



Vishay Sprague

# Solid Tantalum Chip Capacitors, TANTAMOUNT™, Ultra-Low ESR, Conformal Coated, Maximum CV



### **FEATURES**

- New case size offerings
- Terminations: 100 % tin (2) standard; tin / lead available



· Extremely low ESR

- Mounting: surface mount
- Ripple current up to 3.7 A
- 100 % surge current tested
- Moisture sensitivity level 2a
- Material categorization: for definitions of compliance please see <a href="https://www.vishay.com/doc?99912"><u>www.vishay.com/doc?99912</u></a>

### Note

\* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

### **LINKS TO ADDITIONAL RESOURCES**















### PERFORMANCE / ELECTRICAL CHARACTERISTICS

www.vishay.com/doc?40194

Operating Temperature: -55 °C to +125 °C (above 85 °C, voltage derating is required)

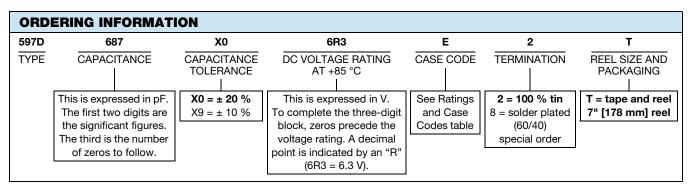
Capacitance Range: 10 μF to 2200 μF

Capacitance Tolerance: ± 10 %, ± 20 % standard

**Voltage Rating:**  $4 V_{DC}$  to  $75 V_{DC}$ 

### Note

• For recommended voltage derating guidelines see "Typical Performance Characteristics"



### Note

Preferred tolerance and reel sizes are in bold.
 We reserve the right to supply higher voltage ratings and tighter capacitance tolerance capacitors in the same case size.
 Low ESR solid tantalum chip capacitors allow delta ESR of 1.25 times the datasheet limits after mounting



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#### **DIMENSIONS** in inches [millimeters] Tantalum wire nib identifies anode (+) terminal D **CASE CODE** L (MAX.) W Н Α В D (REF.) J (MAX.) 0.299 $0.173 \pm 0.016$ 0.079 $0.051 \pm 0.012$ $0.181 \pm 0.024$ 0.004 0.252 $[4.6 \pm 0.6]$ [7.6] $[4.4 \pm 0.4]$ [2.0 max.] $[1.3 \pm 0.3]$ [6.4][0.1]0.004 0.299 0.138 0.252 $0.173 \pm 0.016$ $0.051 \pm 0.012$ $0.181 \pm 0.024$ D [7.6] $[4.4 \pm 0.4]$ [3.5 max.] $[1.3 \pm 0.3]$ $[4.6 \pm 0.6]$ [6.4][0.1]0.299 $0.173 \pm 0.016$ $0.157 \pm 0.016$ $0.051 \pm 0.012$ $0.181 \pm 0.024$ 0.252 0.004 Ε [7.6] $[4.4 \pm 0.4]$ $[4.0 \pm 0.4]$ $[1.3 \pm 0.3]$ $[4.6 \pm 0.6]$ [6.4][0.1]0.004 0.299 $0.238 \pm 0.016$ $0.142 \pm 0.016$ $0.051 \pm 0.012$ $0.181 \pm 0.024$ 0.244 R [7.6] $[6.0 \pm 0.4]$ $[3.6 \pm 0.4]$ $[1.3 \pm 0.3]$ $[4.6 \pm 0.6]$ [6.2][0.1]0.299 $0.238 \pm 0.016$ $0.185 \pm 0.016$ $0.055 \pm 0.016$ 0.244 0.004 $0.181 \pm 0.024$ F [7.6] $[6.0 \pm 0.4]$ $[4.7 \pm 0.4]$ $[1.4 \pm 0.4]$ $[4.6 \pm 0.6]$ [6.2][0.1] 0.004 0.299 $0.238 \pm 0.016$ $0.236 \pm 0.016$ $0.055 \pm 0.016$ $0.181 \pm 0.024$ 0.244 Ζ [7.6] $[6.0 \pm 0.4]$ $[6.0 \pm 0.4]$ $[1.4 \pm 0.4]$ $[4.6 \pm 0.6]$ [6.2][0.1]0.315 0.260 + 0.016 / - 0.024 $0.142 \pm 0.016$ $0.051 \pm 0.012$ $0.197 \pm 0.024$ 0.260 0.004 Μ [8.0] [6.6 + 0.4 / - 0.6] $[3.6 \pm 0.4]$ $[1.3 \pm 0.3]$ $[5.0 \pm 0.6]$ [6.6][0.1]0.004 0.315 0.260 + 0.016 / - 0.024 $0.205 \pm 0.016$ $0.055 \pm 0.016$ $0.197 \pm 0.024$ 0.260 Н [0.1][8.0] [6.6 + 0.4 / - 0.6] $[5.2 \pm 0.4]$ $[1.4 \pm 0.4]$ $[5.0 \pm 0.6]$ [6.6]

### Note

The anode termination (D less B) will be a minimum of 0.012" [0.3 mm]

RATIN	RATINGS AND CASE CODES										
μF	4 V	6.3 V	10 V	16 V	20 V	25 V	35 V	40 V	50 V	63 V	75 <b>V</b>
10										D	R
15									E/R	R	R/F
22									R	F	Z/H
33									F	H/Z	
47							R		H/Z		
68						R	F				
100						F	F/H	Н			
150						F					
220				E	R	М					
330		V	E	F	F/H						
470	V	Е	Е	Н	Н						
680	Е	Е	R	Н							
1000	E/R	R	F								
1500	R	F									
2200	R										



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			MAX. DCL	MAX. DF	MAX. ESR	MAX. RIPPLE
CAPACITANCE (µF)	CASE CODE	PART NUMBER	AT +25 °C (μΑ)	AT +25 °C 120 Hz	AT +25 °C 100 kHz	100 kHz I <sub>RMS</sub>
		4 V AT 195°	C; 2.7 V <sub>DC</sub> AT +125	(%) 5 °C	(mΩ)	(A)
470	V	597D477(1)004V(2)(3)	19	8	60	2.2
680	v E	597D687(1)004F(2)(3)	27	6	25	2.9
1000	E		40	8	20	3.3
		597D108(1)004E(2)(3)	40		18	
1000	R	597D108(1)004R(2)(3)		8		3.7
1500	R	597D158(1)004R(2)(3)	60	8	24	2.9
2200	R	597D228(1)004R(2)(3)	88	30	35	2.7
000			5 °C; 4 V <sub>DC</sub> AT +125		F.C.	0.0
330	V	597D337(1)6R3V(2)(3)	21	8	56	2.0
470	E	597D477(1)6R3E(2)(3)	30	6	30	2.7
680	Е	597D687(1)6R3E(2)(3)	43	6	25	2.9
1000	R	597D108(1)6R3R(2)(3)	63	8	31	2.8
1500	F	597D158(1)6R3F(2)(3)	94	30	35	2.7
			°C; 7 V <sub>DC</sub> AT +125			
330	Е	597D337(1)010E(2)(3)	33	6	35	2.5
470	E	597D477(1)010E(2)(3)	47	6	28	2.8
680	R	597D687(1)010R(2)(3)	68	8	35	2.7
1000	F	597D108(1)010F(2)(3)	100	20	120	1.4
		16 V <sub>DC</sub> AT +85	°C; 10 V <sub>DC</sub> AT +12	5 °C		
220	E	597D227(1)016E(2)(3)	35	8	60	2.3
330	F	597D337(1)016F(2)(3)	53	10	100	1.6
470	Н	597D477(1)016H(2)(3)	75	14	100	1.4
680	Н	597D687(1)016H(2)(3)	100	20	80	1.8
		20 V <sub>DC</sub> AT +85	°C; 13 V <sub>DC</sub> AT +12	5 °C		
220	R	597D227(1)020R(2)(3)	44	8	80	1.8
330	F	597D337(1)020F(2)(3)	66	10	100	1.6
330	Н	597D337(1)020H(2)(3)	66	10	100	1.6
470	Н	597D477(1)020H(2)(3)	94	14	100	1.6
		25 V <sub>DC</sub> AT +85	°C; 17 V <sub>DC</sub> AT +12	5 °C		
68	R	597D686(1)025R(2)(3)	17	6	100	1.6
100	F	597D107(1)025F(2)(3)	25	8	100	1.6
150	F	597D157(1)025F(2)(3)	38	8	80	1.8
220	M	597D227(1)025M(2)(3)	55	8	100	1.6
		35 V <sub>DC</sub> AT +85	°C; 23 V <sub>DC</sub> AT +12	5 °C		
47	R	597D476(1)035R(2)(3)	17	6	130	1.4
68	F	597D686(1)035F(2)(3)	24	6	100	1.6
100	F	597D107X0035F(2)(3)	35	8	100	1.6
100	Н	597D107(1)035H(2)(3)	35	8	100	1.4

### Note

Part number definitions:

<sup>(1)</sup> Tolerance: for 10 % tolerance, specify "X9", for 20 % tolerance, change to "X0"

<sup>(2)</sup> Termination: for 100 % tin specify "2", for solder plated 60/40 specify "8" (3) Packaging code: for 7" reels specify "T"



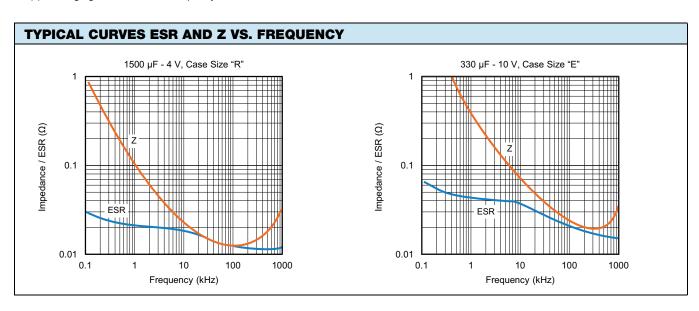


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STANDARD	RATINGS								
CAPACITANCE (μF)	CASE CODE	PART NUMBER	MAX. DCL AT +25 °C (μA)	MAX. DF AT +25 °C 120 Hz (%)	MAX. ESR AT +25 °C 100 kHz (mΩ)	MAX. RIPPLE 100 kHz I <sub>RMS</sub> (A)			
	40 V <sub>DC</sub> AT +85 °C; 26 V <sub>DC</sub> AT +125 °C								
100	Н	597D107X0040H(2)(3)	40	10	150	1.3			
		50 V <sub>DC</sub> AT +85 °	C; 33 V <sub>DC</sub> AT +12	5 °C					
15	E	597D156(1)050E(2)(3)	8	6	300	0.9			
15	R	597D156(1)050R(2)(3)	8	6	250	1.0			
22	R	597D226(1)050R(2)(3)	11	6	220	1.1			
33	F	597D336(1)050F(2)(3)	17	6	150	1.3			
47	Н	597D476X(1)050H(2)(3)	23.5	8	400	0.8			
47	Z	597D476(1)050Z(2)(3)	24	6	240	1.1			
		63 V <sub>DC</sub> AT +85 °	C; 42 V <sub>DC</sub> AT +12	5 °C					
10	D	597D106(1)063D(2)(3)	10	6	400	0.6			
15	R	597D156(1)063R(2)(3)	10	6	400	0.8			
22	F	597D226(1)063F(2)(3)	14	6	250	1.0			
33	Н	597D336X(1)063H(2)(3)	20.8	8	500	0.7			
33	Z	597D336(1)063Z(2)(3)	20.8	8	500	0.7			
		75 V <sub>DC</sub> AT +85 °	C; 50 V <sub>DC</sub> AT +12	5 °C					
10	R	597D106(1)075R(2)(3)	8	6	500	0.7			
15	R	597D156X0075R(2)(3)	12	6	500	0.7			
15	F	597D156X0075F(2)(3)	12	6	500	0.7			
22	Z	597D226(1)075Z(2)(3)	16.5	6	400	0.8			
22	Н	597D226(1)075H(2)(3)	16.5	6	400	0.8			

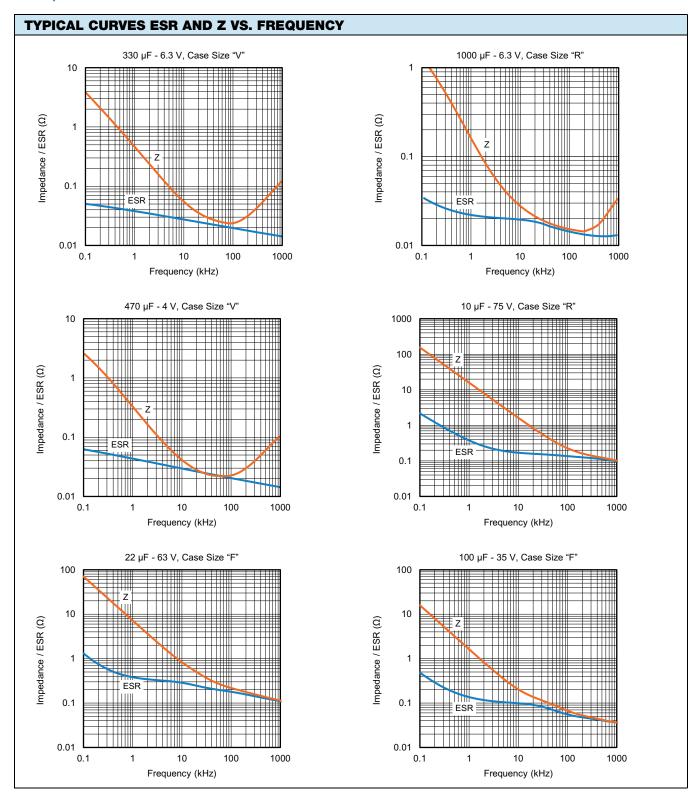
### Note

- Part number definitions:
  - (1) Tolerance: for 10 % tolerance, specify "X9", for 20 % tolerance, change to "X0"
  - (2) Termination: for 100 % tin specify "2", for solder plated 60/40 specify "8"
  - (3) Packaging code: for 7" reels specify "T"





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POWER DISSIPATION	
CASE CODE	MAXIMUM PERMISSIBLE POWER DISSIPATION AT +25 °C (W) IN FREE AIR
V	0.141
D	0.215
E	0.240
R, F, M	0.250
Z	0.265
Н	0.265

STANDARD PACKAGING QUANTITY					
CASE CODE	UNITS PER 7" REEL				
V	1000				
D	400				
E	500				
R	300				
F	250				
Z	250				
M	200				
Н	200				

PRODUCT INFORMATION				
Conformal Coated Guide				
Pad Dimensions	www.vishay.com/doc?40150			
Packaging Dimensions				
Moisture Sensitivity (MSL)	www.vishay.com/doc?40135			
SELECTOR GUIDES				
Solid Tantalum Selector Guide	www.vishay.com/doc?49053			
FAQ				
Frequently Asked Questions	www.vishay.com/doc?40110			

## **Guide for Conformal Coated 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.



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### 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.

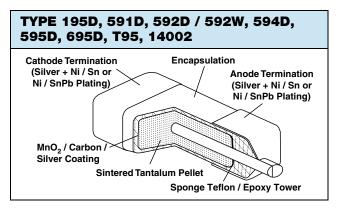
The pellet is next coated with graphite, followed by a layer of metallic silver, which provides a conductive surface between the pellet and the can in which it will be enclosed. After assembly, the capacitors are tested and inspected to assure long life and reliability. It offers excellent reliability and high stability for consumer and commercial electronics with the added feature of low cost.

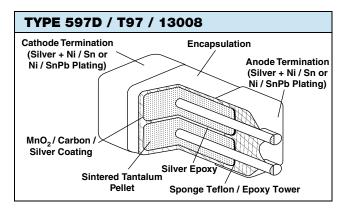
Surface mount designs of "Solid Tantalum" capacitors use lead frames or lead frameless designs as shown in the accompanying drawings.

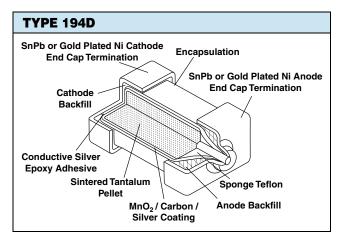
## TANTALUM CAPACITORS FOR ALL DESIGN CONSIDERATIONS

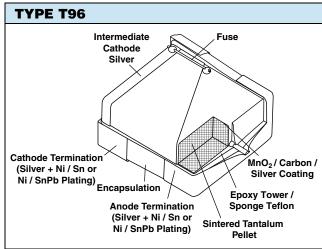
Solid electrolyte designs are the least expensive for a given rating and are used in many applications where their very small size for a given unit of capacitance is of importance. They will typically withstand up to about 10 % of the rated DC working voltage in a reverse direction. Also important are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

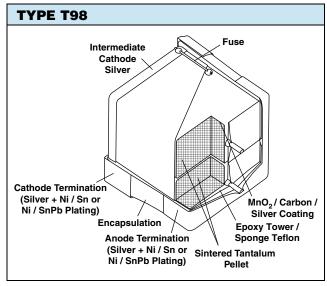
Vishay Sprague patented the original solid electrolyte capacitors and was the first to market them in 1956. Vishay Sprague has the broadest line of tantalum capacitors and has continued its position of leadership in this field. Data sheets covering the various types and styles of Vishay Sprague capacitors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











### Note

 For all types of conformal coated capacitors, tantalum wire to tantalum pellet attachment method could be either embedded (see images on the left side of the page) or welded (see images on the right side), depending on specific rating



### **COMMERCIAL PRODUCTS**

SOLID TANTALUM CAPACITORS - CONFORMAL COATED							
SERIES	592W	592D	591D	595D	594D		
PRODUCT IMAGE							
TYPE		Surface mount	TANTAMOUNT™ chip, co	nformal coated			
FEATURES	FEATURES  Low profile, robust design for use in pulsed applications		Low profile, low ESR, maximum CV	Maximum CV	Low ESR, maximum CV		
TEMPERATURE RANGE	-55 °C to +125 °C (above 40 °C, voltage deratig is required)	-55 °C to +125 °C (above 85 °C, voltage derating is required)					
CAPACITANCE RANGE	330 μF to 2200 μF	1 μF to 2200 μF	1 μF to 1500 μF	0.1 μF to 1500 μF	1 μF to 1500 μF		
VOLTAGE RANGE	6 V to 10 V	4 V to 50 V	4 V to 50 V	4 V to 50 V	4 V to 50 V		
CAPACITANCE TOLERANCE	± 20 %	± 10 %, ± 20 %	± 10 %, ± 20 %	± 10 %, ± 20 %	± 10 %, ± 20 %		
LEAKAGE CURRENT			0.01 CV or 0.5 μA, v	vhichever is greater			
DISSIPATION FACTOR	1 1/1 % to //5 % 1 // %		4 % to 50 %	4 % to 20 %	4 % to 20 %		
CASE CODES	C, M, X	S, A, B, C, D, R, M, X	A, B, C, D, R, M	T, S, A, B, C, D, G, M, R	B, C, D, R		
TERMINATION	100 % matte tin	100 %	matte tin standard, tin /	lead and gold plated av	vailable		

SOLID TANTAL	SOLID TANTALUM CAPACITORS - CONFORMAL COATED								
SERIES	597D	695D	195D	194D					
PRODUCT IMAGE									
TYPE		TANTAMOUNT™ chip	o, conformal coated						
FEATURES	Ultra low ESR, maximum CV, multi-anode	Pad compatible with 194D and CWR06	US and European case sizes	Industrial version of CWR06 / CWR16					
TEMPERATURE RANGE	-55 °C to +125 °C (above 85 °C, voltage derating is required)								
CAPACITANCE RANGE	10 μF to 2200 μF	0.1 μF to 270 μF	0.1 μF to 330 μF	0.1 μF to 330 μF					
VOLTAGE RANGE	4 V to 75 V	4 V to 50 V	2 V to 50 V	4 V to 50 V					
CAPACITANCE TOLERANCE		± 10 %,	± 20 %						
LEAKAGE CURRENT		0.01 CV or 0.5 μA, ν	whichever is greater						
DISSIPATION FACTOR	6 % to 20 %	4 % to 8 %	4 % to 8 %	4 % to 10 %					
CASE CODES	V, D, E, R, F, Z, M, H	A, B, D, E, F, G, H	C, S, V, X, Y, Z, R, A, B, D, E, F, G, H	A, B, C, D, E, F, G, H					
TERMINATION	100 % matte tin standard, tin / lead solder plated available	100 % matte tin / lead and gol	Gold plated standard; tin / lead solder plated and hot solder dipped available						

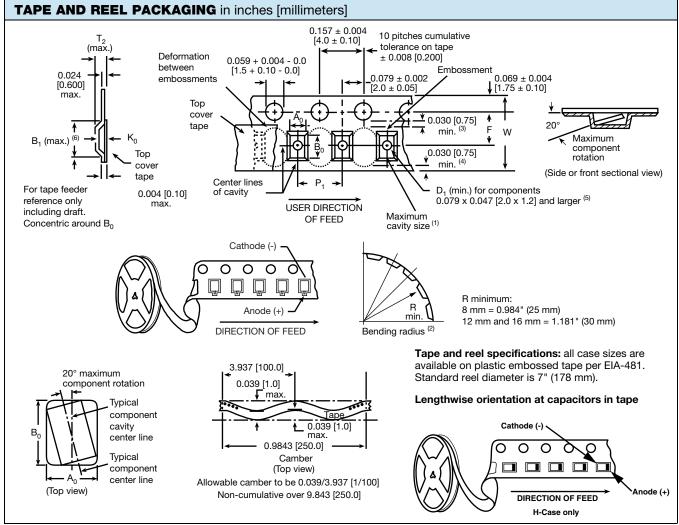


### **HIGH RELIABILITY PRODUCTS**

SOLID TANTALUM CA	PACITORS - CO	NFORMAL COA	TED			
SERIES	CWR06	CWR16	CWR26	13008	14002	
PRODUCT IMAGE						
TYPE	TANTAMOUNT™ chip, conformal coated					
FEATURES	MIL-PRF-55365/4 qualified	MIL-PRF-55365/13 qualified	MIL-PRF-55365/13 qualified	DLA approved		
TEMPERATURE RANGE		-55 °C to +125 °C (a	above 85 °C, voltage	derating is required)		
CAPACITANCE RANGE	0.10 μF to 100 μF	0.33 μF to 330 μF	10 μF to 100 μF	10 μF to 1500 μF	4.7 μF to 680 μF	
VOLTAGE RANGE	4 V to 50 V	4 V to 35 V	15 V to 35 V	4 V to 63 V	4 V to 50 V	
CAPACITANCE TOLERANCE	± 5 %, ± 10 %, ± 20 %	± 5 %, ± 10 %, ± 20 %	± 5 %, ± 10 %, ± 20 %	± 10 %, ± 20 %	± 10 %, ± 20 %	
LEAKAGE CURRENT	0.01 CV	or 1.0 μA, whichever i	s greater	0.01 CV or 0.5 μA, ν	whichever is greater	
DISSIPATION FACTOR	6 % to 10 % 6 % to 10 % 6 % to 12 %		6 % to 20 %	6 % to 14 %		
CASE CODES	A, B, C, D, E, F, G, H	A, B, C, D, E, F, G, H	F, G, H	V, E, F, R, Z, D, M, H, N	B, C, D, R	
TERMINATION	Gold plated	l; tin / lead; tin / lead s	solder fused	Tin /	lead	

SOLID TANTALUM CA	SOLID TANTALUM CAPACITORS - CONFORMAL COATED							
SERIES	T95	T96	T97	T98				
PRODUCT IMAGE								
TYPE		TANTAMOUNT™ chip, Hi-Re	el COTS, conformal coated					
FEATURES	High reliability High reliability, built in fuse		High reliability, ultra low ESR, multi-anode	High reliability, ultra low ESR, built in fuse, multi-anode				
TEMPERATURE RANGE	-55 °C to +125 °C (above 85 °C, voltage derating is required)							
CAPACITANCE RANGE	0.15 μF to 680 μF	10 μF to 680 μF	10 μF to 2200 μF	10 μF to 1500 μF				
VOLTAGE RANGE	4 V to 50 V	4 V to 50 V	4 V to 75 V	4 V to 75 V				
CAPACITANCE TOLERANCE	± 10 %, ± 20 %	± 10 %, ± 20 %	± 10 %, ± 20 %	± 10 %, ± 20 %				
LEAKAGE CURRENT	0.01 CV or 0.5 μA, whichever is greater							
DISSIPATION FACTOR	4 % to 14 %	6 % to 14 %	6 % to 20 %	6 % to 10 %				
CASE CODES	A, B, C, D, R, S, V, X, Y, Z	R	V, E, F, R, Z, D, M, H, N	V, E, F, R, Z, M, H				
TERMINATION	100 % matte tin, tin / lead							

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### Notes

- · Metric dimensions will govern. Dimensions in inches are rounded and for reference only
- (1) A<sub>0</sub>, B<sub>0</sub>, K<sub>0</sub>, 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<sub>0</sub>, B<sub>0</sub>, K<sub>0</sub>) 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<sub>1</sub> dimension is a reference dimension tape feeder clearance only





CARRIER TAPE DIMENSIONS in inches [millimeters]							
TAPE WIDTH	W	D <sub>0</sub>	P <sub>2</sub>	F	E <sub>1</sub>	E <sub>2 min.</sub>	
8 mm	0.315 + 0.012 / - 0.004 [8.0 + 0.3 / - 0.1]	0.059 + 0.004 / - 0 [1.5 + 0.1 / - 0]	0.078 ± 0.0019 [2.0 ± 0.05]	0.14 ± 0.0019 [3.5 ± 0.05]	0.324 ± 0.004 - [1.75 ± 0.1]	0.246 [6.25]	
12 mm	0.479 + 0.012 / - 0.004 [12.0 + 0.3 / - 0.1]			0.216 ± 0.0019 [5.5 ± 0.05]		0.403 [10.25]	
16 mm	0.635 + 0.012 / - 0.004 [16.0 + 0.3 / - 0.1]		[1.5 + 0.1 / - 0] 0.078 ± 0.004	0.295 ± 0.004 [7.5 ± 0.1]		0.570 [14.25]	
24 mm	0.945 ± 0.012 [24.0 ± 0.3]		$[2.0 \pm 0.1]$	0.453 ± 0.004 [11.5 ± 0.1]		0.876 [22.25]	

CARRIER T	APE DIMENSIONS in	inches [millimeters	5]		
ТҮРЕ	CASE CODE	TAPE WIDTH W IN mm	P <sub>1</sub>	K <sub>0 max.</sub>	B <sub>1 max</sub> .
	A	8	0.157 ± 0.004	0.058 [1.47]	0.149 [3.78]
	В	12	[4.0 ± 0.10]	0.088 [2.23]	0.166 [4.21]
	С	12		0.088 [2.23]	0.290 [7.36]
	D	12	0.315 ± 0.004	0.088 [2.23]	0.300 [7.62]
592D 592W	М	16	[8.0 ± 0.10]	0.091 [2.30]	0.311 [7.90]
591D	R	12		0.088 [2.23]	0.296 [7.52]
	S	8	0.157 ± 0.004	0.058 [1.47]	0.139 [3.53]
	Т	12	[4.0 ± 0.10]	0.088 [2.23]	0.166 [4.21]
	Х	24	0.472 ± 0.004 [12.0 ± 0.10]	0.011 [2.72]	0.594 [15.1]
	A	8	0.157 ± 0.004	0.063 [1.60]	0.152 [3.86]
	В	12	$[4.0 \pm 0.10]$	0.088 [2.23]	0.166 [4.21]
	С	12	0.315 ± 0.004 [8.0 ± 0.10]	0.118 [2.97]	0.290 [7.36]
	D	12		0.119 [3.02]	0.296 [7.52]
	G	12		0.111 [2.83]	0.234 [5.95]
595D	Н	12		0.098 [2.50]	0.232 [5.90]
594D	М	12	0.157 ± 0.004 [4.0 ± 0.10]	0.085 [2.15]	0.152 [3.85]
	R	12	0.315 ± 0.004 [8.0 ± 0.10]	0.148 [3.78]	0.296 [7.52]
	S	8	0.157 ± 0.004	0.058 [1.47]	0.149 [3.78]
	Т	8	$[4.0 \pm 0.10]$	0.054 [1.37]	0.093 [2.36]
	A	8		0.058 [1.47]	0.139 [3.53]
	В	12	0.157 ± 0.004	0.059 [1.50]	0.189 [4.80]
	D	12	[4.0 ± 0.10]	0.063 [1.62]	0.191 [4.85]
695D	E	12	]	0.074 [1.88]	0.239 [6.07]
	F	12	0.315 ± 0.004 [8.0 ± 0.10]	0.075 [1.93]	0.259 [6.58]
	G	12	0.157 ± 0.004 [4.0 ± 0.10]	0.109 [2.77]	0.301 [7.65]
	Н	16	0.315 ± 0.004 [8.0 ± 0.10]	0.124 [3.15]	0.31 [7.87]



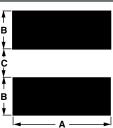
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		TAPE WIDTH			
TYPE	CASE CODE	W IN mm	P <sub>1</sub>	K <sub>0 max</sub> .	B <sub>1 max</sub> .
	A	8		0.058 [1.47]	0.139 [3.53]
	В	12	1	0.058 [1.47]	0.189 [4.80]
	С	8	0.157 ± 0.004	0.054 [1.37]	0.093 [2.36]
			$[4.0 \pm 0.10]$		
	D E	12 12	-	0.067 [1.70] 0.074 [1.88]	0.179 [4.55] 0.239 [6.07]
	<u> </u>	12	0.015 + 0.004	0.074 [1.00]	0.239 [6.07]
	F	12	0.315 ± 0.004 [8.0 ± 0.10]	0.076 [1.93]	0.259 [6.58]
195D	G	12	0.157 ± 0.004 [4.0 ± 0.10]	0.109 [2.77]	0.301 [7.65]
	H <sup>(1)</sup>	12	0.472 ± 0.004 [12.0 ± 0.1]	0.122 [3.11]	0.163 [4.14]
	R	12	0.315 ± 0.004 [8.0 ± 0.10]	0.149 [3.78]	0.296 [7.52]
	S	8		0.058 [1.47]	0.149 [3.78]
	V	8	0.457 0.004	0.060 [1.52]	0.150 [3.80]
	X	12	0.157 ± 0.004	0.069 [1.75]	0.296 [7.52]
	Υ	12	$[4.0 \pm 0.10]$	0.089 [2.26]	0.296 [7.52]
	Z	12	1	0.114 [2.89]	0.288 [7.31]
	A	8		0.069 [1.75]	0.139 [3.53]
	В	12		0.073 [1.85]	0.189 [4.80]
1010	С	12	$0.157 \pm 0.004$	0.069 [1.75]	0.244 [6.20]
194D CWR06	D	12	$[4.0 \pm 0.10]$	0.068 [1.72]	0.191 [4.85]
CWR16	E	12	1	0.074 [1.88]	0.239 [6.07]
CWR26	F	12		0.091 [2.31]	0.262 [6.65]
	G	16	$0.315 \pm 0.004$	0.134 [3.40]	0.289 [7.34]
	Н	16	$[8.0 \pm 0.10]$	0.129 [3.28]	0.319 [8.10]
	D	16	0.317 ± 0.004	0.150 [3.80]	0.313 [7.95]
	E	16	$[8.0 \pm 0.10]$	0.173 [4.40]	0.343 [8.70]
	F	16	[0.0 = 0.10]	0.205 [5.20]	0.309 [7.85]
	H	16	0.476 ± 0.004	0.224 [5.70]	0.313 [7.95]
597D	M	16		0.193 [4.90]	0.339 [8.60]
T97	N	16	[12.0 ± 0.1]	0.193 [4.90]	0.323 [8.20]
13008	R	16			
		-	0.317 ± 0.004	0.159 [4.05]	0.313 [7.95]
	V	12	$[8.0 \pm 0.10]$ 0.476 ± 0.004	0.088 [2.23]	0.300 [7.62]
	Z	16	[12.0 ± 0.1]	0.239 [6.06]	0.311 [7.90]
	A	8	0.157 ± 0.004	0.063 [1.60]	0.152 [3.86]
	В	12	$[4.0 \pm 0.10]$	0.088 [2.23]	0.166 [4.21]
	С	12		0.117 [2.97]	0.290 [7.36]
	D	12	$0.317 \pm 0.004$	0.119 [3.02]	0.296 [7.52]
T95	R	12	$[8.0 \pm 0.10]$	0.149 [3.78]	0.296 [7.52]
- <del>-</del>	S	8	]	0.058 [1.47]	0.149 [3.78]
	V	8	0.157 ± 0.004	0.060 [1.52]	0.150 [3.80]
	X	12	$[4.0 \pm 0.10]$	0.069 [1.75]	0.296 [7.52]
	Y	12	<u> </u>	0.089 [2.26]	0.296 [7.52]
	Z	12		0.114 [2.89]	0.288 [7.31]
14002	В	12	0.157 ± 0.004	0.088 [2.23]	0.166 [4.21]
	С	12	$[4.0 \pm 0.10]$	0.117 [2.97]	0.290 [7.36]
1-1002	D	12	0.317 ± 0.004	0.119 [3.02]	0.296 [7.52]
	R	12	$[8.0 \pm 0.10]$	0.149 [3.78]	0.296 [7.52]
T96	R	16	0.476 ± 0.004 [12.0 ± 0.1]	0.159 [4.05]	0.313 [7.95]
	F	16		0.239 [6.06]	0.311 [7.90]
T98	M	16	$0.476 \pm 0.004$	0.193 [4.90]	0.339 [8.60]
190	Z	16	$[12.0 \pm 0.1]$	0.272 [6.90]	0.307 [7.80]

### Note

 $^{(1)}\,$  H case only, packaging code T: lengthwise orientation at capacitors in tape

## **PAD DIMENSIONS** in inches [millimeters]

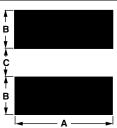


CASE CODE	WIDTH (A)	PAD METALLIZATION (B)	SEPARATION (C)	
592D / W - 591D				
Α	0.075 [1.9]	0.050 [1.3]	0.050 [1.3]	
В	0.118 [3.0]	0.059 [1.5]	0.059 [1.5]	
С	0.136 [3.5]	0.090 [2.3]	0.122 [3.1]	
D	0.180 [4.6]	0.090 [2.3]	0.134 [3.4]	
М	0.050 (0.5)	Anode pad: 0.095 [2.4]	0 120 [2 5]	
IVI	0.256 [6.5]	Cathode pad: 0.067 [1.7]	0.138 [3.5]	
D	0.040 [6.1]	Anode pad: 0.095 [2.4]	0.110 [0.0]	
R	0.240 [6.1]	Cathode pad: 0.067 [1.7]	0.118 [3.0]	
S	0.067 [1.7]	0.032 [0.8]	0.043 [1.1]	
Х	0.310 [7.9]	0.120 [3.0]	0.360 [9.2]	
595D - 594D				
T	0.059 [1.5]	0.028 [0.7]	0.024 [0.6]	
S	0.067 [1.7]	0.032 [0.8]	0.043 [1.1]	
А	0.083 [2.1]	0.050 [1.3]	0.050 [1.3]	
В	0.118 [3.0]	0.059 [1.5]	0.059 [1.5]	
С	0.136 [3.5]	0.090 [2.3]	0.122 [3.1]	
D	0.180 [4.6]	0.090 [2.3]	0.134 [3.4]	
G	0.156 [4.05]	0.090 [2.3]	0.082 [2.1]	
M	0.110 [2.8]	0.087 [2.2]	0.134 [3.4]	
R	0.248 [6.3]	0.090 [2.3]	0.140 [3.6]	
195D				
А	0.067 [1.7]	0.043 [1.1]	0.028 [0.7]	
В	0.063 [1.6]	0.047 [1.2]	0.047 [1.2]	
С	0.059 [1.5]	0.031 [0.8]	0.024 [0.6]	
D	0.090 [2.3]	0.055 [1.4]	0.047 [1.2]	
Е	0.090 [2.3]	0.055 [1.4]	0.079 [2.0]	
F	0.140 [3.6]	0.063 [1.6]	0.087 [2.2]	
G	0.110 [2.8]	0.059 [1.5]	0.126 [3.2]	
Н	0.154 [3.9]	0.063 [1.6]	0.140 [3.6]	
N	0.244 [6.2]	0.079 [2.0]	0.118 [3.0]	
R	0.248 [6.3]	0.090 [2.3]	0.140 [3.6]	
S	0.079 [2.0]	0.039 [1.0]	0.039 [1.0]	
V	0.114 [2.9]	0.039 [1.0]	0.039 [1.0]	
Χ	0.118 [3.0]	0.067 [1.7]	0.122 [3.1]	
Υ	0.118 [3.0]	0.067 [1.7]	0.122 [3.1]	
Z	0.118 [3.0]	0.067 [1.7]	0.122 [3.1]	



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### **PAD DIMENSIONS** in inches [millimeters]



	A					
CASE CODE	WIDTH (A)	PAD METALLIZATION (B)	SEPARATION (C)			
CWR06 / CWR16 / CWR26 - 194	D - 695D					
А	0.065 [1.6]	0.50 [1.3]	0.040 [1.0]			
В	0.065 [1.6]	0.70 [1.8]	0.055 [1.4]			
С	0.065 [1.6]	0.70 [1.8]	0.120 [3.0]			
D	0.115 [2.9]	0.70 [1.8]	0.070 [1.8]			
E	0.115 [2.9]	0.70 [1.8]	0.120 [3.0]			
F	0.150 [3.8]	0.70 [1.8]	0.140 [3.6]			
G	0.125 [3.2]	0.70 [1.8]	0.170 [4.3]			
Н	0.165 [4.2]	0.90 [2.3]	0.170 [4.3]			
T95						
В	0.120 [3.0]	0.059 [1.5]	0.059 [1.5]			
С	0.136 [3.5]	0.090 [2.3]	0.120 [3.1]			
D	0.180 [4.6]	0.090 [2.3]	0.136 [3.47]			
R	0.248 [6.3]	0.090 [2.3]	0.140 [3.6]			
S	0.080 [2.03]	0.040 [1.02]	0.040 [1.02]			
V	0.114 [2.9]	0.040 [1.02]	0.040 [1.02]			
X, Y, Z	0.114 [2.9]	0.065 [1.65]	0.122 [3.1]			
14002						
В	0.120 [3.0]	0.059 [1.5]	0.059 [1.5]			
С	0.136 [3.5]	0.090 [2.3]	0.120 [3.1]			
D	0.180 [4.6]	0.090 [2.3]	0.136 [3.47]			
R	0.248 [6.3]	0.090 [2.3]	0.140 [3.6]			
T96						
R	0.248 [6.3]	0.090 [2.3]	0.140 [3.6]			
597D - T97 - T98 - 13008						
D, E, V	0.196 [4.9]	0.090 [2.3]	0.140 [3.6]			
F, R, Z	0.260 [6.6]	0.090 [2.3]	0.140 [3.6]			
M, H, N	0.284 [7.2]	0.090 [2.3]	0.140 [3.6]			

8 min max.

Time 25 °C to peak temperature

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#### **RECOMMENDED REFLOW PROFILES** Capacitors should withstand reflow profile as per J-STD-020 standard, three cycles. T<sub>C</sub> - 5 °C Max. ramp-up rate = 3 °C/s Max. ramp-down rate = $6 \, ^{\circ}\text{C/s}$ (°C) $T_{s max.}$ Preheat area T<sub>s min.</sub> 25 Time 25 °C to peak TIME (s) **PROFILE FEATURE SnPb EUTECTIC ASSEMBLY LEAD (Pb)-FREE ASSEMBLY** Preheat / soak Temperature min. (T<sub>s min.</sub>) 100 °C 150 °C Temperature max. (T<sub>s max.)</sub> 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<sub>L</sub> to T<sub>p</sub>) 3 °C/s max. 3 °C/s max. Liquidus temperature (T<sub>L</sub>) 183 °C 217 °C Time (t<sub>L</sub>) maintained above T<sub>L</sub> 60 s to 150 s 60 s to 150 s Peak package body temperature (Tp) Depends on type and case - see table below Time (t<sub>p</sub>)\* within 5 °C of the specified 20 s 30 s classification temperature (T<sub>c</sub>) Ramp-down Ramp-down rate $(T_p \text{ to } T_L)$ 6 °C/s max. 6 °C/s max.

TVDF / 040F 00DF	PEAK PACKAGE BODY TEMPERATURE (Tp)			
TYPE / CASE CODE	SnPb EUTECTIC PROCESS	LEAD (Pb)-FREE PROCESS		
591D / 592D - all cases, except X25H, M and R cases	235 °C	260 °C		
591D / 592D - X25H, M and R cases	220 °C	250 °C		
594D / 595D - all cases except C, D, and R	235 °C	260 °C		
594D / 595D - C, D, and R case	220 °C	250 °C		
T95 A, B, S, V, X, Y cases	235 °C	260 °C		
T95 C, D, R, and Z cases	220 °C	250 °C		
14002 B case	235 °C	n/a		
14002 C, D, and R cases	220 °C	n/a		
T96 R case	220 °C	250 °C		
195D all cases, except G, H, R, and Z	235 °C	260 °C		
195D G, H, R, and Z cases	220 °C	250 °C		
695D all cases, except G and H cases	235 °C	260 °C		
695D G, H cases	220 °C	250 °C		
597D, T97, T98 all cases, except V case	220 °C	250 °C		
597D, T97, T98 V case	235 °C	260 °C		
194D all cases, except H and G cases	235 °C	260 °C		
194D H and G cases	220 °C	250 °C		

6 min max.

## Vishay Sprague

### **GUIDE TO APPLICATION**

 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<sub>ESR</sub> = 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<sub>ESR</sub> = 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	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<sub>RMS</sub> value be established when calculating permissible operating levels. (Power dissipation calculated using derating factor (see paragraph 4)).

### 6. Attachment:

- 6.1 **Soldering:** capacitors can be attached by conventional soldering techniques: vapor phase, convection reflow, infrared reflow, 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 <a href="https://www.vishay.com/doc?40214">www.vishay.com/doc?40214</a>.
- Recommended Mounting Pad Geometries: the nib
  must have sufficient clearance to avoid electrical
  contact with other components. The width
  dimension indicated is the same as the maximum
  width of the capacitor. This is to minimize lateral
  movement.
- 8. Cleaning (Flux Removal) After Soldering:

  TANTAMOUNT<sup>TM</sup> 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.



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## **Conformal Coated Tantalum Capacitors**

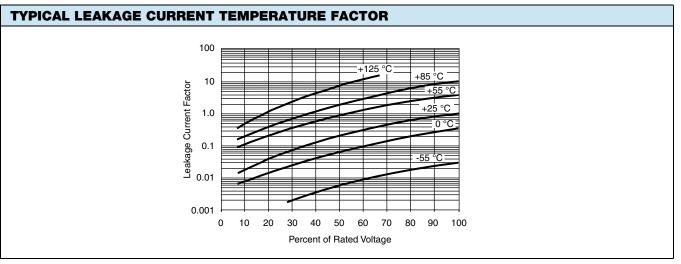
ELECTRICAL PERFOR	MANCE CHARACTI	ERISTICS			
ITEM	PERFORMANCE CHAR	ACTERISTICS			
Category temperature range	-55 °C to +85 °C (to +125 °C with voltage derating)				
Capacitance tolerance	± 20 %, ± 10 %, tested via bridge method, at 25 °C, 120 Hz				
Dissipation factor	Limits per Standard Ratings table. 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 k $\Omega$ resistor in series with the capacitor under test, leakage current at 25 °C is not more than 0.01 CV or 0.5 $\mu$ A, whichever is greater. Note that the leakage current varies with temperature and applied voltage. See graph below for the appropriate adjustment factor.				
Capacitance change by temperature	For capacitance value ≤ : +12 % max. (at +125 °C) +10 % max. (at +85 °C) -10 % max. (at -55 °C)		For capacitance value > 300 μF +20 % max. (at +125 °C) +15 % max. (at +85 °C) -15 % 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 Vishay does not recommend intentional or repetitive application of reverse voltage.				
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				
Maximum operating and surge	+85	5°C	+125	5 °C	
voltages vs. temperature	RATED VOLTAGE	SURGE VOLTAGE	CATEGORY VOLTAGE	SURGE VOLTAGE	
	( <b>V</b> )	( <b>V</b> )	(V) 1.3	(V) 1.7	
	4.0	5.2	2.7	3.4	
	6.3	8.0	4.0	5.0	
	10	13	7.0	8.0	
	15 / 16	20	10	12	
	20	26	13	16	
	25	32	17	20	
	35	46	23	28	
	40	52	26	31	
	50	65	33	40	
	50 <sup>(1)</sup>	60	33	40	
	63 <sup>(2)</sup>	75	42	50	
	75 <sup>(2)</sup>	75	50	50	
Recommended voltage	VOLTAGE RAIL (V)		CAPACITOR VOLTAGE RATING (V)		
derating guidelines	≤ 3.3		6.3		
(below 85 °C)	5		10		
	10		20		
	12		25		
	15		35		
	24		50 or series configuration		
	2	8	63 or series configuration		
	≥ 32		75 or series configuration		

### Notes

- All information presented in this document reflects typical performance characteristics
- For more information about recommended voltage derating see: www.vishay.com/doc?40246
- Capacitance value 15  $\mu$ F and higher
- (2) For 597D only

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### **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

ENVIRONMENT	ENVIRONMENTAL PERFORMANCE CHARACTERISTICS					
ITEM	CONDITION	POST TEST PERFOR	MANCE			
Surge voltage	Post application of surge voltage (as specified in the table above) in series with a 33 $\Omega$ resistor at the rate of 30 s ON, 30 s OFF, for 1000 successive test cycles at 85 °C MIL-PRF-55365	Capacitance change Dissipation factor Leakage current	Within ± 10 % of initial value Initial specified limit Initial specified limit			
Life test at +85 °C	2000 h application of rated voltage at 85 °C MIL-STD-202, method 108	Capacitance change Dissipation factor Leakage current	Within ± 10 % of initial value Initial specified limit Shall not exceed 125 % of initial limit			
Life test at +125 °C	1000 h application 2/3 of rated voltage at 125 °C MIL-STD-202, method 108	Capacitance change: Cap. ≤ 600 µF Cap. > 600 µF Dissipation factor Leakage current	Within ± 10 % of initial value Within ± 20 % of initial value Initial specified limit Shall not exceed 125 % of initial limit			
Humidity test	At 40 °C / 90 % RH, 1000 h, no voltage applied MIL-STD-202, method 103	Capacitance change: Cap. ≤ 600 µF Cap. > 600 µF Dissipation factor Leakage current	Within ± 10 % of initial value Within ± 20 % of initial value Not to exceed 150 % of initial limit Shall not exceed 200 % of initial limit			
Moisture resistance	MIL-STD-202, method 106, 20 cycles	Capacitance change: Cap. ≤ 600 µF Cap. > 600 µF Dissipation factor Leakage current	Within ± 15 % of initial value Within ± 20 % of initial value Shall not exceed 150 % of initial limit Shall not exceed 200 % of initial limit			
Thermal shock	At -55 °C / +125 °C, for 5 cycles, 30 min at each temperature MIL-STD-202, method 107	Capacitance change: Cap. ≤ 600 µF Cap. > 600 µF Dissipation factor Leakage current	Within ± 10 % of initial value Within ± 20 % of initial value Initial specified limit Initial specified limit			



## **Typical Performance Characteristics**

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ITEM	CONDITION	POST TEST PERFORMANCE		
Terminal strength / Shear force test	Apply a pressure load of 5 N for 10 s ± 1 s horizontally to the center of capacitor side body AEC-Q200-006	Capacitance change Dissipation factor Leakage current	Within ± 10 % of initial value Initial specified limit Initial specified limit	
		There shall be no mechanical or visual damage to capacitors post-conditioning.		
Vibration	MIL-STD-202, method 204, condition D, 10 Hz to 2000 Hz, 20 g peak, 8 h, at rated voltage	Electrical measurements are not applicable, since the same parts are used for shock (specified pulse) test.		
		There shall be no mecha capacitors post-condition	anical or visual damage to oning.	
Shock (specified pulse)	MIL-STD-202, method 213, condition I, 100 $g$ peak	Capacitance change: Cap. ≤ 600 µF Cap. > 600 µF Dissipation factor Leakage current	Within ± 10 % of initial value Within ± 20 % of initial value Initial specified limit Initial specified limit	
		There shall be no mecha capacitors post-condition	anical or visual damage to onling.	
Resistance to solder heat	MIL-STD-202, method 210, condition J (SnPb terminations) and K (lead (Pb)-free terminations), one heat cycle	Capacitance change Dissipation factor Leakage current	Within ± 10 % of initial value Initial specified limit Initial specified limit	
Solderability	EIA / IPC / JEDEC J-STD-002 Test B (SnPb) and B1 (lead (Pb)-free).	Solder coating of all cap requirements.	pacitors shall meet specified	
	Preconditioning per category C. Capacitors with SnPb and lead (Pb)-free terminations are backward and forward compatible. Does not apply to gold terminations.	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 %			



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