

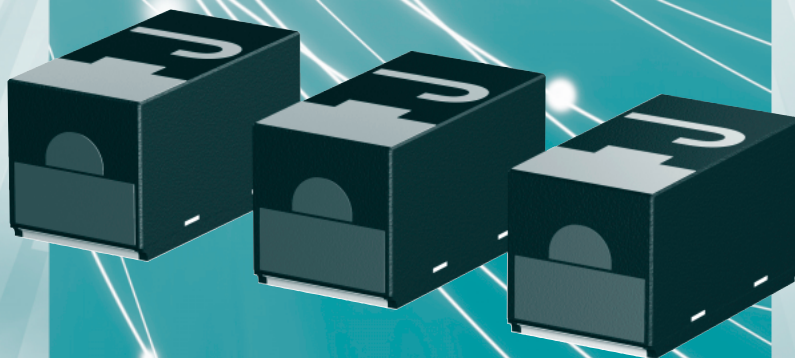
PRODUCTS DATA SHEET

Face-down terminal structure

Tantalum Solid Electrolytic Capacitors with Conductive Polymer

RoHS COMPLIANT
LEAD FREE

Type TCB



MATSUO ELECTRIC CO., LTD.

OUTLINE

Type TCB is a tantalum solid electrolytic capacitor with face-down terminal which uses conductive polymer as cathode layer. Their equivalent series resistance (ESR) is extremely lowered with the characteristics of the polymer having high electric conductivity. This ensures higher permissible ripple current and excellent noise absorption performance on high-frequency circuits.

APPLICATION

Mobile phones, digital cameras, high-performance portable equipments, personal computers, digital TV sets, DC/DC converters, regulators and peripherals

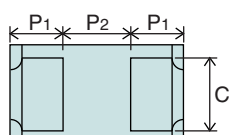
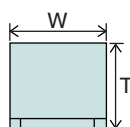
FEATURES

1. Low ESR and Low impedance
Using a conductive polymer as cathode layer makes possible of low ESR and impedance.
Type TCB makes high permissible ripple current and is suitable for noise bypass application.
2. Stable ESR over temperature
ESR is extremely stable from low temperature through high temperature.
3. Ultra Compact and Large capacitance
The face-down terminal structure makes it possible to design the land almost in the same size as the terminals. As the result, the components can be downsized, and the mounting area can be reduced to 1/2 to 1/3 compared to the conventional structures.
4. Benign Failure Mode
Type TCB offers very safe characteristics which makes ignition and smoking harder by taking advantages of characteristics of conductive polymer if the capacitor be short-circuited.
5. Lead Free and RoHS Compliant.

RATINGS

Item	Ratings
Failure Rate Level	1% / 1000 h
Category Temperature Range	-55 to +105°C (to be used at derated voltage when temperature exceeds 85°C)
Rated Voltage	2.5 - 4 - 6.3 - 10 VDC
Derated Voltage	2.0 - 3.2 - 5.0 - 8.0 VDC (105°C)
Capacitance	4.7~22 μF
Capacitance Tolerances	± 20% (M)

DIMENSIONS



Case Size	EIA Code	Height (max.)	L ± 0.1	W ± 0.1	T ± 0.1	P1 ± 0.1	P2 ± 0.1	C ± 0.1
M	1608	0.9	1.6	0.85	0.8	0.5	0.65	0.7

MARKING



Rated voltage⁽¹⁾

Polarity (anode notation)

⁽¹⁾ The rated voltage is indicated with one alphabetic letter.

Code	e	G	J	A
Voltage (V)	2.5	4	6.3	10

ORDERING INFORMATION

TCB TYPE		6301 RATED VOLTAGE	106 CAPACITANCE		M CAPACITANCE TOLERANCE		R STYLE OF REELED PACKAGE			A CASE CODE		0500 ESR(mΩ)	
Rated voltage	Marking		Capacitance	Marking	Capacitance Tolerance	Marking	Code	Reel Size	Anode Notation	EIA Code	Case Code		
2.5 V	2501		4.7 μF	475	± 20%	M	R	φ180 Reel	Feed hole: -	1608	M		
4 V	4001		6.8 μF	685									
6.3 V	6301		10 μF	106									
10 V	1002		15 μF	156									
			22 μF	226									

Note : For a capacitor with special requirements from customers, a 2-digit specific numbers will be added between the case code and the ESR for our product management.

CATALOG NUMBERS AND RATING

December, 2006

Catalog number (1)	Rated Voltage (VDC)	Capacitance (μF)	Tolerances (±%)	Case Code	Lct. (μA)			Max. Dissipation Factor			ESR (mΩ) 100 kHz	Max. Permissible Ripple Current (2) (mA _{rms}) 100 kHz
					20°C	85°C	105°C	-55°C	20°C	105°C		
TCB 2501 475 M ₁ M 0500	2.5	4.7	20	M	1.18	11.8	11.8	0.10	0.10	0.15	500	300
TCB 2501 475 M ₁ M 0200	↓	4.7	↓	M	1.18	11.8	11.8	0.10	0.10	0.15	200	458
TCB 2501 685 M ₁ M 0500	↓	6.8	↓	M	1.70	17.0	17.0	0.10	0.10	0.15	500	300
TCB 2501 685 M ₁ M 0200	↓	6.8	↓	M	1.70	17.0	17.0	0.10	0.10	0.15	200	458
TCB 2501 106 M ₁ M 0500	↓	10	↓	M	2.50	25.0	25.0	0.10	0.10	0.15	500	300
TCB 2501 106 M ₁ M 0200	↓	10	↓	M	2.50	25.0	25.0	0.10	0.10	0.15	200	458
TCB 2501 156 M ₁ M 0500	↓	15	↓	M	3.75	37.5	37.5	0.10	0.10	0.15	500	300
TCB 2501 156 M ₁ M 0200	↓	15	↓	M	3.75	37.5	37.5	0.10	0.10	0.15	200	458
TCB 2501 226 M ₁ M 0500	↓	22	↓	M	5.50	55.0	55.0	0.10	0.10	0.15	500	300
TCB 2501 226 M ₁ M 0200	↓	22	↓	M	5.50	55.0	55.0	0.10	0.10	0.15	200	458
TCB 4001 475 M ₁ M 0500	4	4.7	20	M	1.88	18.8	18.8	0.10	0.10	0.15	500	300
TCB 4001 475 M ₁ M 0200	↓	4.7	↓	M	1.88	18.8	18.8	0.10	0.10	0.15	200	458
TCB 4001 685 M ₁ M 0500	↓	6.8	↓	M	2.72	27.2	27.2	0.10	0.10	0.15	500	300
TCB 4001 685 M ₁ M 0200	↓	6.8	↓	M	2.72	27.2	27.2	0.10	0.10	0.15	200	458
TCB 4001 106 M ₁ M 0500	↓	10	↓	M	4.00	40.0	40.0	0.10	0.10	0.15	500	300
TCB 4001 106 M ₁ M 0200	↓	10	↓	M	4.00	40.0	40.0	0.10	0.10	0.15	200	458
TCB 4001 156 M ₁ M 0500	↓	15	↓	M	6.00	60.0	60.0	0.10	0.10	0.15	500	300
TCB 4001 156 M ₁ M 0200	↓	15	↓	M	6.00	60.0	60.0	0.10	0.10	0.15	200	458
TCB 6301 475 M ₁ M 0500	6.3	4.7	20	M	2.96	29.6	29.6	0.10	0.10	0.15	500	300
TCB 6301 475 M ₁ M 0200	↓	4.7	↓	M	2.96	29.6	29.6	0.10	0.10	0.15	200	458
TCB 6301 685 M ₁ M 0500	↓	6.8	↓	M	4.28	42.8	42.8	0.10	0.10	0.15	500	300
TCB 6301 685 M ₁ M 0200	↓	6.8	↓	M	4.28	42.8	42.8	0.10	0.10	0.15	200	458
TCB 6301 106 M ₁ M 0500	↓	10	↓	M	6.30	63.0	63.0	0.10	0.10	0.15	500	300
TCB 6301 106 M ₁ M 0200	↓	10	↓	M	6.30	63.0	63.0	0.10	0.10	0.15	200	458
TCB 1002 475 M ₁ M 0500	10	4.7	20	M	4.70	47.0	47.0	0.10	0.10	0.15	500	300
TCB 1002 475 M ₁ M 0200	↓	4.7	↓	M	4.70	47.0	47.0	0.10	0.10	0.15	200	458
TCB 1002 685 M ₁ M 0500	↓	6.8	↓	M	6.80	68.0	68.0	0.10	0.10	0.15	500	300
TCB 1002 685 M ₁ M 0200	↓	6.8	↓	M	6.80	68.0	68.0	0.10	0.10	0.15	200	458

Notes : (1) ₁ : No code for single item. "R" for taping specification.
(2) Reference value.

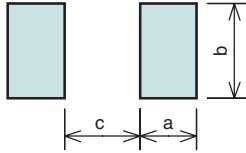
STANDARD RATING

December, 2006

R.V. (VDC) Cap. (μF)	2.5	4	6.3	10
4.7	M (200, 500)	M (200, 500)	M (200, 500)	M (200, 500)
6.8	M (200, 500)	M (200, 500)	M (200, 500)	M (200, 500)
10	M (200, 500)	M (200, 500)	M (200, 500)	
15	M (200, 500)	M (200, 500)		
22	M (200, 500)			

The parenthesized values show ESR. (maximum values in mΩ at 100 kHz)

RECOMMENDED PAD DIMENSIONS



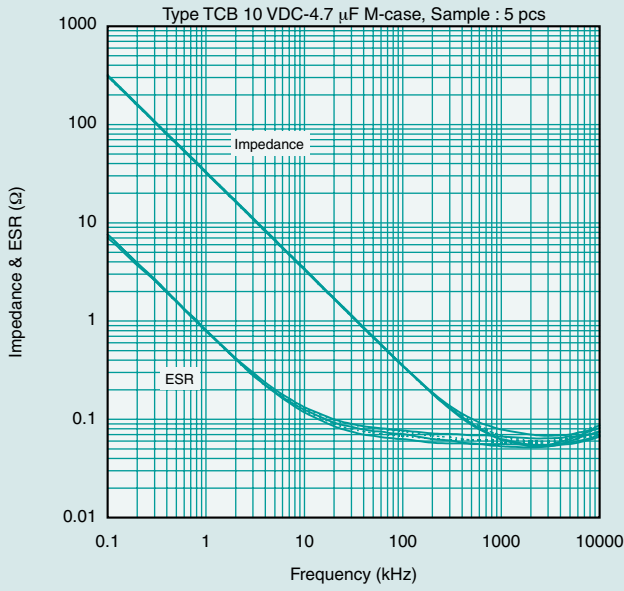
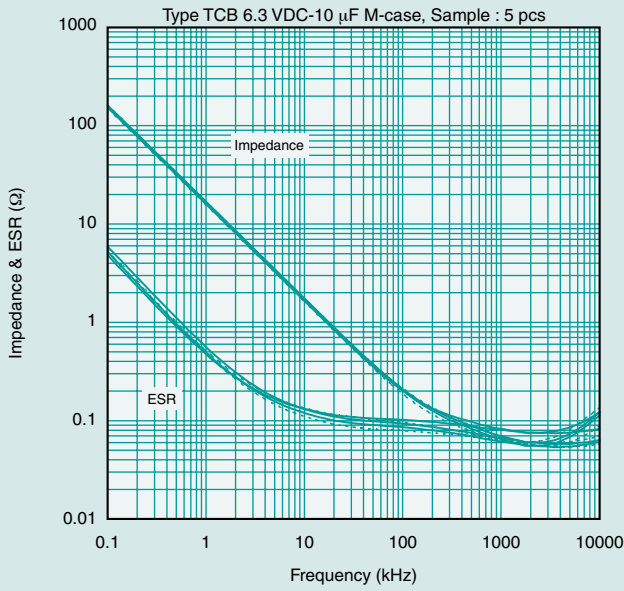
Case Size	a	b	c
M	0.50 or more	0.65	0.65

In order to expect the self alignment effect, it is recommended that the land width is almost the same size as terminal of capacitor, and space between lands(c) nearly equal to the space between terminals for appropriate soldering. Adjust the mask opening so that the mask thickness is equivalent to 100 μm .

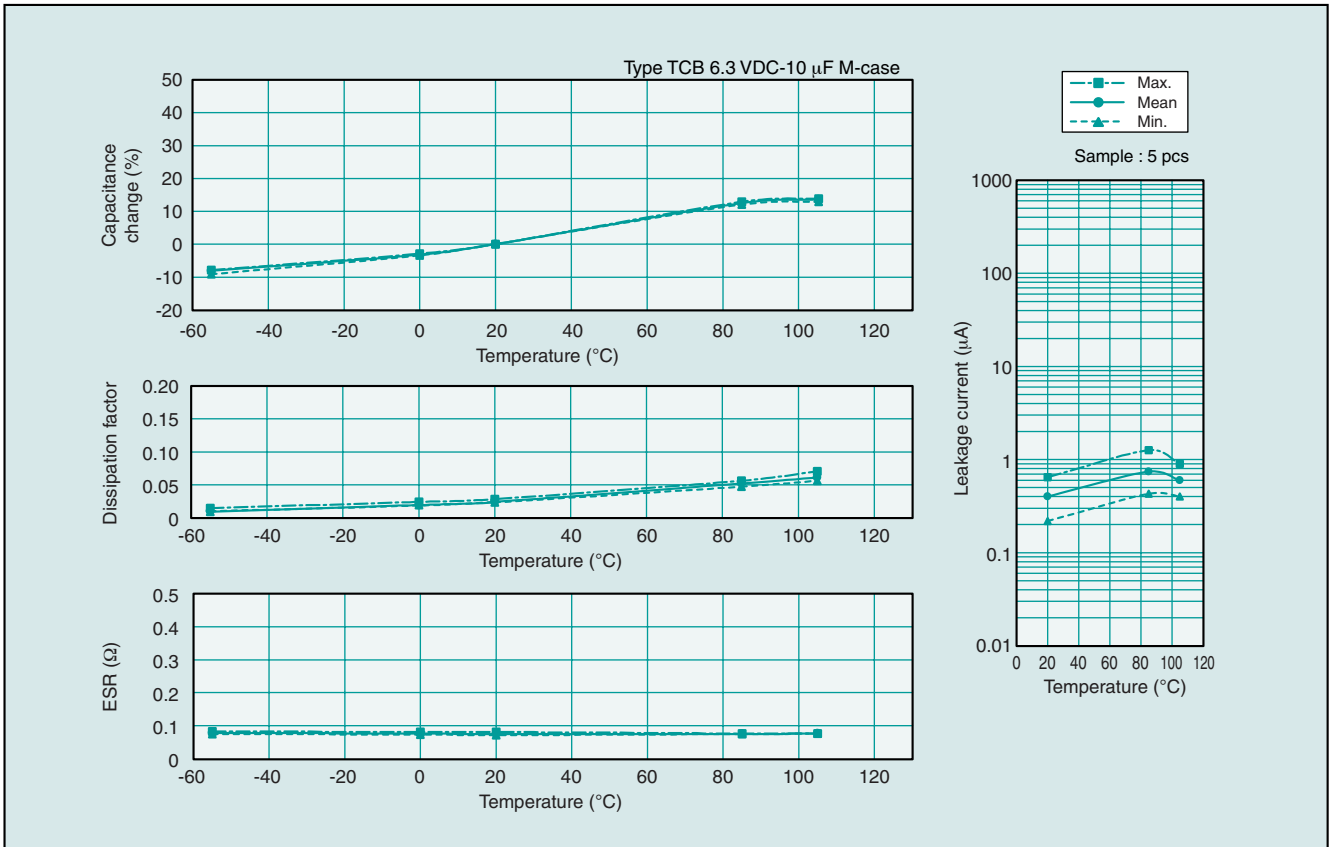
PERFORMANCE

No	ITEM	PERFORMANCE	TEST METHOD															
1	Leakage Current (μA)	Shall not exceed 0.1 CV Max. or the values shown in CATALOG NUMBERS AND RATING.	JIS C 5101-1, 4.9 Applied voltage : Rated voltage Duration : 5 min Measuring temperature : $20 \pm 2^\circ\text{C}$															
2	Capacitance (μF)	Shall be within specified tolerances.	JIS C 5101-1, 4.7 Measuring frequency : $120 \text{ Hz} \pm 20\%$ Measuring temperature : $20 \pm 2^\circ\text{C}$															
3	Dissipation Factor	Shall not exceed the values shown in CATALOG NUMBERS AND RATING.	JIS C 5101-1, 4.8 Test conditions shown in No.2															
4	Equivalent Series Resistance	Shall not exceed the values shown in CATALOG NUMBERS AND RATING.	EIAJ RC-2378, 4.5.4 Measuring frequency : $100 \text{ kHz} \pm 10\%$ Measuring temperature : $20 \pm 2^\circ\text{C}$															
5	Characteristics at High and Low Temperature	Leakage Current	Dissipation Factor															
		Step 1	Step 1															
		Step 2	Step 2															
		Step 3	Step 3															
		Step 4	Step 4															
		Step 5	Step 5															
		Step 6	Step 6															
6	Surge	Leakage current : Shall not exceed 3-times of the value in No.1. Capacitance change : Within $\pm 20\%$ of the value before test Dissipation Factor : Shall not exceed the value in No.3. Visual Examination : There shall be no evidence of mechanical damage.	JIS C 5101-1, 4.26 Test temperature : 85°C and 105°C Applied voltage : According to the following table <table border="1"> <tr> <td>Rated voltage (VDC)</td> <td>2.5</td> <td>4</td> <td>6.3</td> <td>10</td> </tr> <tr> <td>Surge voltage (VDC)</td> <td>85°C 3.3</td> <td>5.2</td> <td>8.2</td> <td>13</td> </tr> <tr> <td></td> <td>105°C 2.6</td> <td>4.2</td> <td>6.5</td> <td>10.4</td> </tr> </table> Series protective resistance : 1000 Ω Discharge resistance : 1000 Ω Number of cycles : 1000 cycles	Rated voltage (VDC)	2.5	4	6.3	10	Surge voltage (VDC)	85°C 3.3	5.2	8.2	13		105°C 2.6	4.2	6.5	10.4
Rated voltage (VDC)	2.5	4	6.3	10														
Surge voltage (VDC)	85°C 3.3	5.2	8.2	13														
	105°C 2.6	4.2	6.5	10.4														
7	Shear Test	There shall be no evidence of mechanical damage.	JIS C 5101-1, 4.34 Force : 5 N Holding time : 10 ± 1 sec															
8	Substrate Bending Test	Capacitance : Initial value to remain steady during measurement. Visual Examination : There shall be no evidence of mechanical damage.	JIS C 5101-1, 4.35 Bending : 1 mm															
9	Vibration	Capacitance : Initial value to remain steady during measurement. Visual Examination : There shall be no evidence of mechanical damage.	JIS C 5101-1 4.17 Frequency range : 10-55 Hz Swing width : 1.5 mm Vibration direction : 3 directions with mutually right-angled Duration : 2 hours in each of these mutually perpendicular directions (total 6 hours) Mounting : Solder terminal to the printed board															
10	Shock	There shall be no intermittent contact of 0.5 ms or greater, short, or open. Nor shall there be any spark discharge, insulation breakdown, or evidence of mechanical damage.	JIS C 5101-1 4.19 Peak acceleration : 490 m/s^2 Duration : 11 ms Wave form : Half-sine															
11	Solderability	Solder shall be in close contact with terminal (pinholes, non-solderability and solder repelling are not allowed). (1) Note (1) : If any question arises relating to the judgment, make sure that the part dipped in solder, more than 3/4 of the terminal surface, is covered with new solder.	JIS C 5101-1 4.15 Solder temperature : $235 \pm 5^\circ\text{C}$ Dipping time : 2 ± 0.5 sec Dipping depth : Terminal shall be dipped into melted solder															
12	Resistance to Soldering Heat	Leakage Current : Shall not exceed 2-times of the value in No.1. Capacitance change : Within $\pm 20\%$ of the value before test. Dissipation Factor : Shall not exceed 1.3-times of the value in No.3. Visual Examination : There shall be no evidence of mechanical damage.	EIAJ RC-2378, 4.6 IR reflow Preheating : 140 to 160°C , 110 to 130 sec Reflow : 200°C , 25 to 30 sec Peak : 240°C max. Number of cycles : 2															
13	Rapid Change of Temperature	Leakage Current : Shall not exceed 2-times of the value in No.1. Capacitance change : Within $\pm 20\%$ of the value before test. Dissipation Factor : Shall not exceed 1.5-times of the value in No.3. Visual Examination : There shall be no evidence of mechanical damage.	JIS C 5101-1, 4.16 Step 1 : $-55 \pm 3^\circ\text{C}$, 30 ± 3 min Step 2 : $25 \pm 5^\circ\text{C}$, 3 min or less Step 3 : $105 \pm 2^\circ\text{C}$, 30 ± 3 min Step 4 : $25 \pm 5^\circ\text{C}$, 3 min or less Number of cycles : 5															
14	Damp Heat, Steady State	Leakage Current : Shall not exceed 2-times of the value in No.1. Capacitance change : Within -20% to $+40\%$ of the value before test. Dissipation Factor : Shall not exceed 1.5-times of the value in No.3. Visual Examination : There shall be no evidence of mechanical damage.	JIS C 5101-1, 4.21 Temperature : $40 \pm 2^\circ\text{C}$ Moisture : 90 to 95% RH Duration : 500 $^{+24}_0$ hrs															
15	Endurance I	Leakage Current : Shall not exceed 2-times of the value in No.1. Capacitance change : Within $\pm 20\%$ of the value before test. Dissipation Factor : Shall not exceed 1.5-times of the value in No.3. Visual Examination : There shall be no evidence of mechanical damage.	JIS C 5101-1, 4.23 Test temperature : $85 \pm 2^\circ\text{C}$ Applied voltage : Rated voltage Duration : 1000 $^{+8}_0$ hrs															
16	Endurance II	Leakage Current : Shall not exceed 2-times of the value in No.1. Capacitance change : Within $\pm 20\%$ of the value before test. Dissipation Factor : Shall not exceed 3-times of the value in No.3. Visual Examination : There shall be no evidence of mechanical damage.	JIS C 5101-1, 4.23 Test temperature : $105 \pm 2^\circ\text{C}$ Applied voltage : Derated voltage Duration : 1000 $^{+8}_0$ hrs															

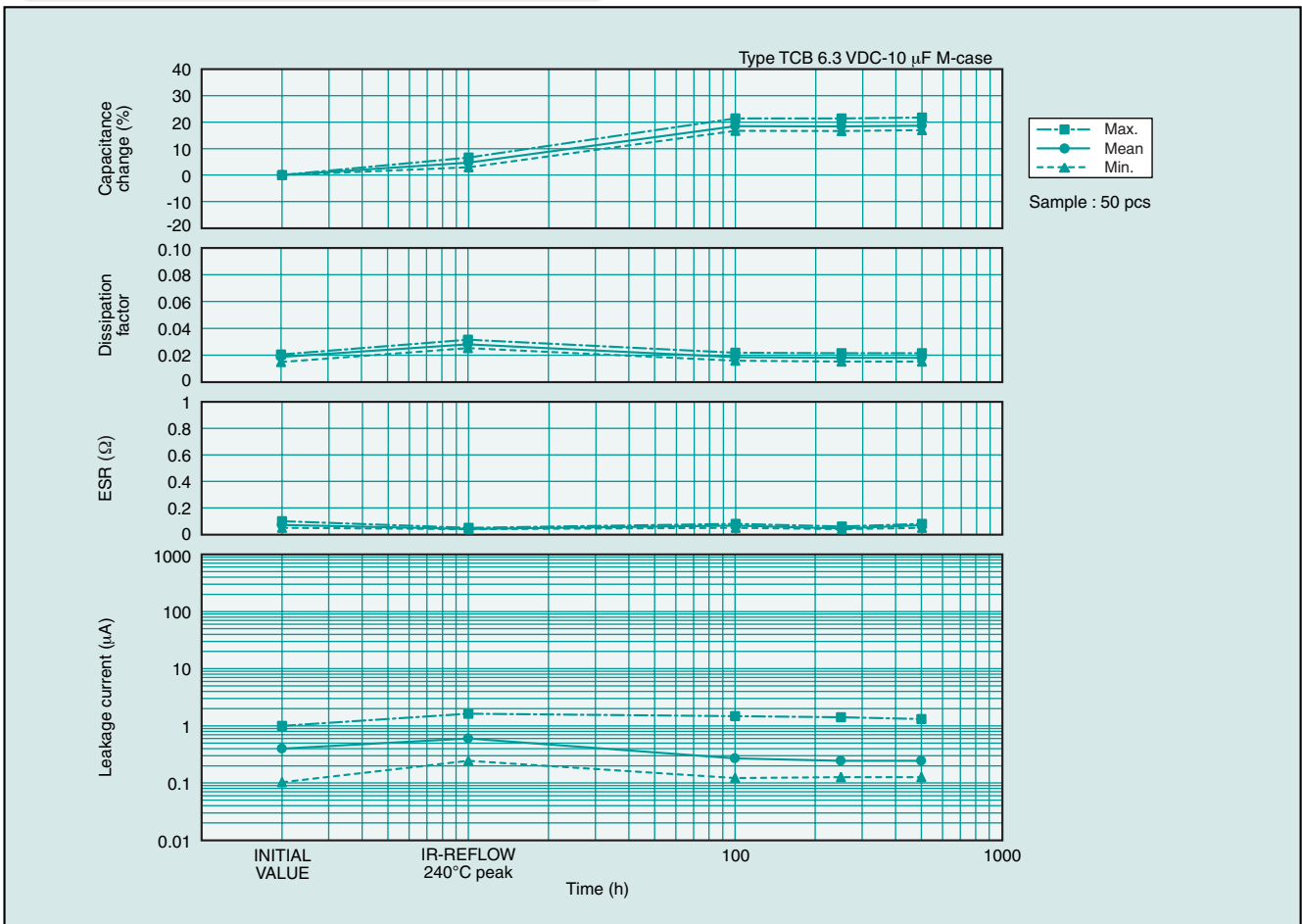
FREQUENCY CHARACTERISTICS



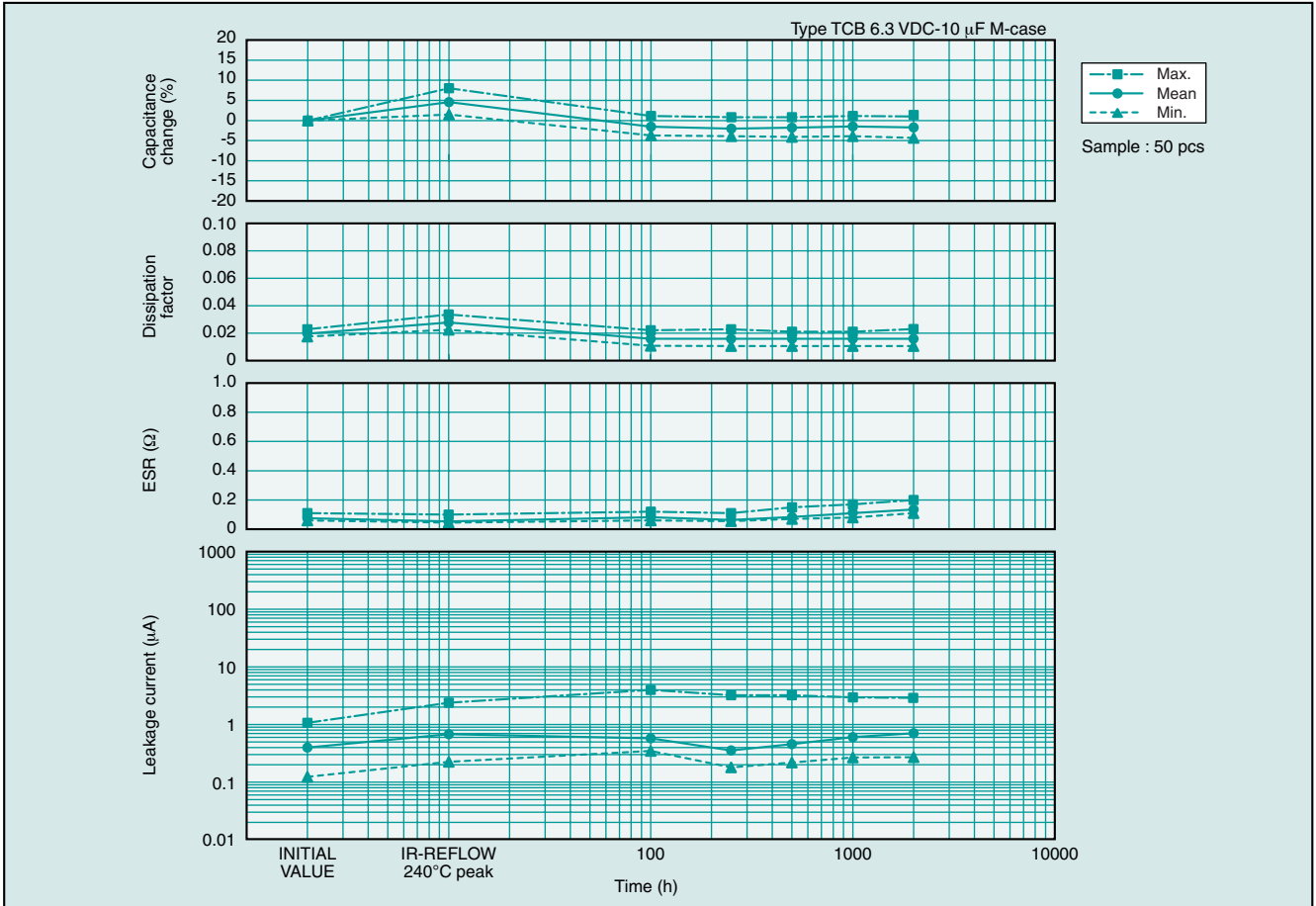
CHARACTERISTICS AT HIGH AND LOW TEMPERATURE



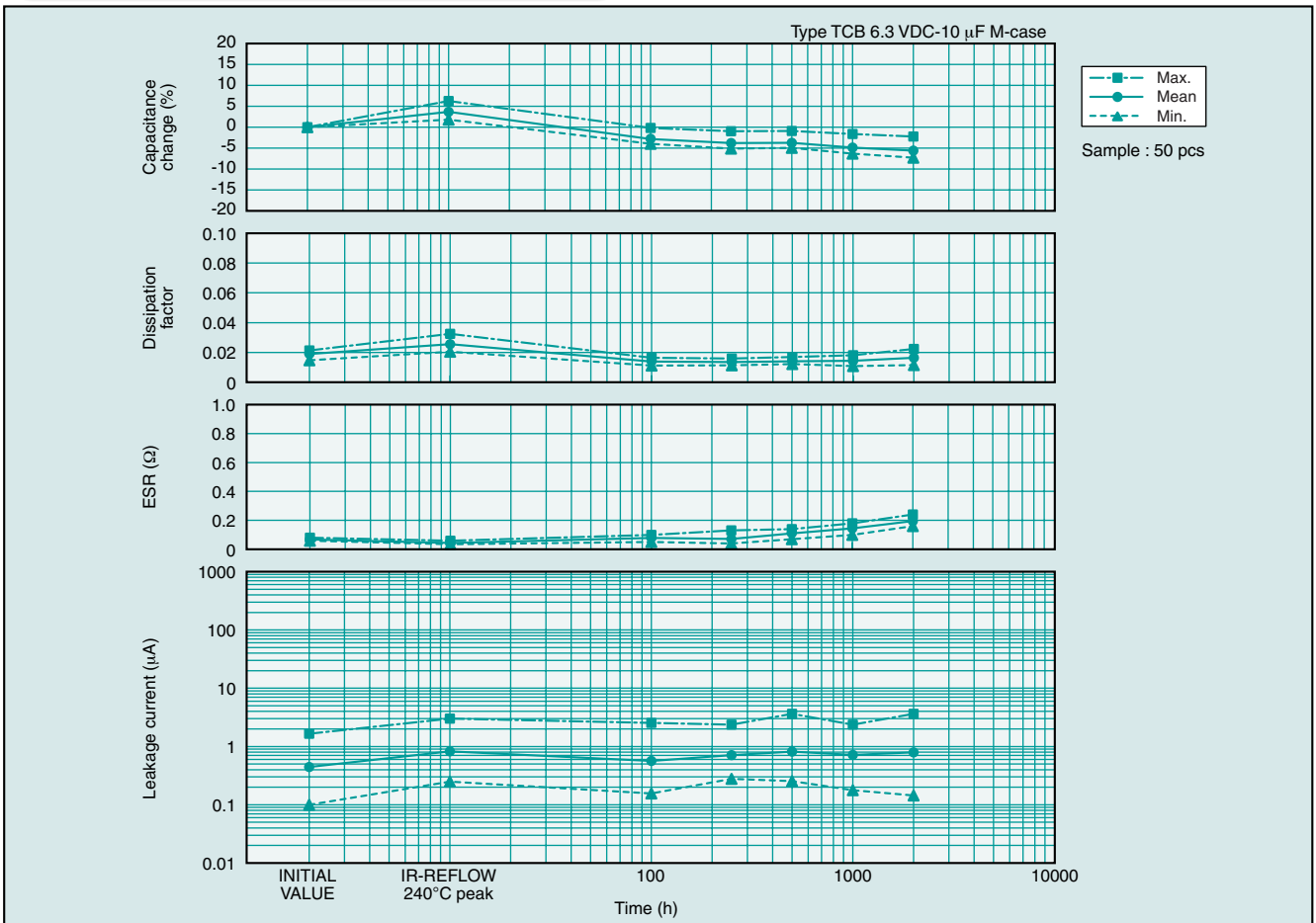
HIGH TEMPERATURE / MOISTURE 40 $^{\circ}$ C, 95%RH



ENDURANCE I 85°C RATED VOLTAGE 6.3 V



ENDURANCE II 105°C DERATED VOLTAGE 5.0 V

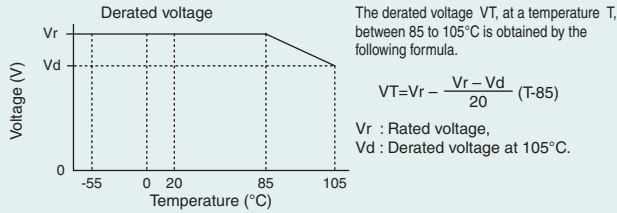


⚠ Application Notes for Tantalum Solid Electrolytic Capacitor with Conductive Polymer

1. Operating voltage

The capacitors shall be operated at the rated voltage or lower. Over rated voltage applied even for a short time may cause short failure. When designing the circuit, the equipment's required reliability must be considered and appropriate voltage derating must be performed.

- Recommended operating voltage : 80% or less of the rated voltage
- When the operating temperature exceeds 85°C, derate the applied voltage. The voltage derating formula is shown below.



Vr	Rated voltage (VDC)	2.5	4	6.3	10
Vd	Derated voltage (VDC)	2.0	3.2	5.0	8.0

2. Application that contain AC Voltage

Special attention to the following 3 items.

- (1) The sum of the DC bias voltage and the positive peak value of the AC voltage should not exceed the rated voltage.
- (2) Reverse voltage should not exceed the allowable values of the negative peak AC voltage.
- (3) Ripple voltage should not exceed the allowable values.

3. Reverse voltage

Special attention to the polar character. Reverse Voltage should not be applied.

4. Permissible ripple current

The permissible ripple current and voltage at about 100 kHz or higher can be determined by the following formula from the permissible power loss (Pmax value) shown in Table 1 and the specified ESR value. However, when the expected operating temperature is higher than room temperature, determine the permissible values multiplying the Pmax value by the specified multiplier (Table 2). For the permissible values at different frequencies, consult our Sales Department.

$$P = I^2 \times ESR \text{ or } P = \frac{E^2 \times ESR}{Z^2}$$

$$\text{Permissible ripple current } I_{max} = \sqrt{\frac{P_{max}}{ESR}} \text{ (Arms)}$$

$$\text{Permissible ripple voltage } E_{max} = \sqrt{\frac{P_{max}}{ESR}} \times Z = I_{max} \times Z \text{ (Vrms)}$$

I_{max} : Permissible ripple current at regulated frequency (Arms : RMS value)
E_{max} : Permissible ripple voltage at regulated frequency (Vrms : RMS value)
P_{max} : Permissible power loss (W)
ESR : Specified ESR value at regulated frequency (Ω)
Z : Impedance at regulated frequency (Ω)

Table 1 Permissible power loss

Case size	Pmax (W)
M	0.042

Note: Above values are measured at 0.8t glass epoxy board mounting in free air and may be changed depending on the kind of board, packing density, and air convection condition. Please consult us if calculated power loss value is different from above list of P max value.

Table 2 Pmax multiplier at each operating temperature

Operating temperature(°C)	Multiplier
20	1.0
55	0.9
85	0.8
105	0.4

5. Non Polar Connection

The capacitor cannot be used as a non-polar unit.

6. Soldering

6.1 Preheating

To obtain optimal reliability, lowering the heat shock during the soldering process is favorable. Capacitors should be pre-heated at 130-160°C for approximately 60 seconds.

6.2 Soldering

The body of the capacitor should not exceed 240°C during soldering.

(1) Reflow Soldering

Reflow soldering is a process in which the capacitors are mounted on a printed circuit board with solder paste. Two methods of Reflow Soldering: Direct and Atmospheric Heat.

- Direct Heat (Hot plate)
- Atmospheric Heat
 - a) Near and Far IR Ray
 - b) Convection Oven

Vapor Phase Soldering and Flow Soldering are not recommended.

(2) Soldering Iron

Soldering with a soldering iron cannot be recommended due to the lack of consistency in maintaining temperatures and process times. If this method should be necessary, the iron should never touch the capacitor's terminals, and the temperature of the soldering iron should never exceed 350°C. The application of the iron should not exceed 3 seconds and 30 watt.

(3) Please consult us for other methods.

7. Solvent cleaning

Cleaning by organic solvent may damage capacitor's appearance and performance. However, our capacitors are not effected even when soaked at 20-30°C 2-propanol for 5 minutes. When introducing new cleaning methods or changing the cleaning term, please consult us.

8. Ultrasonic cleaning

Ultrasonic cleaning under severe condition may break terminals. Also, from an electrical characteristics aspect, it is unfavorable. Therefore, please do not use ultrasonic cleaning if possible. If the Ultrasonic cleaning process will be used, please note the following.

- (1) The solvent should not be boiled. (Lower the ultrasonic wave output or use solvent with the high boiling point.)
- (2) The recommended wattage is less than 0.5 watts per cm².
- (3) The cleaning time should be kept to a minimum. Also, samples must be swang in the solvent. Please consult us.

9. Storage

Capacitors should be tightly sealed in moisture prevention bag and stored with supplied reel.

10. Inapplicable circuits

The capacitors may cause nonconformity if they are used on the following circuits.

- (1) High-impedance voltage holding circuits
- (2) Coupling circuits
- (3) Time constant circuits
- (4) Circuits significantly affected by leakage current

If a short circuit occurs, the capacitors may generate heat or smoke depending on the short-circuit current.

When designing a circuit, take the instructions stated herein into consideration, and take as much redundant measures as possible.

These application notes are prepared based on the technical report RCR-2368B "Guideline of notabilia for fixed tantalum electrolytic capacitors with solid electrolyte for use in electronic equipment" issued by Japan Electronics and Information Technology Industries Association. For the details of the instructions (explanation, reasons and concrete examples), please refer to this guideline, or consult our Sales Department.



MATSUO ELECTRIC CO., LTD.

Please feel free to ask our Sales Department for more information on the Tantalum Solid Electrolytic Capacitor with Conductive Polymer.

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