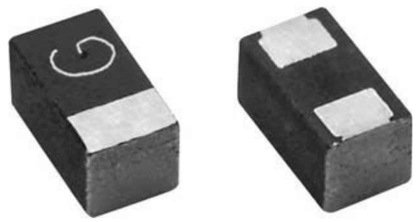
Solid Tantalum Chip Capacitors
MICROTAN™ Low ESR, Leadframeless Molded



FEATURES

- Lead (Pb)-free face-down terminations
- Mounting: Surface mount
- 8 mm tape and reel packaging available per EIA-481 and reeling per IEC 60286-3 7" [178 mm] standard
- Low ESR
- Compliant to RoHS Directive 2002/95/EC

Pb-free
RoHS COMPLIANT
GREEN (5-2008)**

Note

** Please see document "Vishay Material Category Policy": www.vishay.com/doc?99902

PERFORMANCE CHARACTERISTICS

Operating Temperature: - 55 °C to + 85 °C (to + 125 °C voltage derating)

Capacitance Range: 1 µF to 220 µF

Capacitance Tolerance: ± 20 % standard, ± 10 % available

Voltage Range: 4 V_{DC} to 16 V_{DC}

ORDERING INFORMATION

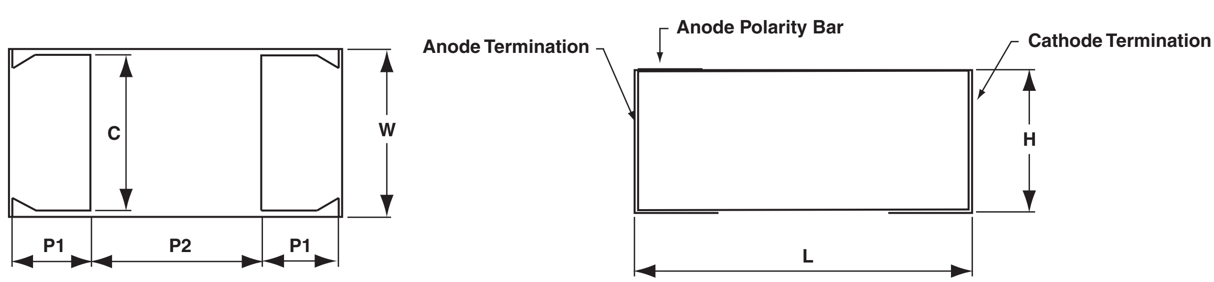
TR8	M	106	M	6R3	C	2000
TYPE	CASE CODE	CAPACITANCE	CAPACITANCE TOLERANCE	DC VOLTAGE RATING AT + 85 °C	TERMINATION	ESR
	See Ratings and Case Codes table	This is expressed in picofarads. The first two digits are the significant figures. The third is the number of zeros to follow.	**K = ± 10 %** **M = ± 20 %**	This is expressed in volts. To complete the three-digit block, zeros precede the voltage rating. A decimal point is indicated by an "R" (6R3 = 6.3 V).	**C = 100 % tin 7" [178 mm] reel**	Maximum 100 kHz ESR in (mΩ) (1)

Notes

- We reserve the right to supply higher voltage ratings and tighter capacitance tolerance capacitors in the same case size. Voltage substitutions will be marked with the higher voltage rating.

(1) The EIA and CECC standards for low ESR solid tantalum chip capacitors, allow delta ESR of 1.25 times the datasheet limit after mounting.

DIMENSIONS in inches [millimeters]



CASE CODE	L	W	H	P1	P2	C
M	0.063 ± 0.008 [1.60 ± 0.2]	0.033 ± 0.008 [0.85 ± 0.2]	0.031 ± 0.004 [0.80 ± 0.1]	0.020 ± 0.004 [0.50 ± 0.1]	0.024 ± 0.004 [0.60 ± 0.1]	0.024 ± 0.004 [0.60 ± 0.1]
P	0.094 ± 0.004 [2.4 ± 0.1]	0.057 ± 0.004 [1.45 ± 0.1]	0.043 ± 0.004 [1.10 ± 0.1]	0.020 ± 0.004 [0.50 ± 0.1]	0.057 ± 0.004 [1.40 ± 0.1]	0.035 ± 0.004 [0.90 ± 0.1]

RATINGS AND CASE CODES

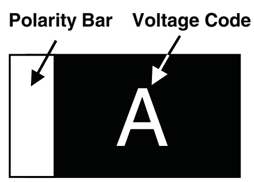
μF	4 V	6.3 V	10 V	16 V
1.0				M
4.7				M (1)
10		M	M	
15			M	
22		M		
33	M	M		
47	M		P (1)	
220	P			

Note

(1) Preliminary values, contact factory for availability

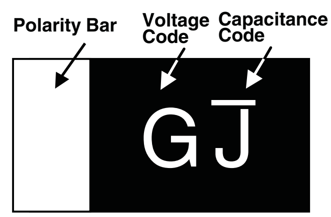
MARKING

M-Case



VOLTAGE CODE		CAPACITANCE CODE	
V	CODE	CAP, μF	CODE
4.0	G	33	n
6.3	J	47	s
10	A	68	w
16	C	100	$\overline{\text{A}}$
20	D	150	$\overline{\text{E}}$
25	E	220	$\overline{\text{J}}$

P-Case



STANDARD RATINGS

CAPACITANCE (μF)	CASE CODE	PART NUMBER	MAX. DC LEAKAGE AT + 25 °C (μA)	MAX. DF AT + 25 °C (%)	MAX. ESR AT + 25 °C 100 kHz (Ω)	MAX. RIPPLE 100 kHz I_{RMS} (A)	ΔC/C (2) (%)
4 V_{DC} AT + 85 °C; 2.7 V_{DC} AT + 125 °C							
33	M	TR8M336M004C1500	2.6	30	1.50	0.129	± 20
47	M	TR8M476M004C1500	3.8	40	1.50	0.129	± 30
220	P	TR8P227(1)004C1000	17.6	30	1.00	0.212	± 30
6.3 V_{DC} AT + 85 °C; 4 V_{DC} AT + 125 °C							
10	M	TR8M106(1)6R3C2000	0.6	8	2.00	0.112	± 10
22	M	TR8M226M6R3C1500	2.8	20	1.50	0.129	± 15
33	M	TR8M336M6R3C1500	4.2	30	1.50	0.129	± 30
10 V_{DC} AT + 85 °C; 7 V_{DC} AT + 125 °C							
10	M	TR8M106M010C2000	1.0	20	2.00	0.112	± 15
15	M	TR8M156(1)010C3000	1.5	30	3.00	0.091	± 20
47	P	TR8P476M010C0800 (1)	4.7	22	0.80	0.237	± 20
47	P	TR8P476M010C1000	4.7	22	1.00	0.212	± 20
16 V_{DC} AT + 85 °C; 10 V_{DC} AT + 125 °C							
1.0	M	TR8M105(1)016C9500	0.5	6.0	9.50	0.05	± 15
4.7	M	TR8M475M016C4000 (1)	0.8	8.0	4.00	0.08	± 15

Notes

- Part number definition:
  (1) Tolerance: For 10 % tolerance, specify “K”; for 20 % tolerance, change to “M”

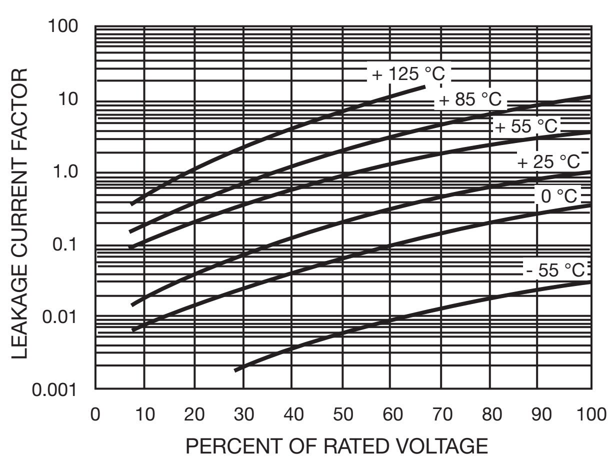
(1) Preliminary values, contact factory for availability

(2) See Performance Characteristics tables

CAPACITORS PERFORMANCE CHARACTERISTICS

ELECTRICAL PERFORMANCE CHARACTERISTICS				
ITEM	**PERFORMANCE CHARACTERISTICS**			
Category Temperature Range	- 55 °C to + 85 °C (to + 125 °C with voltage derating)			
Capacitance Tolerance	± 20 %, ± 10 % (at 120 Hz) 2 V_{RMS} at + 25 °C using a capacitance bridge			
Dissipation Factor (at 120 Hz)	Limits per Standard Ratings table. Tested via bridge method, at 25 °C, 120 Hz.			
ESR (100 kHz)	Limits per Standard Ratings table. Tested via bridge method, at 25 °C, 100 kHz.			
Leakage Current	After application of rated voltage applied to capacitors for 5 min using a steady source of power with 1 kΩ resistor in series with the capacitor under test, leakage current at 25 °C is not more than described in Standard Ratings table. Note that the leakage current varies with temperature and applied voltage. See graph below for the appropriate adjustment factor.			
Reverse Voltage	Capacitors are capable of withstanding peak voltages in the reverse direction equal to: 10 % of the DC rating at + 25 °C 5 % of the DC rating at + 85 °C Vishay does not recommended intentional or repetitive application of reverse voltage			
Temperature Derating	If capacitors are to be used at temperatures above + 25 °C, the permissible RMS ripple current or voltage shall be calculated using the derating factors: 1.0 at + 25 °C 0.9 at + 85 °C 0.4 at + 125 °C			
Operating Temperature	**+ 85 °C RATING**		**+ 125 °C RATING**	
	WORKING VOLTAGE (V)	**SURGE VOLTAGE (V)**	**WORKING VOLTAGE (V)**	**SURGE VOLTAGE (V)**
	4.0	5.2	2.7	3.4
	6.3	8.0	4.0	5.0
	10	13	7.0	8.0
	16	20	10	12
	20	26	13	16
	25	32	17	20
	35	46	23	28
	50	65	33	40

TYPICAL LEAKAGE CURRENT FACTOR RANGE



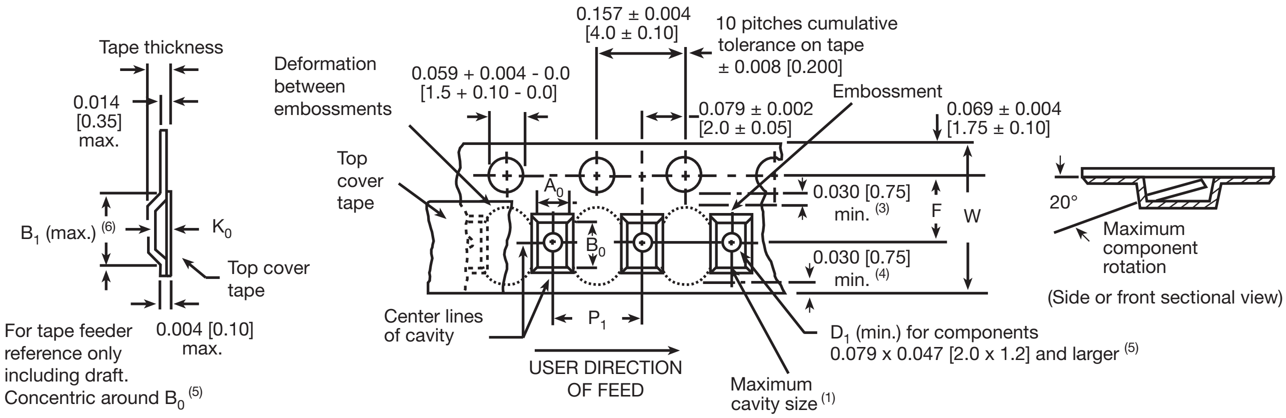
Notes

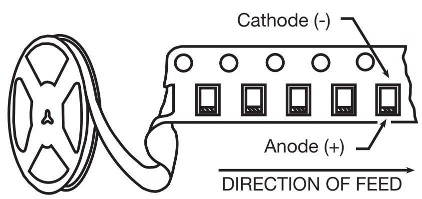
- **At + 25 °C**, the leakage current shall not exceed the value listed in the Standard Ratings table.
- **At + 85 °C**, the leakage current shall not exceed 10 times the value listed in the Standard Ratings table.
- **At + 125 °C**, the leakage current shall not exceed 12 times the value listed in the Standard Ratings table.

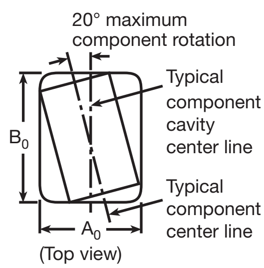
ENVIRONMENTAL PERFORMANCE CHARACTERISTICS			
ITEM	**CONDITION**	**POST TEST PERFORMANCE**	
Life Test at + 85 °C	1000 h application of rated voltage at 85 °C with a 3 Ω series resistance, MIL-STD 202G method 108A	Capacitance change Dissipation factor Leakage current	Refer to Standard Ratings table Not to exceed 150 % of initial Not to exceed 200 % of initial
Humidity Tests	At 40 °C/90 % RH 500 h, no voltage applied MIL-STD 202G method 103B	Capacitance change Dissipation factor Leakage current	Refer to Standard Ratings table Not to exceed 150 % of initial Not to exceed 200 % of initial
Thermal Shock	At - 55 °C/+ 125 °C, 30 min each, for 5 cycles. MIL-STD 202G method 107G	Capacitance change Dissipation factor Leakage current	Refer to Standard Ratings table Not to exceed 150 % of initial Not to exceed 200 % of initial

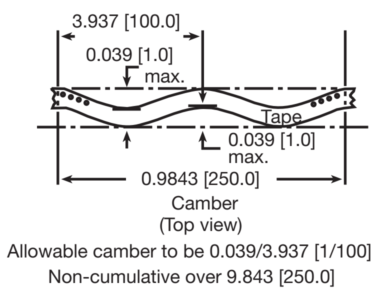
MECHANICAL PERFORMANCE CHARACTERISTICS			
ITEM	**CONDITION**	**POST TEST PERFORMANCE**	
Terminal Strength	Apply a pressure load of 5 N for 10 s ± 1 s horizontally to the center of capacitor side body. AEC-Q200 rev. C method 006	Capacitance change Dissipation factor Leakage current There shall be no mechanical or visual damage to capacitors post-conditioning.	Refer to Standard Ratings table Initial specified value or less Initial specified value or less
Substrate Bending (Board Flex)	With parts soldered onto substrate test board, apply force to the test board for a deflection of 1 mm. AEC-Q200 rev. C method 005	Capacitance change Dissipation factor Leakage current	Refer to Standard Ratings table Initial specified value or less Initial specified value or less
Vibration	MIL-STD-202G, method 204D, 10 Hz to 2000 Hz, 20 *g* Peak	Capacitance change Dissipation factor Leakage current There shall be no mechanical or visual damage to capacitors post-conditioning.	Refer to Standard Ratings table Initial specified value or less Initial specified value or less
Shock	MIL-STD-202G, method 213B, condition I, 100 *g* peak	Capacitance change Dissipation factor Leakage current There shall be no mechanical or visual damage to capacitors post-conditioning.	Refer to Standard Ratings table Initial specified value or less Initial specified value or less
Resistance to Solder Heat	At 260 °C, for 10 s, reflow	Capacitance change Dissipation factor Leakage current There shall be no mechanical or visual damage to capacitors post-conditioning.	Refer to Standard Ratings table Not to exceed 150 % of initial Not to exceed 200 % of initial
Solderability	MIL-STD-202G, method 208H, ANSI/J-STD-002, Test B. Applies only to solder and tin plated terminations. Does not apply to gold terminations.	There shall be no mechanical or visual damage to capacitors post-conditioning.	
Resistance to Solvents	MIL-STD-202, method 215D	There shall be no mechanical or visual damage to capacitors post-conditioning.	
Flammability	Encapsulation materials meet UL 94 V-0 with an oxygen index of 32 %.		

PLASTIC TAPE AND REEL PACKAGING in inches [millimeters]









Tape and Reel Specifications: All case sizes are available on plastic embossed tape per EIA-481. Tape reeling per IEC 60286-3 is also available. Standard reel diameter is 7" [178 mm], 13" [330 mm] reels are available and recommended as the most cost effective packaging method.

The most efficient packaging quantities are full reel increments on a given reel diameter. The quantities shown allow for the sealed empty pockets required to be in conformance with EIA-481. Reel size and packaging orientation must be specified in the Vishay Sprague part number.

Notes

- Metric dimensions will govern. Dimensions in inches are rounded and for reference only.

(1) A_0, B_0, K_0, are determined by the maximum dimensions to the ends of the terminals extending from the component body and/or the body dimensions of the component. The clearance between the ends of the terminals or body of the component to the sides and depth of the cavity (A_0, B_0, K_0) must be within 0.002" (0.05 mm) minimum and 0.020" (0.50 mm) maximum. The clearance allowed must also prevent rotation of the component within the cavity of not more than 20°.

(2) Tape with components shall pass around radius "R" without damage. The minimum trailer length may require additional length to provide "R" minimum for 12 mm embossed tape for reels with hub diameters approaching N minimum.

(3) This dimension is the flat area from the edge of the sprocket hole to either outward deformation of the carrier tape between the embossed cavities or to the edge of the cavity whichever is less.

(4) This dimension is the flat area from the edge of the carrier tape opposite the sprocket holes to either the outward deformation of the carrier tape between the embossed cavity or to the edge of the cavity whichever is less.

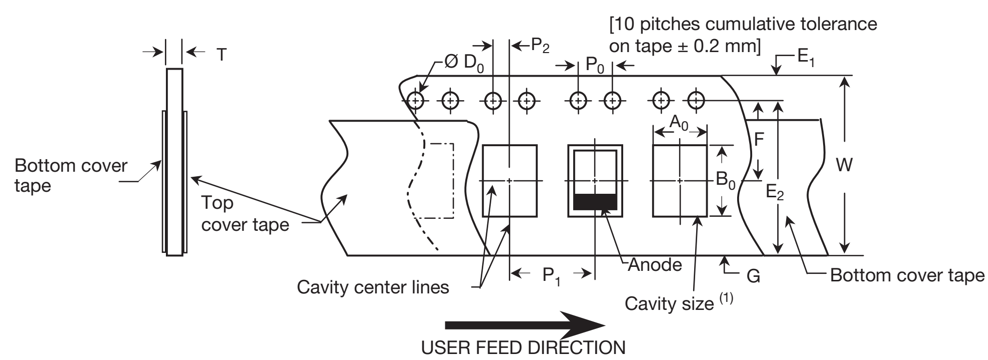
(5) The embossed hole location shall be measured from the sprocket hole controlling the location of the embossement. Dimensions of embossement location shall be applied independent of each other.

(6) B_1 dimension is a reference dimension tape feeder clearance only.

CARRIER TAPE DIMENSIONS in inches [millimeters]

CASE CODE	TAPE SIZE	B_1 (MAX.)	D_1 (MIN.)	F	K_0 (MAX.)	P_1	W
P	8 mm	0.108 [2.75]	0.039 [1.0]	0.138 ± 0.002 [3.5 ± 0.05]	0.054 [1.37]	0.157 ± 0.004 [4.0 ± 1.0]	0.315 + 0.0118/- 0.0039 [8.0 + 0.30/- 0.10]

PAPER TAPE AND REEL PACKAGING in inches [millimeters]



CASE SIZE	TAPE SIZE	A_0	B_0	D_0	P_0	P_1	P_2	E	F	W	T
M	8 mm	0.041 ± 0.002 [1.05 ± 0.05]	0.071 ± 0.002 [1.8 ± 0.05]	0.06 ± 0.004 [1.5 ± 0.1]	0.157 ± 0.004 [4.0 ± 0.1]	0.157 ± 0.004 [4.0 ± 0.1]	0.079 ± 0.002 [2.0 ± 0.05]	0.069 ± 0.004 [1.75 ± 0.1]	0.0138 ± 0.002 [3.5 ± 0.05]	0.315 ± 0.008 [8.0 ± 0.2]	0.037 ± 0.002 [0.95 ± 0.05]

Note

(1) A_0, B_0 are determined by the maximum dimensions to the ends of the terminals extending from the component body and/or the body dimensions of the component. The clearance between the ends of the terminals or body of the component to the sides and depth of the cavity (A_0, B_0) must be within 0.002" (0.05 mm) minimum and 0.020" (0.50 mm) maximum. The clearance allowed must also prevent rotation of the component within the cavity of not more than 20°.

STANDARD PACKAGING QUANTITY

CASE CODE	QUANTITY (PCS/REEL)
	7" REEL
M	4000
P	3000

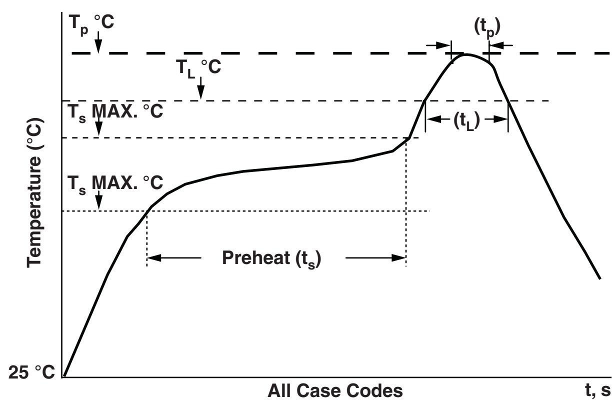
RECOMMENDED VOLTAGE DERATING GUIDELINES

STANDARD CONDITIONS. FOR EXAMPLE: OUTPUT FILTERS	
Capacitor Voltage Rating	**Operating Voltage**
4.0	2.5
6.3	3.6
10	6.0
16	10
20	12
25	15
35	24
50	28
SEVERE CONDITIONS. FOR EXAMPLE: INPUT FILTERS	
Capacitor Voltage Rating	**Operating Voltage**
4.0	2.5
6.3	3.3
10	5.0
16	8.0
20	10
25	12
35	15
50	24

POWER DISSIPATION

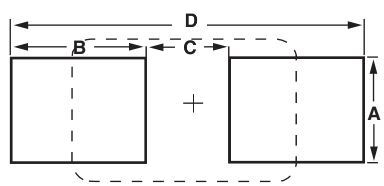
CASE CODE	MAXIMUM PERMISSIBLE POWER DISSIPATION AT + 25 °C (W) IN FREE AIR
M	0.025
P	0.045

RECOMMENDED REFLOW PROFILES



T_P lead (Pb)-free	T_P Sn/Pb	t_P	T_L lead (Pb)-free	T_L Sn/Pb	T_S MIN. lead (Pb)-free	T_S MIN. Sn/Pb	T_S MAX. lead (Pb)-free	t_S MAX. Sn/Pb	t_S lead (Pb)-free	T_S Sn/Pb	t_L
260 °C	225 °C	10	217 °C	183 °C	150 °C	100 °C	200 °C	150 °C	60 to 150	60 to 90	60

PAD DIMENSIONS in inches [millimeters]



CASE CODE	A (MIN.)	B (NOM.)	C (NOM.)	D (NOM.)
M	0.039 [1.00]	0.028 [0.70]	0.024 [0.60]	0.080 [2.00]
P	0.063 [1.60]	0.031 [0.80]	0.047 [1.20]	0.110 [2.80]

GUIDE TO APPLICATION

1. **AC Ripple Current:** The maximum allowable ripple current shall be determined from the formula:

$$I_{RMS} = \sqrt{\frac{P}{R_{ESR}}}$$

where,

P = Power dissipation in watts at + 25 °C (see paragraph number 5 and the table Power Dissipation)

R_{ESR} = The capacitor equivalent series resistance at the specified frequency

2. **AC Ripple Voltage:** The maximum allowable ripple voltage shall be determined from the formula:

$$V_{RMS} = Z\sqrt{\frac{P}{R_{ESR}}}$$

or, from the formula:

$$V_{RMS} = I_{RMS} \times Z$$

where,

P = Power dissipation in watts at + 25 °C (see paragraph number 5 and the table Power Dissipation)

R_{ESR} = The capacitor equivalent series resistance at the specified frequency

Z = The capacitor impedance at the specified frequency

2.1 The sum of the peak AC voltage plus the applied DC voltage shall not exceed the DC voltage rating of the capacitor.

2.2 The sum of the negative peak AC voltage plus the applied DC voltage shall not allow a voltage reversal exceeding 10 % of the DC working voltage at + 25 °C.

3. **Reverse Voltage:** These capacitors are capable of withstanding peak voltages in the reverse direction equal to 10 % of the DC rating at + 25 °C, 5 % of the DC rating at + 85 °C and 1 % of the DC rating at + 125 °C.

4. **Temperature Derating:** If these capacitors are to be operated at temperatures above + 25 °C, the permissible RMS ripple current or voltage shall be calculated using the derating factors as shown:

TEMPERATURE	DERATING FACTOR
+ 25 °C	1.0
+ 85 °C	0.9
+ 125 °C	0.4

5. **Power Dissipation:** Power dissipation will be affected by the heat sinking capability of the mounting surface. Non-sinusoidal ripple current may produce heating effects which differ from those shown. It is important that the equivalent I_{RMS} value be established when calculating permissible operating levels. (Power Dissipation calculated using + 25 °C temperature rise.)

6. **Printed Circuit Board Materials:** Molded capacitors are compatible with commonly used printed circuit board materials (alumina substrates, FR4, FR5, G10, PTFE-fluorocarbon and porcelanized steel).

7. **Attachment:**

7.1 **Solder Paste:** The recommended thickness of the solder paste after application is 0.007" ± 0.001" [0.178 mm ± 0.025 mm]. Care should be exercised in selecting the solder paste. The metal purity should be as high as practical. The flux (in the paste) must be active enough to remove the oxides formed on the metallization prior to the exposure to soldering heat. In practice this can be aided by extending the solder preheat time at temperatures below the liquidous state of the solder.

7.2 **Soldering:** Capacitors can be attached by conventional soldering techniques; vapor phase, convection reflow, infrared reflow, wave soldering and hot plate methods. The Soldering Profile charts show recommended time/temperature conditions for soldering. Preheating is recommended. The recommended maximum ramp rate is 2 °C per s. Attachment with a soldering iron is not recommended due to the difficulty of controlling temperature and time at temperature. The soldering iron must never come in contact with the capacitor.

7.2.1 **Backward and Forward Compatibility:** Capacitors with SnPb or 100 % tin termination finishes can be soldered using SnPb or lead (Pb)-free soldering processes.

8. **Cleaning (Flux Removal) After Soldering:** Molded capacitors are compatible with all commonly used solvents such as TES, TMS, Prelete, Chlorethane, Terpene and aqueous cleaning media. However, CFC/ODS products are not used in the production of these devices and are not recommended. Solvents containing methylene chloride or other epoxy solvents should be avoided since these will attack the epoxy encapsulation material.

8.1 When using ultrasonic cleaning, the board may resonate if the output power is too high. This vibration can cause cracking or a decrease in the adherence of the termination. Do not exceed 9W/l at 40 kHz for 2 min.

9. **Recommended Mounting Pad Geometries:** Proper mounting pad geometries are essential for successful solder connections. These dimensions are highly process sensitive and should be designed to minimize component rework due to unacceptable solder joints. The dimensional configurations shown are the recommended pad geometries for both wave and reflow soldering techniques. These dimensions are intended to be a starting point for circuit board designers and may be fine tuned if necessary based upon the peculiarities of the soldering process and/or circuit board design.

PRODUCT INFORMATION	
Moisture Sensitivity	www.vishay.com/doc?40135
SELECTOR GUIDES	
Solid Tantalum Selector Guide	www.vishay.com/doc?49053
Solid Tantalum Chip Capacitors	www.vishay.com/doc?40091
FAQ	
Frequently Asked Questions	www.vishay.com/doc?40110

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