

## Solid Tantalum Capacitors: Frequently Asked Questions (FAQs)

- Q. What is the difference between a fused (Vishay Sprague 893D) and standard, non-fused (Vishay Sprague 293D, 593D, TR3 and T83) tantalum capacitors?
- Q. What are the materials in a tantalum capacitor?
- Q. How are tantalum capacitors packaged?
- Q. What labeling information is present on reels and boxes of tantalum capacitors?
- Q. What are the recommended storage conditions for solid tantalum capacitors?
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- Q. What is the termination coating on Vishay solid tantalum capacitors?
- Q. How can reliability of solid tantalum capacitors be calculated?
- Q. What is the moisture sensitivity of Vishay solid tantalum capacitors?
- Q. What is the shelf life of a solid tantalum capacitor?
- Q. What do the markings on Vishay leaded parts mean?
- Q. Are all Vishay solid tantalum capacitors RoHS compliant?
- Q. Why can’t I use this 10 V rated capacitor using a 10 V power supply?
- Q. How long can you operate Vishay solid tantalums with the applied reverse voltage bias?
- Q. How long can you operate Vishay wet tantalums with the applied reverse voltage bias?

### **Q. WHAT IS THE DIFFERENCE BETWEEN A FUSED (VISHAY SPRAGUE 893D) AND STANDARD, NON-FUSED (VISHAY SPRAGUE 293D AND 593D) TANTALUM CAPACITOR?**

A. The 893D series was designed to operate in high-current applications (> 10 A) and employs an “electronic” fusing mechanism. An “electronic” fuse activation time is based on I<sup>2</sup>R heating and is therefore dependent on the fuse length (fuse length determines SR, the fuse resistance) and available current. This type of fuse is ideal for high-current applications, but is not suitable for low-current applications. As the fusing activation indicates, the fusing time increases significantly when the available current is below approximately 3.5 A. The 893D fuse will not “open” below 2 A because the I<sup>2</sup>R is below the energy required to activate the fuse. Between 2 and 3 A, the fuse will eventually activate, but some capacitor and circuit board “charring” may occur. In summary, 893D capacitors are ideal for high-current circuits where capacitor “failure” can cause system failure. Type 893D capacitors will prevent capacitor or circuit board “charring” and usually prevent any circuit interruption that can be associated with capacitor failure. A “shorted” capacitor across the power source can cause current and/or voltage transients that can trigger system shutdown. The 893D fuse activation time is sufficiently fast in most instances to eliminate excessive current drain or voltage swings. The 893D series is designed to operate in circuits with no external series resistance. The 893D series will have failure rate levels equivalent to the 293D non-fused molded tantalum chip series. The 893D series changes the failure mode from a “short” circuit to an “open” circuit.

The following table shows the total weight for the major components of Vishay Sprague type 893D solid tantalum chip capacitors.

CASE SIZE	WEIGHT (g)	TANTALUM PELLETT		MOLDING COMPOUND		LEAD FRAME (g)
		(g)	(%)	(g)	(%)	
C	0.129	0.059	46	0.051	39	0.019
D	0.299	0.105	35	0.170	57	0.024
E	0.364	0.176	48	0.164	45	0.024



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Vishay Sprague

### Q. WHAT ARE THE MATERIALS IN A TANTALUM CAPACITOR?

A. The following table shows the total weight for the major components of Vishay Sprague types 594D/595D solid tantalum chip capacitors.

CASE SIZE	WEIGHT (g)	TANTALUM PELLETT		EPOXY COATING AND TERMINATIONS (g)
		(g)	(%)	
A	0.028	0.024	86	0.004
B	0.085	0.080	94	0.005
C	0.270	0.252	93	0.018
D	0.415	0.364	88	0.051
R	0.708	0.630	89	0.078
S	0.024	0.015	62	0.009
T	0.044	0.031	71	0.013

The tantalum pellet consists of tantalum, Ta<sub>2</sub>O<sub>5</sub>, MnO<sub>2</sub>, carbon, and silver. The combined percentage of Ta<sub>2</sub>O<sub>5</sub>, carbon, and silver is less than 1 % of the total weight. The terminations are electroplated with a 100 % matte tin coating. The epoxy coating has a UL 94-V0 flammability rating.

The following table shows the total weight for the major components of Vishay Sprague type 572D solid tantalum chip capacitors.

CASE SIZE	WEIGHT (g)	TANTALUM PELLETT		EPOXY COATING AND TERMINATIONS (g)
		(g)	(%)	
A	0.038	0.027	72	0.011
B	0.087	0.070	81	0.017
P	0.015	0.008	56	0.006
Q	0.018	0.011	58	0.008
S	0.024	0.015	62	0.009
T	0.044	0.031	71	0.013

The tantalum pellet consists of tantalum, Ta<sub>2</sub>O<sub>5</sub>, MnO<sub>2</sub>, carbon and silver. The combined percentage of Ta<sub>2</sub>O<sub>5</sub>, carbon and silver is less than 1 % of the total weight. The terminations are electroplated with a 100 % matte tin coating. The epoxy coating has a UL 94-V0 flammability rating.

The following table shows the total weight for the major components of Vishay Sprague types 293D, 593D, T83, TR3, TH3, TP3, TF3, 793DE, 793DX, CTC3 and CTC4 solid tantalum chip capacitors.

CASE SIZE	WEIGHT (g)	TANTALUM PELLETT		MOLDING COMPOUND		LEAD FRAME (g)
		(g)	(%)	(g)	(%)	
A	0.032	0.014	44	0.013	41	0.004
B	0.065	0.029	45	0.024	37	0.011
C	0.150	0.064	43	0.060	40	0.022
D	0.295	0.145	49	0.108	37	0.040
E	0.478	0.245	51	0.175	37	0.040

The tantalum pellet consists of tantalum, Ta<sub>2</sub>O<sub>5</sub>, MnO<sub>2</sub>, carbon, and silver. The combined percentage of Ta<sub>2</sub>O<sub>5</sub>, carbon, and silver is less than 1 % of the total weight. The lead frame is alloy 42 (42 % nickel and 58 % iron). The lead frame terminations are electroplated with 100 % matte tin (200" minimum). There is a nickel barrier (60" minimum) below the matte tin. The molding compound encapsulant is a semiconductor-grade epoxy Novolac with a UL-94-V0 flammability rating. The oxygen index is 32 %.

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Vishay Sprague

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The following table shows the total weight for the major components of Vishay Sprague types 597D/T97/T98 solid tantalum chip capacitors.

CASE SIZE	WEIGHT (g)	TANTALUM PELLETT		EPOXY COATING AND TERMINATION (g)
		(g)	(%)	
E	0.67	0.352	52.54	0.1468
F/R	1.01	0.676	66.80	0.1469

The tantalum pellet consists of tantalum, Ta<sub>2</sub>O<sub>5</sub>, MnO<sub>2</sub>, carbon, and silver. The combined percentage of Ta<sub>2</sub>O<sub>5</sub>, carbon, and silver is less than 1 % of the total weight. The terminations for 597D are 100 % matte tin, while for the T97 and T98, 60/40, Sn/Pb are standard and 100 % matte tin is available.

The following table shows the total weight for the major components of Vishay Sprague types T95 solid tantalum chip capacitors

CASE SIZE	WEIGHT (g)	TANTALUM PELLETT		EPOXY COATING AND TERMINATION (g)
		(g)	(%)	
B	0.034	0.016	47.05	0.011
C	0.044	0.022	50.00	0.012
D	0.062	0.032	51.61	0.014
R	0.867	0.544	62.75	0.057
S	0.033	0.015	45.45	0.010
V	0.043	0.021	48.84	0.011
X	0.090	0.047	52.22	0.021
Y	0.168	0.097	57.74	0.024
Z	0.275	0.165	60.00	0.029

The tantalum pellet consists of tantalum, Ta<sub>2</sub>O<sub>5</sub>, MnO<sub>2</sub>, carbon, and silver. The combined percentage of Ta<sub>2</sub>O<sub>5</sub>, carbon, and silver is less than 1 % of the total weight. The terminations are 60/40, Sn/Pb coating, with 100% matte also available. The epoxy coating has UL 94-V0 flammability rating.

The following table shows the weights for the major components of Vishay Sprague types 592D/591D solid tantalum chip capacitors

CASE SIZE		WEIGHT (g)	TANTALUM PELLETT		EPOXY COATING AND TERMINATION (g)
OLD	NEW		(g)	(%)	
A	A	0.03	0.024	80	0.006
B	B	0.06	0.051	85	0.009
C	C	0.08	0.080	89	0.010
D	D	0.097	0.097	88	0.013
R	R	0.18	0.160	89	0.020
U	C_20H	0.18	0.169	94	0.011
V	D_20H	0.26	0.242	93	0.018
W	R_20H	0.345	0.304	88	0.041
X	X_15H	0.80	0.704	88	0.096
Y	X_20H	1.10	0.968	88	0.132

The tantalum pellet consists of tantalum, Ta<sub>2</sub>O<sub>5</sub>, MnO<sub>2</sub>, carbon, and silver. The combined weight of Ta<sub>2</sub>O<sub>5</sub>, carbon, and silver is less than 1 % of the total weight. The terminations are electroplated with a 100 % matte tin coating. The epoxy coating has a UL 94-V0 flammability rating.



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Vishay Sprague

The following table shows the total weight for the major components of Vishay Sprague types 298D/TM8/TR8 solid tantalum chip capacitors.

CASE SIZE	WEIGHT (g)	TANTALUM PELLETT		EPOXY COATING AND TERMINATION (g)
		(g)	(%)	
M	0.0079	0.0040	50.38	0.0015
K	0.0018	0.0008	45.809	0.0007
P	0.0246	0.0184	72.00	0.0027

The tantalum pellet consists of tantalum, Ta<sub>2</sub>O<sub>5</sub>, MnO<sub>2</sub>, carbon, and silver. The combined percentage of Ta<sub>2</sub>O<sub>5</sub>, carbon, and silver is less than 1 % of the total weight. The terminations are electroplated with a 100 % matte tin coating.

### Q. HOW ARE TANTALUM CAPACITORS PACKAGED?

- A. Surface-mount tantalum chip capacitors are packaged in 8 mm, 12 mm, and 24 mm plastic-embossed tape on 7" (178 mm) and 13" (330 mm) reels per EIA-481-1.  
Specific reel quantities are specified in each datasheet.

### Q. WHAT LABELING INFORMATION IS PRESENT ON REELS AND BOXES OF TANTALUM CAPACITORS?

- A. Vishay provides the customer part number, shipping order number, customer order number, and date code information as it pertains to manufacturing date and reeling date. Full traceability is available for all shipments. For more information, contact your Vishay Sales Representative.

### Q. WHAT ARE THE RECOMMENDED STORAGE CONDITIONS FOR SOLID TANTALUM CAPACITORS?

- A. Vishay recommends that solid tantalum capacitors be vacuum-sealed with desiccant tape and reels be stored at 40 °C with 65 % relative humidity

### Q. WHAT IS VISHAY'S SELECTION OF SOLID TANTALUM CAPACITORS?

#### A. Molded, Leadframe:

293D TANTAMOUNT®, Commercial  
 593D TANTAMOUNT, Commercial, Low ESR  
 893D TANTAMOUNT, Commercial, Fusible  
 TH3 TANTAMOUNT, Molded, High Temperature  
 TR3 TANTAMOUNT, Molded, Low ESR  
 TP3 TANTAMOUNT, Molded, High Performance  
 TF3 TANTAMOUNT, Molded, Fused, Low ESR

#### Military:

CWR11 TANTAMOUNT, MIL-PRF-55365/8-Qualified  
 CWR16 TANTAMOUNT, MIL-PRF-55365/13-Qualified  
 T83 TANTAMOUNT, Molded, Hi-Rel COTS  
 T95 TANTAMOUNT, Conformal-Coated, Hi-Rel COTS  
 CWR 06 TANTAMOUNT, Conformal-Coated,  
 MIL-PRF-55365/8-Qualified  
 T97 TANTAMOUNT, Conformal-Coated, Hi-Rel COTS,  
 Ultra-Low ESR  
 T96 TANTAMOUNT, Conformal-Coated, Hi-Rel COTS  
 T98 TANTAMOUNT, Conformal-Coated, Hi-Rel COTS

#### Molded, Leadframeless:

292D TANTAMOUNT, 0805

#### Molded, Leadframeless:

298D MICROTAN® Face-Down Terminations, 0603, 0805  
 TR8 MICROTAN® Face-Down Terminations, 0603, 0805,  
 Low ESR

#### Conformal-Coated:

595D TANTAMOUNT, Conformal-Coated, Maximum CV  
 597D TANTAMOUNT, Conformal-Coated, Multi-Anode,  
 Ultra-Low ESR  
 572D TANTAMOUNT, Conformal-Coated, Low Profile, Small  
 Case size  
 695D TANTAMOUNT, Conformal-Coated, Pad-compatible  
 with CWR06  
 194D TANTAMOUNT, MIDGET®, Conformal-Coated,  
 CECC-Qualified  
 195D TANTAMOUNT, Conformal-Coated, CCEC-Qualified  
 CC/EC TANTAMOUNT, Extended Range  
 594D TANTAMOUNT, Conformal-Coated, Maximum CV,  
 Low ESR  
 592D TANTAMOUNT, Conformal-Coated, Low Profile,  
 Maximum C  
 591D TANTAMOUNT, Conformal-Coated, Low Profile



## Q. WHAT IS THE TERMINATION COATING ON VISHAY SOLID TANTALUM CAPACITORS?

A. Many Vishay SMD tantalum capacitor series have been lead (Pb)-free for several years. For these series, there will be no part number changes.

- **Type 292D, Leadframeless Molded Capacitors**  
Standard, 100 % Matte Tin-Plated Terminations.  
Also available with 60/40 Sn/Pb solder terminations. Put “8” as termination code.  
Example: 292D475X0010R8T designates 60/40 Sn/Pb solder terminations.
- **Type 298D, TR8 Leadframeless Molded Capacitors**  
Standard, 100 % Matte Tin-Plated Terminations.  
Lead (Pb)-bearing terminations not available.  
Gold Plated Terminations available
- **Conformal Coated Capacitors**  
(Type 194D, 195D, 572D, 591D, 592D, 594D, **595D**, 597D, 695D series)  
Standard, 100 % Matte Tin-Plated Terminations.  
Example : 595D157X0020R8T
- **Hi-Rel COTS**
  - Type T83 TANTAMOUNT, Molded  
Standard, with SnPb, 100 % Tin and Gold are also available
  - Type T95, T96, T97, T98 TANTAMOUNT, Conformal-Coated SnPb is standard with 100 % tin available
- **Molded Chip (TR3, TF3, TP3 Series)**  
Standard, 100 % Matte Tin, SnPb available
- **Type 194D and CC/EC, Conformal Coated Capacitors**  
Standard, Gold-Plated Terminations  
Also available with 60/40 Sn/Pb solder terminations. Put “8” or “S” as termination code.  
Example: 194D336X9015H8T designates 60/40 Sn/Pb solder terminations for the 194D series and CC336H015KAS for the CC series.
- **Molded Chip (293D/593D/893D Series)**  
Part number changes for lead (Pb)-free capacitors. Add E3 code at the end of the current part number.  
Examples:  
From 293D476X9010D2T to 293D476X9010D2TE3  
From 593D106X9016A2T to 593D106X9016A2TE3
- **CECC-Approved Capacitors**  
From 793DX685X9035D2T to 793DX685X9035D2TE3  
From CTC3156X9020D2T to CTC3156X9020D2TE3
- **Molded Chip (293D/593D Series)**  
For special requirements:  
When the last three characters of the part number are used to define non standard requirements, the packaging code is used to indicate lead (Pb)-free terminations.
- **Molded Chip (013 Series)**  
100 % Tin, SnPb and Gold available

REEL SIZE	LEAD (PB)- BEARING CODE	LEAD (Pb)-FREE CODE
7 INCHES	T	S
13 INCHES	W	Y

Examples:

From 293D106X9020B2T503 to 293D106X9020B2S503  
From 593D226X9025D2W402 to 593D226X9025D2Y402

These products are available in lead (Pb)-bearing terminations. Put “8” as the termination code.

Example:

A 593D 10 µF-16V A case capacitor with lead (Pb)-bearing termination is part number 593D106X9016A8T.

- **Through-hole Products: Solid Tantalum**  
Lead (Pb)-free capacitors not currently available.
- **Through-hole Products: Wet Tantalum**
  - Type 199D, TANTALEX Resin-Coated, Radial Lead, Solid Tantalum Capacitor
  - Types 489D/499D, Resin Coated Radial Lead, Solid Tantalum Capacitor
  - Type 790D Resin Molded Radial Lead, Solid Tantalum
  - Type 299D, Tantalex, Tripole Triple Lead
- **Military Grade Capacitors**  
MIL-PRF-39003 and MIL-PRF-39006: Through-hole Capacitors  
• Lead (Pb)free terminations are not allowed.
- **MIL-PRF-55365: Surface Mount Capacitors**  
CWR06: Standard, Gold-Plated terminations  
Also available with 60/40 Sn/Pb solder terminations.  
CWR11: Standard, 90/10 Sn/Pb solder terminations.
- No lead (Pb)-free terminations available from Vishay.

All have SnPb as standard, 100 % matte Tin is available by adding “E3” to the end of the part number



### Q. HOW CAN RELIABILITY OF SOLID TANTALUM CAPACITORS BE CALCULATED?

A. Vishay calculates product reliability based on MIL-HDBK-217F. Refer to this specification for your reliability calculations

### Q. WHAT IS THE MOISTURE SENSITIVITY OF VISHAY SOLID TANTALUM CAPACITORS?

A. IPC/JEDEC J-STD-033A is titled: "Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices." This is the specification that defines the packaging, labeling, baking/dry-pack, etc., for moisture-sensitive devices as defined by IPC/JEDEC J-STD-020 C.

DESCRIPTION	SERIES	COMPARABLE LEVEL (1)	FLOOR LIFE	
			TIME	STORAGE CONDITIONS
Conformal Coated, MnO <sub>2</sub> Cathode	195D, 572D, 591D, 592D, 594D, 595D, 597D, 695D, T95, T96, T97, T98	2a	4 weeks	≤ 30 °C/60 °C RH
Molded, MnO <sub>2</sub> Cathode	292D, 293D, 298D, 593D, 893D, T83, TR3, TH3, TP3, TF3, TR8	1	Unlimited	≤ 30 °C/60 °C RH
High Reliability and Military, MnO <sub>2</sub> Cathode	194D, 793DE, 793DX, CTC3, CTC4, CWR06, CWR11, CWR16	1	Unlimited	≤ 30 °C/60 °C RH

Note

(1) Moisture sensitivity levels and test conditions to assure capability were developed by the semiconductor industry, for surface mount devices that are susceptible to the 'popcorn' phenomenon. Passive component manufacturers, including solid tantalum capacitors, have done some preliminary investigation regarding moisture sensitivity but have not adopted the J-STD-020C standard or offered an alternative at this time.

Type 195D, 572D, 591D, 592D, 594D, 595D, 597D, T95, T96, T97, T98 and 695D conformal-coated capacitors are vacuum packaged in metallized bags and meet a moisture sensitivity level rating (MSL) of 2a and 3 respectively, as specified in J-STD-020C. SP unused capacitors should be resealed in the metallized bag with fresh desiccant. A moisture strip (Humidity Indicator Card) is included in the bag to assure dryness. If excess moisture remains, capacitors can be dried at 40 °C for 168 h (standard "drybox" conditions). However, to avoid this type of issue, it is advised to use these capacitors within the Floor Life specified.

### Q. WHAT IS THE SHELF LIFE OF A SOLID TANTALUM CAPACITOR?

A. Solid tantalum capacitors are stable with time, with no known wear-out mechanism. Aside from solderability concerns with unmounted capacitors, solid tantalum capacitors have no restrictions with standard shelf conditions (40 °C maximum, 60 % RH). After the 1999/2000 timeframe, demand for tantalum capacitors dropped sharply, resulting in high inventory levels of capacitors that exceeded the standard 2 year date code restriction. Vishay instituted a solderability testing program that showed excellent solderability for capacitors up to 3 to 4 years. The solderability test is an 8 hour steam age test per ANSI/J-002, MIL-STD-202, Method 208.

### Q. WHAT DO THE MARKINGS ON VISHAY LEADED PARTS MEAN?

A. The markings for Vishay axial-leaded parts are as follows:

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Vishay Sprague

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## FOR SERIES 135D, 109D, 138D, 738D COMMERCIAL PRODUCTS AND THE CECC PRODUCTS 735D, CT79, 769D AND CT9:

PART NUMBER	135D
CAP, TOLERANCE	25 $\mu$ F X9
RATED VOLTAGE	8 VDC
DATE CODE AND LOT SYMBOL LOGO	0221AB

## FOR THE MILITARY PRODUCT SERIES M39006/XX:

PART NUMBER	M39006/
DASH #	09-8378
JAN AND LOGO	JAN
CAGE CODE	SH905
DATE CODE	0000XX
CAPACITANCE	4.7 $\mu$ F
RATED VOLTAGE	100 V

## FOR THE MILITARY M39003/01/03/06 SERIES PRODUCTS A CASE :

CAGE CODE +	SH905 +
PART NUMBER	M39003
SLASH SHEET # - LOGO	xx-
DASH # J +	XXXXJ +
LOT DATE CODE	0000XX

## FOR THE MILITARY M39003/01/03/06 SERIES PRODUCTS B CASE :

PART NUMBER	M39003
SLASH SHEET # - LOGO +	xx- +
DASH # J +	XXXXJ
CAGE CODE +	SH905
LOT DATE CODE	0000XX

## FOR THE MILITARY M39003/01/03/06/09 SERIES PRODUCTS R AND S CASE :

PART NUMBER	M39003
SLASH SHEET AND DASH # J	xx-XXXXJ
CAPACITANCE +	100 $\mu$ F +
CAPACITANCE TOLERANCE AND VOLTAGE	10 % 20 V
CAGE CODE +	SH905
LOT DATE CODE	0000XX

## FOR THE 150D/152D PRODUCT, A CASE :

PART NUMBER +	150D
TOLERANCE	$\pm$ 10 %
CAPACITANCE	2.2 $\mu$ F
CAPACITANCE AND VOLTAGE +	20 DC
LOGO	
DATE CODE +	0000XX

## FOR THE 150D/152D, B, R, AND S CASES AND R AND S CASES:

PART NUMBER, TOLERANCE	150D $\pm$ 10 %
CAPACITANCE +	10 $\mu$ F +
VOLTAGE	20 DC +
LOGO	
DATE CODE +	0000XX +

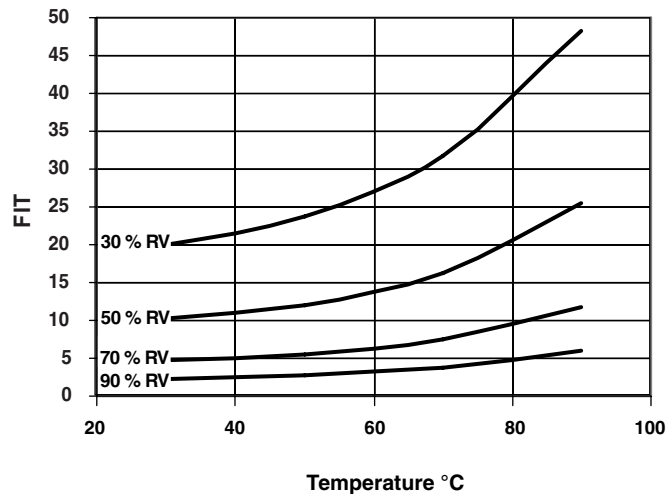


### Q. ARE ALL VISHAY SOLID TANTALUM CAPACITORS ROHS COMPLIANT?

A. We are currently in the process of qualifying the manufacturing of our entire series of Solid Tantalum Capacitors and will be complete in 2007. To check the status of all Solid Tantalum Capacitors, go to: <http://www.vishay.com/doc?49322>

### Q. WHY CAN'T I USE THIS 10 V RATED CAPACITOR USING A 10 V POWER SUPPLY?

A. Tantalum capacitors require proper derating in order to operate properly within a customer's application. This has been established for many years since the military acceptance of tantalum's in the late 1950's, which led to the establishing of standard life test procedures. That being, operation at rated voltage for 1000 h at + 85 °C using a current limiting resistor of  $< 3 \Omega$  in series. This "steady state" test procedure is still the industry standard today. "M" level exponential failure rates were 1 % per 1000 h. Standard military and commercial product was designed to meet this failure rate requirement. Now, low impedance circuitry (minimal current limiting resistance) requires better than M failure rates. Thus, voltage derating greatly enhances reliability. As field failure rate data became available, mostly through military studies, actual reliability calculations became possible. Hence, Mil-Std-217 was developed for capacitors of all types. Derating of the applied voltage from the full rated voltage down to 50 % dropped field failure rates to approximately a FIT of 5.



### Q. HOW LONG CAN YOU OPERATE VISHAY SOLID TANTALUMS WITH THE APPLIED REVERSE VOLTAGE BIAS?

A. Tantalum capacitors are capable of withstanding peak voltages in the reverse direction equal to 10 % of the DC rating at + 25 °C and 5 % of the DC rating at + 85 °C.

### Q. HOW LONG CAN YOU OPERATE VISHAY WET TANTALUMS WITH THE APPLIED REVERSE VOLTAGE BIAS?

A. The peak reverse voltage does not exceed 1.5 V and the peak current times the duration of the reverse transient does not exceed 0.05 ampere seconds. In addition, the repetition frequency of the reverse voltage surge is less than 10 Hz.