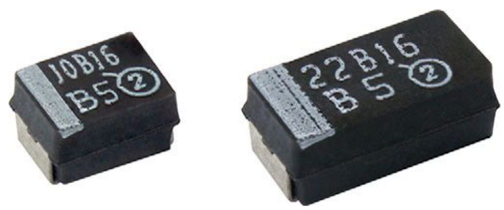
Solid Tantalum Surface-Mount Chip Capacitors TANTAMOUNT™ Molded Case, HI-TMP® High Temperature 175 °C, Automotive Grade



LINKS TO ADDITIONAL RESOURCES

3D Models | Calculators | Related Documents | Infographics | Did You Know? | Technical Notes

PERFORMANCE / ELECTRICAL CHARACTERISTICS

www.vishay.com/doc?40215

Operating Temperature: -55 °C to +175 °C

Capacitance Range: 4.7 µF to 100 µF

Capacitance Tolerance: ± 10 %, ± 20 %

Voltage Range: 6.3 V_{DC} to 50 V_{DC}

Note

- For recommended voltage derating guidelines see “Typical Performance Characteristics”

FEATURES

- Operating temperature up to 175 °C with 50 % voltage derating
- AEC-Q200 qualified
- 100 % surge current tested
- RoHS-compliant terminations available: matte tin (all cases), gold (D / E cases)
- Standard EIA 535BAAC case sizes
- Moisture sensitivity level 1
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE

Pb-free

RoHS COMPLIANT

HALOGEN FREE

GREEN (5-2008)

APPLICATIONS

- Automotive
- Industrial
- High temperature

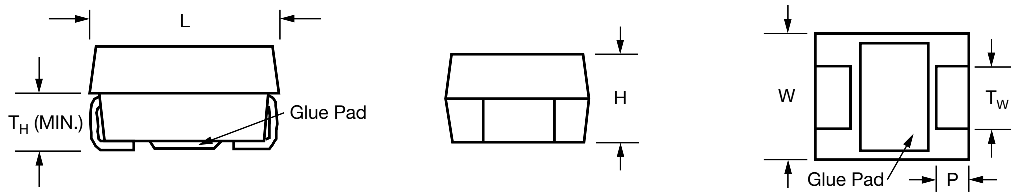
ORDERING INFORMATION

TH4	C	226	K	016	C	1000
TYPE	CASE CODE	CAPACITANCE	CAPACITANCE TOLERANCE	DC VOLTAGE RATING AT +85 °C	TERMINATION AND PACKAGING	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 V. To complete the three-digit block, zeros precede the voltage rating. A decimal point is indicated by an “R” (6R3 = 6.3 V)	**Matte tin** **C** = 7" (178 mm) reel **D** = 13" (330 mm) reel **V** = 7" (178 mm) reel, dry pack **U** = 13" (330 mm) reel, dry pack **Gold plating** **A** = 7" (178 mm) reel **B** = 13" (330 mm) reel	Maximum 100 kHz ESR 0500 = 500 mΩ 5000 = 5.0 Ω 10R0 = 10.0 Ω

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
- Dry pack as specified in J-STD-033
- Gold plated terminations are available for D / E cases only

DIMENSIONS in inches [millimeters]



CASE CODE	EIA SIZE	L	W	H	P	T_W	T_H (MIN.)
B	3528-21	0.138 ± 0.008 [3.5 ± 0.20]	0.110 ± 0.008 [2.8 ± 0.20]	0.075 ± 0.008 [1.9 ± 0.20]	0.031 ± 0.012 [0.80 ± 0.30]	0.087 ± 0.004 [2.2 ± 0.10]	0.028 [0.70]
C	6032-28	0.236 ± 0.012 [6.0 ± 0.30]	0.126 ± 0.012 [3.2 ± 0.30]	0.098 ± 0.012 [2.5 ± 0.30]	0.051 ± 0.012 [1.3 ± 0.30]	0.087 ± 0.004 [2.2 ± 0.10]	0.039 [1.0]
D	7343-31	0.287 ± 0.012 [7.3 ± 0.30]	0.169 ± 0.012 [4.3 ± 0.30]	0.110 ± 0.012 [2.8 ± 0.30]	0.051 ± 0.012 [1.3 ± 0.30]	0.094 ± 0.004 [2.4 ± 0.10]	0.039 [1.0]
E	7343-43	0.287 ± 0.012 [7.3 ± 0.30]	0.169 ± 0.012 [4.3 ± 0.30]	0.157 ± 0.012 [4.0 ± 0.30]	0.051 ± 0.012 [1.3 ± 0.30]	0.094 ± 0.004 [2.4 ± 0.10]	0.039 [1.0]

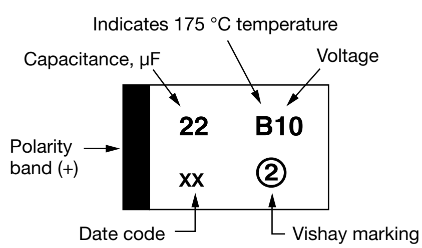
Note

- Glue pad (non-conductive, part of molded case) is dedicated for glue attachment (as user option)

RATINGS AND CASE CODES

µF	6.3 V	10 V	16 V	35 V	50 V
4.7					D (0.9)
10	B (1.8)	B (1.8)	B (2.0)		
22	B (1.5)	B (1.6) C (1.4)	B (1.9) C (1.4, 1.0) D (0.8, 0.6)	D (0.5)	
47	C (0.8)	C (0.5)	C (0.8) D (0.4, 0.7)		
100			E (0.6)		

MARKING



Marking

Capacitor marking includes an anode (+) polarity band, capacitance in microfarads and the voltage rating.

The Vishay identification marking is included if space permits. Vishay marking ("circled 2") may show additives in the form of short lines, depicting actual manufacturing facility. For A case capacitors discontinuation in polarity bar maybe used as actual manufacturing facility designation. Capacitors rated at 6.3 V are marked 6 V.

A manufacturing date code is marked on all capacitors.

Call the factory for further explanation.

STANDARD RATINGS

CAPACITANCE (μF)	CASE CODE	PART NUMBER	MAX. DCL AT +25 °C (μA)	MAX. DF AT +25 °C 120 Hz (%)	MAX. ESR AT +25 °C 100 kHz (Ω)	MAX. RIPPLE AT +25 °C 100 kHz I_{RMS} (A)
6.3 V_{DC} AT +85 °C; 3 V_{DC} AT +175 °C						
10	B	TH4B106(1)6R3(2)1800	0.6	6.0	1.800	0.22
22	B	TH4B226(1)6R3(2)1500	1.4	6.0	1.500	0.24
47	C	TH4C476(1)6R3(2)0800	3.0	6.0	0.800	0.37
10 V_{DC} AT +85 °C; 5 V_{DC} AT +175 °C						
10	B	TH4B106(1)010(2)1800	1.0	4.5	1.800	0.22
22	B	TH4B226(1)010(2)1600	2.2	6.0	1.600	0.23
22	C	TH4C226(1)010(2)1400	2.2	6.0	1.400	0.28
47	C	TH4C476(1)010(2)0500	4.7	4.5	0.500	0.47
16 V_{DC} AT +85 °C; 8 V_{DC} AT +175 °C						
10	B	TH4B106(1)016(2)2000	1.6	6.0	2.000	0.21
22	B	TH4B226(1)016(2)1900	3.5	6.0	1.900	0.21
22	C	TH4C226(1)016(2)1400	3.5	6.0	1.400	0.28
22	C	TH4C226(1)016(2)1000	3.5	6.0	1.000	0.33
22	D	TH4D226(1)016(2)0800	3.5	6.0	0.800	0.43
22	D	TH4D226(1)016(2)0600	3.5	6.0	0.600	0.50
47	C	TH4C476(1)016(2)0800	7.5	6.0	0.800	0.37
47	D	TH4D476(1)016(2)0700	7.5	6.0	0.700	0.46
47	D	TH4D476(1)016(2)0400	7.5	6.0	0.400	0.61
100	E	TH4E107(1)016(2)0600	16	8.0	0.600	0.52
35 V_{DC} AT +85 °C; 17.5 V_{DC} AT +175 °C						
22	D	TH4D226(1)035(2)0500	6.0	6.0	0.500	0.55
50 V_{DC} AT +85 °C; 25 V_{DC} AT +175 °C						
4.7	D	TH4D475(1)050(2)0900	2.4	6.0	0.900	0.41

Note
- Part number definitions:
  (1) Capacitance tolerance: K, M
  (2) Termination and packaging: C, D, V, U, A, B (A and B - for cases D / E only)

POWER DISSIPATION

CASE CODE	MAXIMUM PERMISSIBLE POWER DISSIPATION AT +25 °C (W) IN FREE AIR
B	0.085
C	0.110
D	0.150
E	0.165

RIPPLE CURRENT FACTOR	
TEMPERATURE (°C)	DERATING FACTOR
25	1.0
85	0.9
125	0.4
150	0.3
175	0.2

STANDARD PACKAGING QUANTITY		
CASE CODE	UNITS PER REEL	
	7" REEL	13" REEL
B	2000	8000
C	500	3000
D	500	2500
E	400	1500

PRODUCT INFORMATION	
Guide for Molded Tantalum Capacitors	www.vishay.com/doc?40074
Pad Dimensions	
Packaging Dimensions	
Moisture Sensitivity (MSL)	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

Guide for Molded Tantalum Capacitors

INTRODUCTION

Tantalum electrolytic capacitors are the preferred choice in applications where volumetric efficiency, stable electrical parameters, high reliability, and long service life are primary considerations. The stability and resistance to elevated temperatures of the tantalum / tantalum oxide / manganese dioxide system make solid tantalum capacitors an appropriate choice for today's surface-mount assembly technology.

Vishay Sprague has been a pioneer and leader in this field, producing a large variety of tantalum capacitor types for consumer, industrial, automotive, military, and aerospace electronic applications.

Tantalum is not found in its pure state. Rather, it is commonly found in a number of oxide minerals, often in combination with Columbium ore. This combination is known as “tantalite” when its contents are more than one-half tantalum. Important sources of tantalite include Australia, Brazil, Canada, China, and several African countries. Synthetic tantalite concentrates produced from tin slags in Thailand, Malaysia, and Brazil are also a significant raw material for tantalum production.

Electronic applications, and particularly capacitors, consume the largest share of world tantalum production. Other important applications for tantalum include cutting tools (tantalum carbide), high temperature super alloys, chemical processing equipment, medical implants, and military ordnance.

Vishay Sprague is a major user of tantalum materials in the form of powder and wire for capacitor elements and rod and sheet for high temperature vacuum processing.

THE BASICS OF TANTALUM CAPACITORS

Most metals form crystalline oxides which are non-protecting, such as rust on iron or black oxide on copper. A few metals form dense, stable, tightly adhering, electrically insulating oxides. These are the so-called “valve”metals and include titanium, zirconium, niobium, tantalum, hafnium, and aluminum. Only a few of these permit the accurate control of oxide thickness by electrochemical means. Of these, the most valuable for the electronics industry are aluminum and tantalum.

Capacitors are basic to all kinds of electrical equipment, from radios and television sets to missile controls and automobile ignitions. Their function is to store an electrical charge for later use.

Capacitors consist of two conducting surfaces, usually metal plates, whose function is to conduct electricity. They are separated by an insulating material or dielectric. The dielectric used in all tantalum electrolytic capacitors is tantalum pentoxide.

Tantalum pentoxide compound possesses high-dielectric strength and a high-dielectric constant. As capacitors are being manufactured, a film of tantalum pentoxide is applied to their electrodes by means of an electrolytic process. The film is applied in various thicknesses and at various voltages and although transparent to begin with, it takes on different colors as light refracts through it. This coloring occurs on the tantalum electrodes of all types of tantalum capacitors.

Rating for rating, tantalum capacitors tend to have as much as three times better capacitance / volume efficiency than aluminum electrolytic capacitors. An approximation of the capacitance / volume efficiency of other types of capacitors may be inferred from the following table, which shows the dielectric constant ranges of the various materials used in each type. Note that tantalum pentoxide has a dielectric constant of 26, some three times greater than that of aluminum oxide. This, in addition to the fact that extremely thin films can be deposited during the electrolytic process mentioned earlier, makes the tantalum capacitor extremely efficient with respect to the number of microfarads available per unit volume. The capacitance of any capacitor is determined by the surface area of the two conducting plates, the distance between the plates, and the dielectric constant of the insulating material between the plates.

COMPARISON OF CAPACITOR DIELECTRIC CONSTANTS

DIELECTRIC	e DIELECTRIC CONSTANT
Air or vacuum	1.0
Paper	2.0 to 6.0
Plastic	2.1 to 6.0
Mineral oil	2.2 to 2.3
Silicone oil	2.7 to 2.8
Quartz	3.8 to 4.4
Glass	4.8 to 8.0
Porcelain	5.1 to 5.9
Mica	5.4 to 8.7
Aluminum oxide	8.4
Tantalum pentoxide	**26**
Ceramic	12 to 400K

In the tantalum electrolytic capacitor, the distance between the plates is very small since it is only the thickness of the tantalum pentoxide film. As the dielectric constant of the tantalum pentoxide is high, the capacitance of a tantalum capacitor is high if the area of the plates is large:

$$C = \frac{eA}{t}$$

where

C = capacitance

e = dielectric constant

A = surface area of the dielectric

t = thickness of the dielectric

Tantalum capacitors contain either liquid or solid electrolytes. In solid electrolyte capacitors, a dry material (manganese dioxide) forms the cathode plate. A tantalum lead is embedded in or welded to the pellet, which is in turn connected to a termination or lead wire. The drawings show the construction details of the surface-mount types of tantalum capacitors shown in this catalog.

SOLID ELECTROLYTE TANTALUM CAPACITORS

Solid electrolyte capacitors contain manganese dioxide, which is formed on the tantalum pentoxide dielectric layer by impregnating the pellet with a solution of manganous nitrate. The pellet is then heated in an oven, and the manganous nitrate is converted to manganese dioxide.

The pellet is next coated with graphite, followed by a layer of metallic silver, which provides a conductive surface between the pellet and the leadframe.

Molded Chip tantalum capacitor encases the element in plastic resins, such as epoxy materials. The molding compound has been selected to meet the requirements of UL 94 V-0 and outgassing requirements of ASTM E-595. After assembly, the capacitors are tested and inspected to assure long life and reliability. It offers excellent reliability and high stability for consumer and commercial electronics with the added feature of low cost

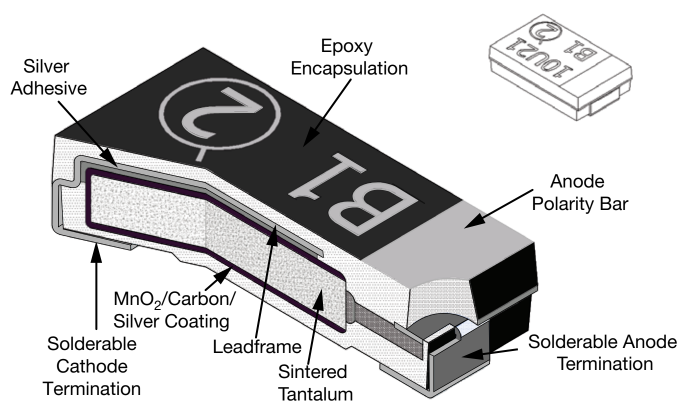
Surface-mount designs of “solid tantalum” capacitors use lead frames or lead frameless designs as shown in the accompanying drawings.

TANTALUM CAPACITORS FOR ALL DESIGN CONSIDERATIONS

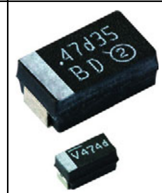
Solid electrolyte designs are the least expensive for a given rating and are used in many applications where their very small size for a given unit of capacitance is of importance. They will typically withstand up to about 10 % of the rated DC working voltage in a reverse direction. Also important are their good low temperature performance characteristics and freedom from corrosive electrolytes.

Vishay Sprague patented the original solid electrolyte capacitors and was the first to market them in 1956. Vishay Sprague has the broadest line of tantalum capacitors and has continued its position of leadership in this field. Data sheets covering the various types and styles of Vishay Sprague capacitors for consumer and entertainment electronics, industry, and military applications are available where detailed performance characteristics must be specified.

MOLDED CHIP CAPACITOR



COMMERCIAL PRODUCTS

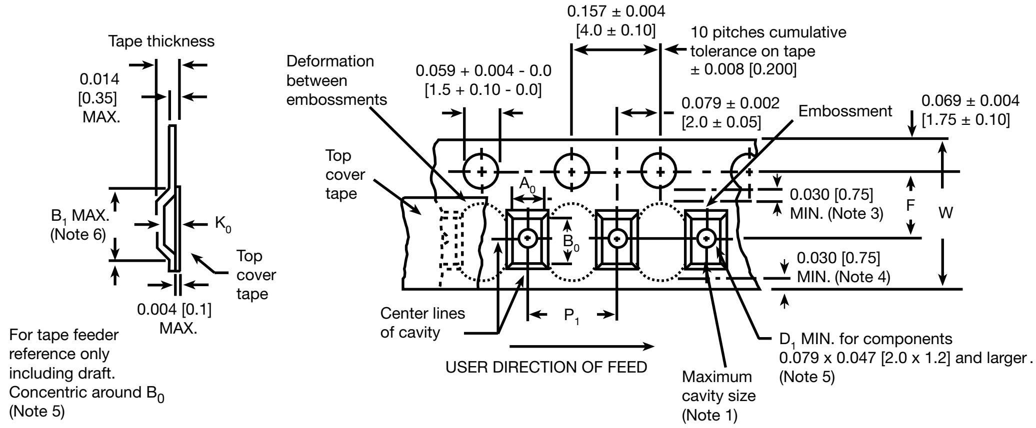
SOLID TANTALUM CAPACITORS - MOLDED CASE						
SERIES	**293D**	**793DX-CTC3-CTC4**	**593D**	**TR3**	**TP3**	**TL3**
PRODUCT IMAGE						
TYPE	Surface-mount TANTAMOUNT™, molded case					
FEATURES	Standard industrial grade	CECC approved	Low ESR	Low ESR	High performance, automotive grade	Very low DCL
TEMPERATURE RANGE	-55 °C to +125 °C					
CAPACITANCE RANGE	0.1 µF to 1000 µF	0.1 µF to 100 µF	1 µF to 470 µF	0.47 µF to 1000 µF	0.1 µF to 470 µF	0.1 µF to 470 µF
VOLTAGE RANGE	4 V to 75 V	4 V to 50 V	4 V to 50 V	4 V to 75 V	4 V to 50 V	4 V to 50 V
CAPACITANCE TOLERANCE	± 10 %, ± 20 %					
LEAKAGE CURRENT	0.01 CV or 0.5 µA, whichever is greater					0.005 CV or 0.25 µA, whichever is greater
DISSIPATION FACTOR	4 % to 30 %	4 % to 6 %	4 % to 15 %	4 % to 30 %	4 % to 15 %	4 % to 15 %
CASE CODES	A, B, C, D, E	A, B, C, D	A, B, C, D, E	A, B, C, D, E, W	A, B, C, D, E	A, B, C, D, E
TERMINATION	100 % matte tin standard, tin / lead available					

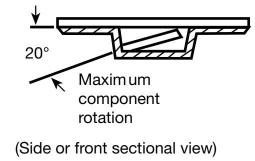
SOLID TANTALUM CAPACITORS - MOLDED CASE				
SERIES	**TX3**	**TH3**	**TH4**	**TH5**
PRODUCT IMAGE				
TYPE	Surface-mount TANTAMOUNT™, molded case			
FEATURES	E-detonators	High temperature +150 °C, automotive grade	High temperature +175 °C, automotive grade	Very high temperature +200 °C
TEMPERATURE RANGE	-55 °C to +125 °C	-55 °C to +150 °C	-55 °C to +175 °C	-55 °C to +200 °C
CAPACITANCE RANGE	10 µF to 100 µF	0.33 µF to 220 µF	10 µF to 100 µF	4.7 µF to 100 µF
VOLTAGE RANGE	16 V to 25 V	6.3 V to 50 V	6.3 V to 35 V	5 V to 24 V
CAPACITANCE TOLERANCE	± 10 %, ± 20 %			
LEAKAGE CURRENT	0.005 CV	0.01 CV or 0.5 µA, whichever is greater		
DISSIPATION FACTOR	6 % to 20 %	4 % to 8 %	4.5 % to 8 %	6 % to 10 %
CASE CODES	B, C	A, B, C, D, E	B, C, D, E	D, E
TERMINATION	100 % matte tin	100 % matte tin standard, tin / lead and gold plated available	100 % matte tin	Gold plated

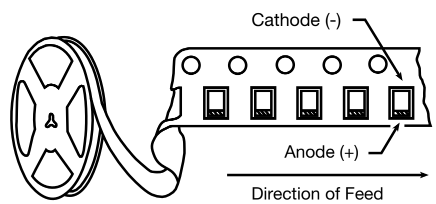
HIGH RELIABILITY PRODUCTS

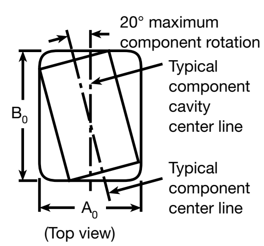
SOLID TANTALUM CAPACITORS - MOLDED CASE				
SERIES	**TM3**	**T83**	**CWR11**	**95158**
PRODUCT IMAGE				
TYPE	TANTAMOUNT™, molded case, hi-rel.	TANTAMOUNT™, molded case, hi-rel. COTS	TANTAMOUNT™, molded case, DLA approved	
FEATURES	High reliability, for medical Instruments	High reliability, standard and low ESR	MIL-PRF-55365/8 qualified	Low ESR
TEMPERATURE RANGE	-55 °C to +125 °C			
CAPACITANCE RANGE	1 µF to 220 µF	0.1 µF to 470 µF	0.1 µF to 100 µF	4.7 µF to 220 µF
VOLTAGE RANGE	4 V to 20 V	4 V to 63 V	4 V to 50 V	
CAPACITANCE TOLERANCE	± 10 %, ± 20 %		± 5 %, ± 10 %, ± 20 %	± 10 %, ± 20 %
LEAKAGE CURRENT	0.005 CV or 0.25 µA, whichever is greater	0.01 CV or 0.5 µA, whichever is greater		
DISSIPATION FACTOR	4 % to 8 %	4 % to 15 %	4 % to 6 %	4 % to 12 %
CASE CODES	A, B, C, D, E	A, B, C, D, E	A, B, C, D	C, D, E
TERMINATION	100 % matte tin; tin / lead	100 % matte tin; tin / lead; tin / lead solder fused	Tin / lead; tin / lead solder fused	Tin / lead solder plated; gold plated

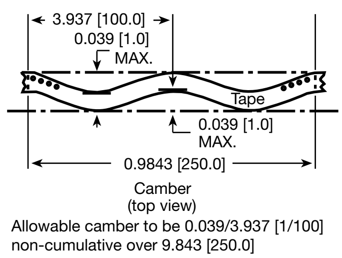
PLASTIC TAPE AND REEL PACKAGING in inches [millimeters]











Tape and Reel Specifications: all case sizes are available on plastic embossed tape per EIA-481. 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

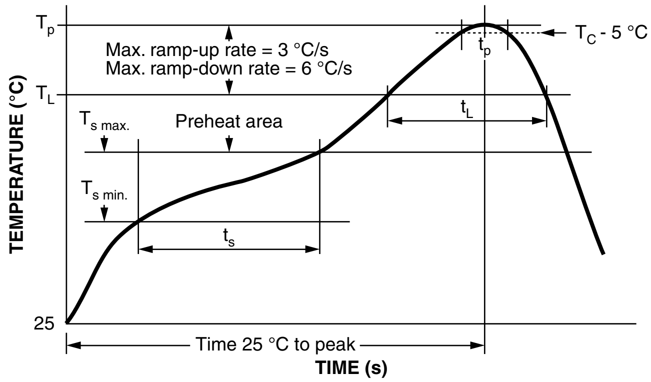
(5) The embossed hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location shall be applied independent of each other

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

CASE CODE	TAPE SIZE	B_1 (MAX.)	D_1 (MIN.)	F	K_0 (MAX.)	P_1	W
MOLDED CHIP CAPACITORS; ALL TYPES							
A	8 mm	0.165 [4.2]	0.039 [1.0]	0.138 ± 0.002 [3.5 ± 0.05]	0.094 [2.4]	0.157 ± 0.004 [4.0 ± 1.0]	0.315 ± 0.012 [8.0 ± 0.30]
B							
C	12 mm	0.32 [8.2]	0.059 [1.5]	0.217 ± 0.00 [5.5 ± 0.05]	0.177 [4.5]	0.315 ± 0.004 [8.0 ± 1.0]	0.472 ± 0.012 [12.0 ± 0.30]
D							
E							
W							

RECOMMENDED REFLOW PROFILES

Capacitors should withstand reflow profile as per J-STD-020 standard, three cycles.

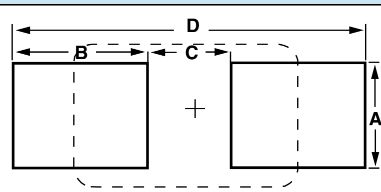


PROFILE FEATURE	SnPb EUTECTIC ASSEMBLY	LEAD (Pb)-FREE ASSEMBLY
Preheat / soak		
Temperature min. ($T_{s\ min.}$)	100 °C	150 °C
Temperature max. ($T_{s\ max.}$)	150 °C	200 °C
Time (t_s) from ($T_{s\ min.}$ to $T_{s\ max.}$)	60 s to 120 s	60 s to 120 s
Ramp-up		
Ramp-up rate (T_L to T_p)	3 °C/s max.	3 °C/s max.
Liquidus temperature (T_L)	183 °C	217 °C
Time (t_L) maintained above T_L	60 s to 150 s	60 s to 150 s
Peak package body temperature (T_p)	Depends on case size - see table below	
Time (t_p) within 5 °C of the specified classification temperature (T_C)	20 s	30 s
Time 25 °C to peak temperature	6 min max.	8 min max.
Ramp-down		
Ramp-down rate (T_p to T_L)	6 °C/s max.	6 °C/s max.

PEAK PACKAGE BODY TEMPERATURE (T_p)

CASE CODE	PEAK PACKAGE BODY TEMPERATURE (T_p)	
	SnPb EUTECTIC PROCESS	LEAD (Pb)-FREE PROCESS
A, B, C	235 °C	260 °C
D, E, W	220 °C	250 °C

PAD DIMENSIONS in inches [millimeters]



CASE CODE	A (MIN.)	B (NOM.)	C (NOM.)	D (NOM.)
MOLDED CHIP CAPACITORS, ALL TYPES				
A	0.071 [1.80]	0.067 [1.70]	0.053 [1.35]	0.187 [4.75]
B	0.118 [3.00]	0.071 [1.80]	0.065 [1.65]	0.207 [5.25]
C	0.118 [3.00]	0.094 [2.40]	0.118 [3.00]	0.307 [7.80]
D	0.157 [4.00]	0.098 [2.50]	0.150 [3.80]	0.346 [8.80]
E	0.157 [4.00]	0.098 [2.50]	0.150 [3.80]	0.346 [8.80]
W	0.185 [4.70]	0.098 [2.50]	0.150 [3.80]	0.346 [8.80]

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 W at +25 °C as given in the tables in the product datasheets (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:

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

or, from the formula:

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

where,

P = power dissipation in W at +25 °C as given in the tables in the product datasheets (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:** solid tantalum capacitors are not intended for use with reverse voltage applied. However, they have been shown to be capable of withstanding momentary reverse voltage peaks of up to 10 % of the DC rating at 25 °C and 5 % of the DC rating at +85 °C.

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

TEMPERATURE (°C)	DERATING FACTOR
+25	1.0
+85	0.9
+125	0.4
+150 (1)	0.3
+175 (1)	0.2
+200 (1)	0.1

Note

(1) Applicable for dedicated high temperature product series

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 3 °C per second. 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. For details see www.vishay.com/doc?40214.

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.

Molded Chip Tantalum Capacitors, Automotive Grade

ELECTRICAL PERFORMANCE CHARACTERISTICS					
ITEM	**PERFORMANCE CHARACTERISTICS**				
Category temperature range	-55 °C to +85 °C (to +125 °C / +150 °C / +175 °C with voltage derating - refer to graph “Category Voltage vs. Temperature”) (1)				
Capacitance tolerance	± 20 %, ± 10 %, tested via bridge method, at 25 °C, 120 Hz				
Dissipation factor	Limits per Standard Ratings table. Tested via bridge method, at 25 °C, 120 Hz				
ESR	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 0.01 CV or 0.5 μA, whichever is greater. *Note that the leakage current varies with temperature and applied voltage. See graph “Typical Leakage Current Temperature Factor” for the appropriate adjustment factor.*				
Capacitance change by temperature	+30 % max. (at +175 °C) +20 % max. (at +125 °C and +150 °C) +10 % max. (at +85 °C) -10 % max. (at -55 °C)				
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 1 % of the DC rating at +125 °C				
Ripple current	For maximum ripple current values (at 25 °C) refer to relevant datasheet. 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 0.3 at +150 °C 0.2 at +175 °C				
Maximum operating and surge voltages vs. temperature	**+85 °C**		**+125 °C**		**+150 °C / +175 °C**
	RATED VOLTAGE (V)	**SURGE VOLTAGE (V)**	**CATEGORY VOLTAGE (V)**	**SURGE VOLTAGE (V)**	**CATEGORY VOLTAGE (V)**
	4	5.2	2.7	3.4	n/a
	6.3	8	4	5	3
	10	13	7	8	5
	16	20	10	12	8
	20	26	13	16	10
	25	32	17	20	12.5
	35	46	23	28	17.5
	50	65	33	40	25
	50 (2)	60	33	40	n/a
	63	75	42	50	n/a
	75 (3)	75	50	50	n/a

Notes
- All information presented in this document reflects typical performance characteristics

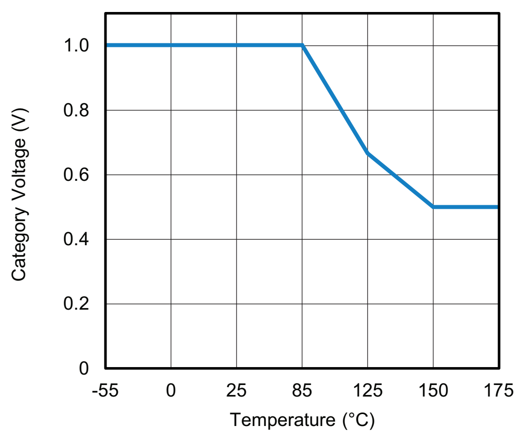
(1) Series TH3 - up to 150 °C; TH4 - up to 175 °C
(2) Capacitance value 15 μF and higher
(3) For 293D and TR3 only

RECOMMENDED VOLTAGE DERATING GUIDELINES (for temperature below +85 °C)	
VOLTAGE RAIL (V)	CAPACITOR VOLTAGE RATING (V)
≤ 3.3	6.3
5	10
10	20
12	25
15	35
24	50 or series configuration

Notes

- For temperatures above +85 °C the same voltage derating ratio is recommended, but with respect to category voltage.
  Up to +85 °C: category voltage = rated voltage
  At +125 °C: category voltage = 2/3 of rated voltage
  At 150 °C / 175 °C: category voltage = 1/2 of rated voltage
- For more information about recommended voltage derating see: www.vishay.com/doc?40246

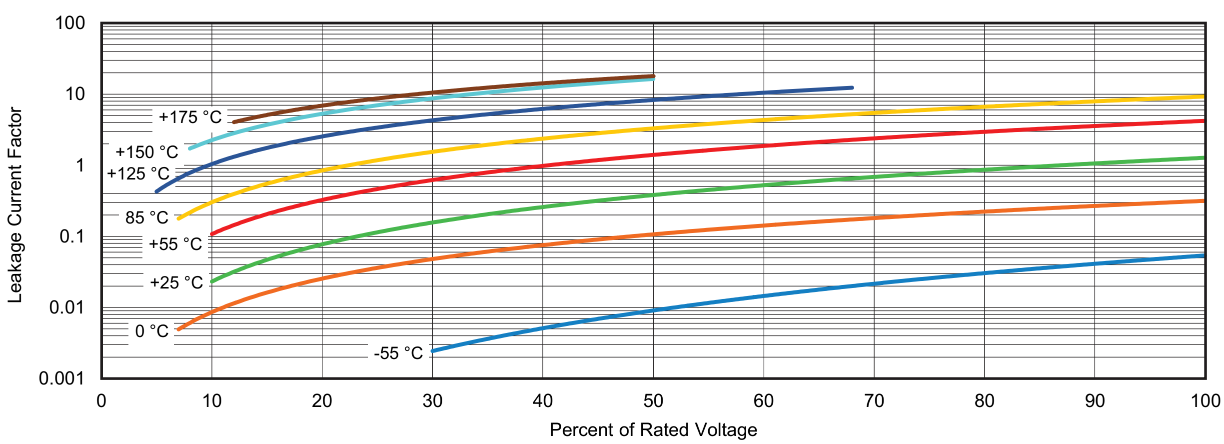
CATEGORY VOLTAGE VS. TEMPERATURE



Note

- Below 85 °C category voltage is equal to rated voltage

TYPICAL LEAKAGE CURRENT FACTOR



Note

- **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.
  At +150 °C, the leakage current shall not exceed 15 times the value listed in the Standard Ratings table.
  At +175 °C, the leakage current shall not exceed 18 times the value listed in the Standard Ratings table

For technical questions, contact: tantalum@vishay.com

ENVIRONMENTAL PERFORMANCE CHARACTERISTICS

ITEM	CONDITION	POST TEST PERFORMANCE	
High temperature exposure (storage)	MIL-STD-202, method 108 1000 h, at maximum rated temperature, unpowered	Capacitance change Dissipation factor Leakage current ESR	Within ± 20 % of initial value Initial specified limit Initial specified limit Initial specified limit
Operational life test at +125 °C	AEC-Q200 1000 h application 2/3 of rated voltage	Capacitance change Dissipation factor Leakage current ESR	Within ± 20 % of initial value Initial specified limit Shall not exceed 10 times the initial limit Initial specified limit
Operational life test at +150 °C (for TH3) and at +175 °C (for TH4)	AEC-Q200 1000 h application 1/2 of rated voltage	Capacitance change Dissipation factor Leakage current ESR	Within ± 20 % of initial value Shall not exceed 3 times the initial limit Shall not exceed 10 times the initial limit Shall not exceed 3 times the initial limit
Surge voltage	MIL-PRF-55365: 1000 successive test cycles at 85 °C of surge voltage (as specified in the table above), in series with a 33 Ω resistor at the rate of 30 s ON, 30 s OFF	Capacitance change Dissipation factor Leakage current ESR	Within ± 30 % of initial value Shall not exceed 1.5 times the initial limit Shall not exceed 2 times the initial limit Shall not exceed 1.5 times the initial limit
Biased humidity test	AEC-Q200 At 85 °C / 85 % RH, 1000 h, with rated voltage applied	Capacitance change Dissipation factor Leakage current ESR	Within ± 20 % of initial value Shall not exceed 3 times the initial limit Shall not exceed 10 times the initial limit Shall not exceed 3 times the initial limit
Temperature cycling	AEC-Q200 / JESD22, method JA-104 -55 °C / +125 °C, for 1000 cycles	Capacitance change Dissipation factor Leakage current ESR	Within ± 20 % of initial value Initial specified limit Initial specified limit Initial specified limit

MECHANICAL PERFORMANCE CHARACTERISTICS

ITEM	CONDITION	POST TEST PERFORMANCE	
Vibration	MIL-STD-202, method 204: 10 Hz to 2000 Hz, 5 *g* peak for 20 min, 12 cycles each of 3 orientations (total 36 cycles), at rated voltage	Capacitance change Dissipation factor Leakage current There shall be no mechanical or visual damage to capacitors post-conditioning.	Within ± 20 % of initial value Initial specified limit Initial specified limit
Mechanical shock	MIL-STD-202, method 213, condition F, 1500 *g* peak, 0.5 ms, half-sine	Capacitance change Dissipation factor Leakage current There shall be no mechanical or visual damage to capacitors post-conditioning.	Within ± 20 % of initial value Initial specified limit Initial specified limit
Resistance to solder heat	MIL-STD-202, method 210, condition D Solder dip 260 °C ± 5 °C, 10 s	Capacitance change Dissipation factor Leakage current	Within ± 20 % of initial value Initial specified limit Initial specified limit
Resistance to solvents	MIL-STD-202, method 215	Capacitance change Dissipation factor Leakage current There shall be no mechanical or visual damage to capacitors post-conditioning. Body marking shall remain legible.	Within ± 20 % of initial value Initial specified limit Initial specified limit
Solderability	AEC-Q200 / J-STD-002	Electrical test not required	
Terminal strength / Shear force test	AEC-Q200-006 Apply a pressure load of 17.7 N (1.8 kg) for 60 s horizontally to the center of capacitor side body Exception: for case size 0603 pressure load is 5N	Part should not be sheared off the pads and no body cracking post-conditioning. Electrical test not required.	
Flammability	Encapsulation materials meet UL 94 V-0 with an oxygen index of 32 %	n/a	

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