～0%	0～+10%	0～+12%
tan δ Value shown table or less	0.04	0.05	0.04	0.05
	0.06	0.08	0.06	0.06
	0.08	0.12	0.1	0.12
	0.1	0.14	0.12	0.14
	0.12	0.16	0.14	0.16
	0.18	0.22	0.20	0.22
	0.20	0.24	0.22	0.24
LC	Refer to standard product table	—	1000% or less specified initial value or less	1250% or less specified initial value or less

	Specified initial value	-55	85	125
△C/C	—	-10～0%	0～+10%	0～+12%
tan δ Value shown table or less	0.06	0.1	0.08	0.1
	0.08	0.12	0.1	0.12
	0.1	0.14	0.12	0.14
	0.15	0.22	0.18	0.22
	0.30	0.60	0.30	0.40
LC	0.01CV	—	0.1CV	0.125CV

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Specifications Table

	TMCH	TMCTX	THC	Test conditions JIS C5101-1:1998
Specifications Table	-55℃～+125℃	The same as shown at left	-55℃～+150℃	
Rated voltage	DC4～35V	DC10～35V	DC10～35V	85℃
Surge voltage	DC5～45V	DC13～45V	DC13～45V	85℃
Derated voltage	DC2.5～22V	DC6.3～22V	DC6.3～22V	125℃（TNC:105℃, THC:150℃）
Capacitance	0.1～100 μF	1～68 μF	0.33～47 μF	
Capacitance tolerance	±10% or 20%	The same as shown at left	The same as shown at left	Paragraph 4.7, 120 Hz
Leakage current	0.005 CV or 0.25 μA, whichever is larger or less	0.01 CV or 0.5 μA, whichever is larger or less	0.05 CV or 0.25 μA, whichever is larger or less	Paragraph 4.9, in 5 minutes after the rated voltage is applied.
tanδ	0.1～1.0 0.04 or less 1.5～100 0.06 or less	1.0 or less 0.04 or less 1.5～22 0.05 or less 33 or more 0.06 or less	1.0 or less 0.04 or less 1.5 or more 0.06 or less	Paragraph 4.8, 120 Hz
Surge withstanding voltage	△C/C ±5% or less tan δ Specified initial value or less LC Specified initial value or less	The same as shown at left	△C/C ±10% or less tan δ Specified initial value or less LC Specified initial value or less	Paragraph 4.26
Temperature characteristics	<table><tr><td></td><td>Specified initial value</td><td>-55</td><td>85</td><td>125</td></tr><tr><td>△C/C</td><td>—</td><td>-10～0%</td><td>0～+10%</td><td>0～+12%</td></tr><tr><td>tan δ</td><td>0.04</td><td>0.04</td><td>0.05</td><td>0.05</td></tr><tr><td>Value shown</td><td>0.06</td><td>0.06</td><td>0.07</td><td>0.07</td></tr><tr><td>table</td><td>0.08</td><td>0.08</td><td>0.10</td><td>0.12</td></tr><tr><td>or less</td><td></td><td></td><td></td><td></td></tr><tr><td>LC</td><td>0.005CV or 0.25 μA or less</td><td>—</td><td>0.05CV or 2.5 μA or less</td><td>0.062CV or 3.12 μA or less</td></tr></table>	<table><tr><td></td><td>Specified initial value</td><td>-55</td><td>85</td><td>125</td></tr><tr><td>△C/C</td><td>—</td><td>-10～0%</td><td>0～+10%</td><td>0～+12%</td></tr><tr><td>tan δ</td><td>0.04</td><td>0.09</td><td>0.07</td><td>0.09</td></tr><tr><td>Value shown</td><td>0.05</td><td>0.1</td><td>0.08</td><td>0.1</td></tr><tr><td>table</td><td>0.06</td><td>0.12</td><td>0.1</td><td>0.12</td></tr><tr><td>or less</td><td></td><td></td><td></td><td></td></tr><tr><td>LC</td><td>0.01CV or 0.5 μA or less</td><td>—</td><td>0.1CV or 5 μA or less</td><td>0.125CV or 6.25 μA or less</td></tr></table>	<table><tr><td></td><td>Specified initial value</td><td>-55</td><td>105</td><td>150</td></tr><tr><td>△C/C</td><td>—</td><td>-10～0%</td><td>0～+10%</td><td>0～+20%</td></tr><tr><td>tan δ</td><td>0.04</td><td>0.04</td><td>0.06</td><td>0.08</td></tr><tr><td>Value shown</td><td>0.06</td><td>0.06</td><td>0.08</td><td>0.1</td></tr><tr><td>table</td><td></td><td></td><td></td><td></td></tr><tr><td>or less</td><td></td><td></td><td></td><td></td></tr><tr><td>LC</td><td>0.005CV or 0.25 μA or less</td><td>—</td><td>0.1CV or 5 μA or less</td><td>0.125CV or 6.25 μA or less</td></tr></table>	Paragraph 4.24
Solder heat resistance	△C/C ±5% or less tan δ Specified initial value or less LC Specified initial value or less	The same as shown at left	△C/C ±5% or less tan δ Specified initial value or less LC Specified initial value or less	Solder Dip 260±5℃ LM,J,LP,P,LA, C,E,F case UA,A,UB,B case 10±1 sec. 5±0.5 sec. Reflow 260℃ 10±1 sec.
Moisture resistance no load	△C/C ±5% or less tan δ 150% or less Specified initial value or less LC 200% or less Specified initial value or less	△C/C ±10% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±10% or less tan δ 150% or less Specified initial value or less LC 200% or less Specified initial value or less	Paragraph 4.22 40℃ 90 ～ 95%RH, 500h （TMCH,THC:85℃,85%RH, 1000hours）
High-temperature load	△C/C ±10% or less tan δ Specified initial value or less LC 125% or less Specified initial value or less	The same as shown at left	The same as shown at left	Paragraph 4.23 85℃ The rated voltage is applied for 2000 hours. （TMCH:Derated voltage in 125℃, THC:Derated voltage in 150℃）
Thermal shock	△C/C ±5% or less tan δ Specified initial value or less LC 200% or less Specified initial value or less	△C/C ±10% or less tan δ Specified initial value or less LC Specified initial value or less	△C/C ±10% or less tan δ Specified initial value or less LC 200% or less Specified initial value or less	Leave at -55℃, normal temperature, 125℃, and normal temperature for 30 min., 3 min., 30 min., and 3 min. Repeat this operation 5 cycles running. TMCS,TMCTX:20 cycles TMCH,THC:1000 cycles
Moisture resistance load	△C/C ±5% or less tan δ 150% or less Specified initial value or less LC 200% or less Specified initial value or less	△C/C ±10% or less tan δ 150% or less Specified initial value or less LC 200% or less Specified initial value or less	△C/C ±10% or less tan δ 150% or less Specified initial value or less LC 200% or less Specified initial value or less	40℃, humidity 90 to 95%RH The rated voltage is applied for 500 hours. （TMCH,THC:65℃）
Failure rate	0.5%／1000hrs	1%／1000hrs	0.5%／1000hrs	85℃. The rated voltage is applied (through a protective resistor of 1Ω/V).

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