Solid Tantalum Capacitors
Frequently Asked Questions (FAQs)

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GENERAL

Q: What is Vishay's selection of tantalum capacitors with solid MnO_2 electrolyte?

A: See section "Vishay Selection" below.

Q: What are your cage codes?

A: Vishay manufactures solid tantalum capacitors in four locations: Dimona, Israel (cage code 2800A); Bennington, VT, USA (cage code 05079); Danshui, China (cage code SDU70); Miharu, Japan (cage code SXP61).
Contact tantalum@vishay.com for information on a particular capacitor series.

Q: Is my part counterfeit?

A: The best way to avoid receiving counterfeit parts is to buy products through Vishay-authorized channels. For more information on Vishay's policy on counterfeit component purchases, go to www.vishay.com/doc?99907.

Q: What is the CTE of tantalum capacitors?

A: CTE (coefficient of thermal expansion) for conformal coated and lead frameless MICROTAN® tantalum capacitors is approximately 10 ppm/°C, which is suitable for use in both FR4 and alumina substrate applications. Terminations of molded tantalum chip capacitors utilize a compliant lead frame construction - the leadframe can flex slightly to minimize any effects due to mismatch in CTE. As a result, CTE mismatches are not applicable.

Q: What is the shelf life of this part in the original packaging?

A: The following is the position of the EIA/ECA P-2.5 Engineering Committee for Tantalum Capacitors: solid tantalum capacitors have no known wear-out mechanism or shelf-life limitations. However, solderability and cover-tape peel strength may be affected by storage conditions. See FAQ "What is recommended storage temperature for solid tantalum capacitors" (see section Storage, Processing, and Mounting).

Q: How can I obtain tin whisker growth information?

A: For general information go to www.vishay.com/how/leadfree/#whisker.
For family-specific information, please send part number request to tantalum@vishay.com.

Q: What is the flammability rating of tantalum capacitors per UL 94 V-0/1/2?

A: All solid tantalum capacitor encapsulation materials meet a flammability rating of UL 94 V-0.

VISHAY SELECTION

Q: What is Vishay's selection of tantalum capacitors with solid MnO_2 electrolyte?

A. Vishay Sprague surface-mount chip capacitors, TANTAMOUNT™, molded case, metal leadframe
- 293D industrial grade
- 593D industrial grade, low ESR
- 893D built-in-fuse, miniature
- TR3 low ESR
- TF3 built-in-fuse, low ESR
- TP3 high performance, automotive grade
- TH3 high temperature, 150 °C, automotive grade
- TH4 high temperature, 175 °C, automotive grade
- TH5 HITM® very high temperature, 200 °C
- TL3 very low DC leakage
- TM3 for medical instruments
- 793DX CECC 30801/005 approved
- CTC3 CECC 30801/009 approved
- CTC4 CECC 30801/011 approved

A1. TANTAMOUNT™, molded case, metal leadframe, high reliability, and DLA approved
- CWR11 MIL-PRF-55365/8 qualified
- 95158 DLA approved, low ESR
- T83 Hi rel COTS
- T86 Hi rel COTS, built-in-fuse

B. Vishay Polytech, surface-mount chip capacitors, molded case, metal leadframe
- TMCS standard industrial grade
- TMCM extended range
- TMCU ultra flat, low profile
- TMCJ molded case, 0603 size
- TMCP molded case, 0805 size
- TMCTX built-in-fuse
- TMCR low ESR

B1. Vishay Polytech, high reliability
- TMCH hi rel
- THC high temperature 150 °C, hi rel

C. Vishay Sprague surface-mount chip capacitors, TANTAMOUNT™, conformal coated case
- 194D metal end caps
- 195D conformal coated
- 572D low profile, maximum CV
- 591D low profile, low ESR, maximum CV
- 592D low profile, maximum CV
- 592W low profile, pulse application capacitor
- 594D maximum CV, low ESR
- 595D maximum CV
- 597D ultra low ESR, maximum CV (multianode)
- 695D pad-compatible with CWR06 / 194D

C1. TANTAMOUNT™, conformal coated case, high reliability and DLA approved
- •CWR06 MIL-PRF-55365/4 qualified
- •CWR16 MIL-PRF-55365/13 qualified, extended range
- •CWR26 MIL-PRF-55365/13 qualified, low ESR
- •13008 DLA approved, ultra low ESR (multianode)
- •14002 DLA approved, low ESR
- •T95 hi rel COTS
- •T96 hi rel COTS, low ESR, built-in-fuse
- •T97 ultra low ESR, hi rel COTS (multianode)
- •T98 ultra low ESR, hi rel COTS, built-in-fuse (multianode)

D. Solid tantalum SMD capacitors TANTAMOUNT™, hi rel COTS, low ESR, hermetically sealed / metal case
- •T25

E. Vishay Sprague surface-mount chip capacitors, MICROTAN®, molded, leadframeless
- •298D case sizes from 0402 to 1411
- •298W extended range
- •TR8 MICROTAN® terminations, low ESR
- •TL8 high CV, low DC leakage
- •TP8 high performance, automotive grade

E1. MICROTAN®, high reliability and DLA approved
- •11020 DLA approved
- •TM8 hi rel COTS, low DC leakage

F. TANTAMOUNT™, molded case, leadframeless
- •T42 built-in-fuse, low ESR, multianode

G. Vishay Sprague through-hole mounted capacitors, resin coated, radial leads
- •199D TANTALEX™, dipped
- •299D TANTALEX™, dipped, triple lead
- •489D, dipped
- •499D, dipped
- •ETQW, dipped
- •ETPW, dipped
- •790D, molded

H. Vishay Sprague through-hole mounted capacitors, resin molded, axial leads
- •173D

I. Vishay Sprague through-hole mounted capacitors, TANTALEX™, hermetically sealed / metal case, axial leads
- •150D
- •152D extended range
- •550D for high-frequency power supplies
- •CTS1 CECC 30201/002 approved
- •CTS13 CECC 30201/005 approved
- •749DX CECC 30201/029 approved

J. Vishay Sprague through-hole mounted capacitors, TANTALEX™, hermetically sealed / metal case, axial leads - DLA approved
- •M39003/01 (style CSR13) MIL-PRF-39003/1 qualified
- •M39003/03 (style CSR23) MIL-PRF-39003/3 qualified
- •M39006/09 (style CSR21) MIL-PRF-39003/9 qualified

APPLICATIONS

Q: For DC/DC converters, what are the recommended design-in guidelines for Vishay tantalum capacitors?

A: There are several basic converter topologies: buck, boost, and flyback. Various capacitor types can be used in the input and outputs of DC/DC converters. The application typically dictates the best choice of capacitor type (MLCC, aluminum electrolytic, polymer, or tantalum) to use in the design. Some important considerations for **input capacitors** used in DC/DC converters are the power dissipation and ripple performance. To maintain the voltage and to make sure the rail voltage is stable to the converter, an input capacitor is required.

The Vishay datasheet contains maximum ESR information, which is useful in determining how to right-size the capacitor for the available AC current. Maximum power dissipation and ripple current capabilities can be found in datasheets or application notes on the Vishay website.

The **hold up capacitor(s)** is needed in converters for controlling the output ripple and transients. Output ripple can be controlled by the capacitor. Key considerations for ripple control are the capacitor’s equivalent series resistance (ESR). Transients during light- and heavy-load conditions need to be evaluated with the selected capacitor. Vishay can supply impedance vs. frequency information so the ESR and ESL can be used to determine the proper type capacitor for the application capacitance for the output of the converter.

Contact your local Vishay application engineer for more assistance in selecting the right capacitor for your converter application.

Q: How can I avoid the overstressing of tantalum capacitors that can lead to overheating and possibly ignition?

A: Solid tantalum capacitors have no known wear-out mechanism(s). However, excessive voltage, current, and temperature can impact their long-term reliability. Reducing any of the mentioned stresses results in improved reliability. The most common method for reducing tantalum dielectric stress to improve reliability and guard against catastrophic failure is to reduce the applied voltage so that it is less than the capacitor’s rated voltage (normally a 60 % to 50 % voltage derating is recommended for solid tantalum capacitors. For individual devices please refer to the derating table in the relevant datasheet).

Q: Can Vishay solid tantalum capacitors be used at temperatures above 125 °C?

A: Yes. The TH3 series is designed for up to 150 °C applications, the TH4 up to 175 °C, and the TH5 up to 200 °C.

ENVIRONMENTAL

Q: Are all Vishay solid tantalum capacitors RoHS-compliant?

A: All commercial solid tantalum capacitors are offered with a RoHS-compliant material option.

Q: Where do I get RoHS, REACH, Green, halogen-free status, and material declaration documentation?

A: Send an email to VPECM.surveys@vishay.com. Include specific part number(s) in your request.

Q: What is your position on DFAR clause 252.225-7009, Restriction on Acquisition of Certain Articles Containing Specialty Metals?

A: All electronic components, therefore all tantalum capacitors, are covered by exception to this clause.

MATERIALS AND CONSTRUCTION

Q: What are the materials used in a tantalum capacitor and what is the typical weight?

A: Major materials used in tantalum capacitors are: tantalum powder, tantalum wire, Mn Nitrate, silver-filled paints / adhesives, metal leadframe (molded chip with metal leadframe only), and plastic encapsulant (except: hermetically sealed capacitors with metal case).

For component weight information and for material content (declaration) data please send a request to VPECM.surveys@vishay.com.

Please note the full Vishay part number.

Q: What is the termination structure of Vishay tantalum capacitors?

A: All surface-mount solid tantalum capacitors from Vishay have a nickel barrier layer covered by an outer termination finish. Vishay offers termination finishes of 100 % matte tin, tin / lead, and gold for certain product series. Please refer to specific product datasheets. For typical layer thickness contact tantalum@vishay.com.

MARKING, PACKAGING, LABELING

Q: How do you identify the correct polarity for Vishay solid tantalum capacitors?

A: Because tantalum capacitors are polarized devices, they can be damaged if the capacitor is connected using the wrong polarity. The oxide dielectric construction that is used in tantalum capacitors has a basic rectified property which blocks current flow in one direction and at the same time offers a low resistance path in the opposite direction. Attention to maintaining the proper polarity when using tantalum capacitors is very important. The anode of the tantalum capacitor is the positive (+) terminal, while the cathode is the negative (-) terminal. Vishay surface-mount tantalum capacitors are clearly marked with a white bar which indicates the anode terminal of the part. The anode of leaded (through-hole) capacitors is marked with a plus symbol(s).

Conformal-coated capacitors (with orange epoxy coating) do not have body markings, but their anode terminal can be easily identified by their tantalum wire nib.


Q: How do I determine the date code on a molded tantalum chip capacitor?

A: On case sizes B, C, D, E, V, and W, the date code is a two-digit alpha numeric code. As shown in the next table, the "N3" is the date code which represents March 2001. On case A, the date code designation is done with combination of strokes; for details see tables below.

Date codes for B, C, D, V, E, and W may be decoded as follows:

YEAR	CODE
1990 / 2010	A
1991 / 2011	B
1992 / 2012	C
1993 / 2013	D
1994 / 2014	E
1995 / 2015	F
1996 / 2016	H
1997 / 2017	J
1998 / 2018	K
1999 / 2019	L
2000 / 2020	M
2001 / 2021	N
2002 / 2022	P
2003 / 2023	R
2004 / 2024	S
2005 / 2025	T
2006 / 2026	U
2007 / 2027	V
2008 / 2028	W
2009 / 2029	X

MONTH	CODE
JANUARY	1
FEBRUARY	2
MARCH	3
APRIL	4
MAY	5
JUNE	6
JULY	7
AUGUST	8
SEPTEMBER	9
OCTOBER	O
NOVEMBER	N
DECEMBER	D

Date codes for A case repeat every four years and may be decoded as follows:

MONTH	1999 / 2003 2007 / 2011 2015 / 2019	2000 / 2004 2008 / 2012 2016 / 2020	2001 / 2005 2009 / 2013 2017 / 2021	2002 / 2006 2010 / 2014 2018 / 2022
January	$\overline{\underline{C}1}05$	$C\overline{10}5$	$\overline{C}\underline{1}05$	$\underline{C}10\overline{5}$
February	$\overline{C\underline{1}}05$	$C1\overline{05}$	$\overline{C}1\underline{0}5$	$C\underline{1}0\overline{5}$
March	$\overline{C1}\underline{0}5$	$\underline{C1}05$	$\overline{C}10\underline{5}$	$C1\underline{0}\overline{5}$
April	$\overline{C}105$	$C\underline{10}5$	$C\overline{\underline{1}}05$	$\overline{C}10\overline{5}$
May	$C\overline{1}05$	$C1\underline{05}$	$\underline{C}\overline{1}05$	$\underline{C}10\underline{5}$
June	$C1\overline{0}5$	$\overline{C10}5$	$C\overline{1}\underline{0}5$	$\overline{\underline{C}}105$
July	$C10\overline{5}$	$C\overline{105}$	$C\overline{1}0\underline{5}$	$C\underline{10}5$
August	$\underline{C}105$	$\underline{C10}5$	$C1\overline{\underline{0}}5$	$C1\overline{\underline{05}}$
September	$C\underline{1}05$	$C\underline{105}$	$\underline{C}1\overline{0}5$	$\overline{\underline{C10}}5$
October	$C1\underline{0}5$	$\overline{C105}$	$C\underline{1}\overline{0}5$	$C\overline{\underline{105}}$
November	$C10\underline{5}$	$\underline{C105}$	$C1\overline{0}\underline{5}$	$\overline{\underline{C105}}$
December	$\overline{C1}05$	$\overline{\underline{C}}105$	$C10\overline{\underline{5}}$	C105

Q: How are hermetically sealed / metal case tantalum capacitors marked?

A: Marking on metal case of hermetically sealed capacitors (series 150D / 152D / 550D / CTS1 / CTS13 / 749DX) shows: series name, tolerance in percents (for CTS1 / CTS13 / 749DX - as one digit code: J - for ± 5 %, K - for ± 10 %, M - for ± 20 %), capacitance value in microfarads, rated voltage in volts, date code (four digit: YYWW), Vishay marking (circled two), polarity signs (pluses). For lead (Pb)-free capacitors capital letter L is added after date code. There is slight variation between different case sizes. Typical marking example is shown below:

150D ± 10 %
10UF +
20DC +
②
Date code +

For military style hermetically sealed capacitors (M39003/01, /03, /09) marking shows: military specification number, specification sheet number, dash number, surge current option letter (if applicable) and "J" for JAN, cage code, lot date code, Vishay marking (circled two), polarity signs (pluses). Capacitance value (in microfarads), tolerance, and rated voltage (in volts) are shown on bigger case sizes only. Typical marking example is shown below:

M39003
03 - 2 +
XXXXJ
Cage code +
Lot date code

Q: How are tantalum capacitors packaged? What are your bulk packaging options?

A: Standard packaging for surface-mount tantalum chip capacitors is 8 mm to 24 mm plastic embossed tape on 7" (178 mm) and 13" (330 mm) reels per EIA-481. Specific reel quantities and other packaging options are specified in each datasheet.

All through-hole solid tantalum capacitors are available with tape and reel or ammopack packaging and, except for the 173D series, with bulk packaging. Standard packaging options and ordering information for each series are specified in datasheets.

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.

PERFORMANCE AND RELIABILITY

Q: How can the reliability of solid capacitors be calculated?

A: Vishay calculates solid tantalum capacitor reliability based upon MIL-HDBK-217. For your reliability calculations, refer to Vishay's FIT calculator program. The Vishay FIT calculator program was developed using the calculations defined in MIL-HDBK-217 (revision F). This FIT calculator program enables users to predict the reliability of tantalum capacitors. Vishay customers can input information about applications, ambient temperature, operating voltage, and environmental factors to create multipliers of established failure rates for most tantalum capacitor types. The failure rates are listed as "FIT" (failures in time) and as "MTBF" (mean time between failures). Vishay's FIT calculator program enables instantaneous results and provides important design-related information.

The Vishay FIT calculator can be found at: www.vishay.com/capacitors/tantalum-reliability-calculator-list/.

Q: How long can you operate Vishay solid tantalum capacitors with the applied reverse voltage bias?

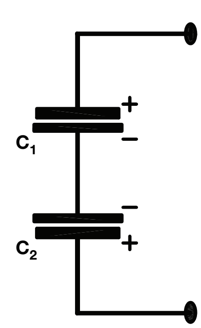
A: Because tantalum capacitors are polarized devices, they can be damaged if the capacitor is connected using the wrong polarity. The oxide dielectric construction that is used in tantalum capacitors has a basic rectified property which blocks current flow in one direction and at the same time offers a low resistance path in the opposite direction.

Vishay does not recommend the intentional application of reverse voltage on solid tantalum capacitors. However, occasionally tantalum capacitors may be subjected to reverse voltages. Solid tantalum capacitors are capable of withstanding short duration peak voltages in the reverse direction limited to 5 % of the DC rating at +25 °C, 3 % of the DC rating at +85 °C, and 1 % of the rated voltage at +125 °C.

In addition to the voltage limits above, the time to failure and risk of damage due to reverse voltage are also dependent on the temperature and available current in the application.

Tantalum capacitors can handle a reverse voltage if oriented in a "back-to-back" (or cathode-to-cathode) configuration.

The "back-to-back" configuration is a good method for handling bipolar filtering applications.



In the configuration above, C_1 and C_2 should each individually meet the circuit voltage and derating requirements.

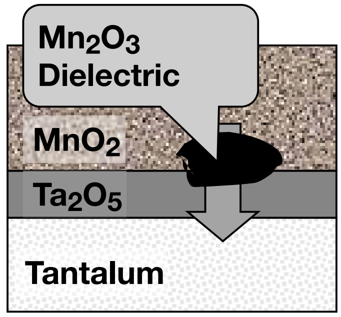
If C_1 is equal to C_2, the resulting capacitance of the C_{total} is half the value of each capacitor (example: if C_1 and C_2 are each 22 µF, then C_{total} is 11 µF).

Q: What is the self-healing effect for tantalum capacitors?

A: All tantalum capacitors have low resistance paths through the dielectric which can self-heal, repairing the potential fault site. Because of the cathode manganese dioxide construction, an inherent feature of tantalum capacitors is the ability of the capacitors to self-heal dielectric defects.

The self-healing effect occurs when a voltage is applied to the capacitor.

As the capacitor is charging, current flows through the lower resistance path in the dielectric. As the current continues to penetrate these areas, localized heating occurs, depicted by the arrow in the diagram below, causing oxygen to be released from manganese dioxide (MnO_2).



The MnO_2 acts as a semiconductor material converting to a lower-order oxide (Mn_2O_3), with a change to higher resistivity in and around the potential failure site. These lower oxides (Mn_2O_3) have resistance higher by orders of magnitude than MnO_2. Ultimately, due to the oxide reaction, the conductive failure site is blocked and current flow decreases to an acceptable level. The high-resistance manganese oxide material electrically isolates the dielectric defect.

The level of localized heat determines the resultant oxide formation.

If the resistance path is such that self-healing cannot occur then the capacitor will be rejected due to high DC leakage during the final electrical test.

Q: How do I know if I am exceeding the ripple current capability of the capacitor?

A: Maximum allowed ripple current is provided in the relevant product datasheet.
For details, please refer to www.vishay.com/doc?40031.

Q: Do you have a SPICE model for this capacitor?

A: The SPICE model is under development. Please contact marketing for information.

STORAGE, PROCESSING, AND MOUNTING

Q: What is the shelf life of this part in the original packaging?

A: Solid tantalum capacitors are very 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. Vishay performs periodic solderability testing that demonstrates excellent solderability for its tantalum capacitors up to four years. The solderability test is performed in accordance with ANSI/J-STD-002 and MIL-STD-202 Method 208.

Note: cover tape peel strength may be affected by storage conditions.

Q: What is the recommended storage temperature for solid tantalum capacitors?

A: 40 °C (max.), 70 % RH (max.), re-certify for solderability after two years.

Q: What is the moisture sensitivity of Vishay solid tantalum capacitors?

A: Moisture sensitivity levels (MSL) and test conditions to assure product 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, use the J-STD-020 specification for MSL grading.

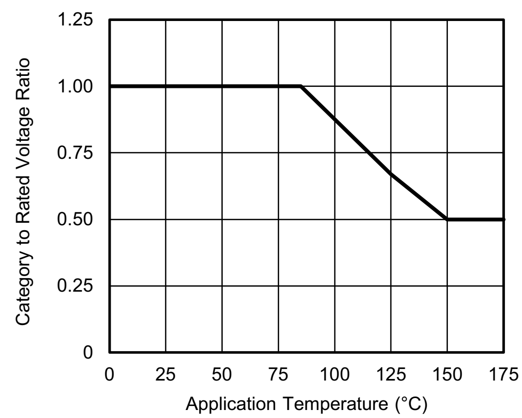
For the MSL data of specific capacitors series, please refer to the product datasheet or the following document: www.vishay.com/doc?40135.

All capacitors series classified as MSL 2a or 3 (mostly conformal coated capacitors) are vacuum-packaged in metallized bags as specified in J-STD-033, with desiccant and a moisture strip (Humidity Indicator Card). For the capacitor’s floor life and storage conditions after opening of the original bag, please follow the mentioned specifications. If excess moisture remains, the capacitors can be dried at 40 °C for 168 hours (standard “dry box” conditions).

TECHNICAL

Q: Why are voltage and temperature derating needed for tantalum capacitors?

A: Tantalum capacitors require voltage derating in order to operate properly within a customer's application. The voltage on the capacitor is equal to the sum of the DC and AC voltages. This sum should never exceed the category voltage. For tantalum capacitors at temperatures below or equal to 85 °C the category voltage is equal to the rated voltage and then it linearly decreases to the specified value at the maximum operating temperature (see relevant product datasheet for details). For reliable capacitor performance, it is recommended that the DC voltage applied to the capacitor not exceed the derated value as provided in the relevant product datasheet.



As an example, if a tantalum capacitor is used without any derating, failure rates of 0.1 % to 1 % will occur. Tantalum capacitor manufacturers generally recommend that a minimum of 60 % voltage derating should be applied (if not specified differently in a product datasheet). However, specific derating rules need to be determined based upon the application of the tantalum capacitor in the circuit. In a worst-case scenario, for example, a capacitor being used as an input filter might need to sink a high level of surge-current at turn-on. More typical might be the use of tantalum devices as hold-up capacitors at the output of a well-regulated converter. For recommended derating guidelines please refer to the relevant datasheet.

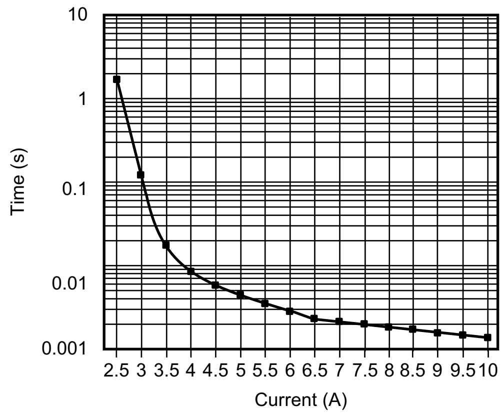
Derating guidelines were established by U.S. military procurement agencies in the 1950s to help to improve the long-term reliability of tantalum capacitors. The military did extensive testing of tantalum capacitors, developing an established standard life test procedure which was defined as operation at rated voltage for 1000 h at +85 °C using a current limiting resistor of < 3 Ω 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 products were designed to meet this failure rate requirement. As field failure rate data studies became available, mostly through military studies, actual reliability calculations became possible.

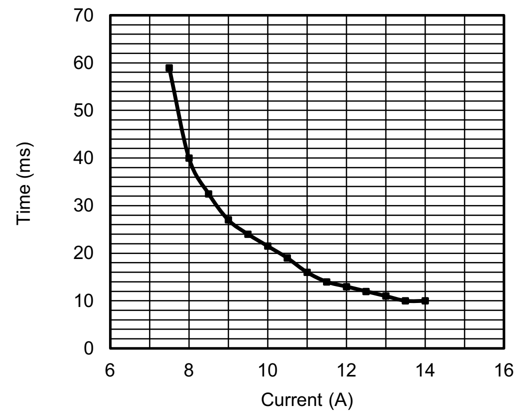
Q: What is the difference between fused (Vishay Sprague 893D, TF3, T86, T96, T98, T42) and standard, non-fused (Vishay Sprague 293D, 593D, TR3, T83, T95, T97 and others) tantalum capacitors?

A: The fused series were designed to operate in high-current applications (> 10 A) and employ a fusing mechanism. The TF3 series, in addition to its built-in-fuse, offers lower ESR levels. The T86 series is hi rel COTS with a built-in-fuse and two ESR levels. Among the conformal-coated capacitors there are two product series with a built-in fuse: the T96 and T98. All series employ similar fuse mechanisms.

The fuse activation time is based on a current heating (I^2R) effect and is therefore dependent on the fuse resistance (i.e. material, length, and diameter) 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 (see Typical Fuse Activation Curve). The capacitor fuse will not "open" below 2 A because the I^2R is below the energy required to activate the fuse. Between 2 A and 3 A, the fuse will eventually activate, but some capacitor and circuit board "charring" may occur. In summary, built-in-fuse capacitors are ideal for high-current circuits where capacitor "failure" can cause system failure. The fuse will prevent capacitor or circuit board "charring" and usually will 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 trigger system shutdown. The fuse activation time is sufficiently fast in most instances to eliminate excessive current drain or voltage swings. Built-in-fuse capacitors were designed to operate in circuits with no external series resistance. The fuse changes the failure mode from a "short" circuit to an "open" circuit.



Typical Fuse Activation Curve



T96 / T98: Typical Fuse Activation Curve

Q: Are solid tantalum capacitors available in hermetic packaging?

A: Hermetically sealed solid tantalum capacitors are available as axial leaded with metal case (150D, 152D, 550D, CTS1, CTS13, 749DX, M39003/01, /03 and /09) and the surface-mount T25 series.

Q: How do I obtain ESR / Z vs. frequency data?

A: Sample ESR / Z vs. frequency information is provided in individual product datasheets. For a specific rating, please send the part number request to tantalum@vishay.com.

Q: Are tantalum capacitors ESD-sensitive?

A: Tantalum capacitors are not ESD-sensitive. Vishay does offer ESD packaging as an option if customers need to store tantalum capacitors alongside ESD-sensitive components. Please contact your authorized Vishay sales office for more information.

Q: What is the ESL of this part?

A: The following table provides ESL data for selected product series. For other part series or case sizes, contact tantalum@vishay.com.

VISHAY TANTALUM SOLID SURFACE-MOUNT CAPACITORS	CASE	ESL (nH)
Molded chip, metal leadframe [1]	A	1.20
	B	1.60
	C	2.40
	D	2.70
	E	2.90
	V	2.50
	W	2.60
Conformal-coated capacitors (except: 595D, S/T cases, 592D X case, and multianode series)	A	0.56
	B	0.60
	C	0.79
	D	0.93
	R	0.86
595D	S	0.51
	T	0.32
592D	X20 / X21 / X22	1.80
	X25	1.96
Conformal-coated capacitors (multianode series 597D / T97 / T98)	V	0.63
	D	0.82
	E	0.88
	R	0.90
	F	0.93
	Z	0.95
	M	0.96
	H	0.98

Note

[1] For full product list see "Vishay Selection"

Q: What are the test conditions for standard electrical measurements (capacitance, dissipation factor, ESR)?

A: Capacitance and dissipation factor (DF) are measured at 25 °C and a frequency of 120 Hz, with 1 V_{RMS} max.
ESR is measured at 25 °C and at frequency of 100 kHz, with 0.5 V_{RMS} max.

Q: How do I test for DC leakage (DCL) on Vishay tantalum capacitors?

A: All capacitors exhibit some degree of DC leakage. The value of leakage current is dependent on the capacitor rating (capacitance-voltage), voltage applied, the charging period, and ambient temperature.

For accurate DC leakage measurements, capacitors must be removed from the PC board and tested individually. The specified DC leakage is measured at 25 °C with the rated voltage applied through a series resistance of 1000 Ω. The 1000 Ω resistor limits the possibility of damage and provides a convenient measuring point. The voltage drop across the resistor can be used to calculate the DC leakage using Ohm's law. For example, with rated voltage applied, a 10 mV drop across the resistor corresponds to a 10 μA DC leakage. After the leakage current stabilizes (three to five minutes is an industry standard), the leakage current must not exceed the maximum value indicated in the datasheet. The leakage current varies with temperature and voltage. Details can be found in the Performance Characteristics table provided in each product datasheet.

Q: Why is surge testing done on tantalum capacitors and how is it performed?

A: During outgoing electrical testing, 100 % surge current testing (SCT) is performed by Vishay on most solid tantalum capacitors. Surge current testing ensures that the tantalum capacitor will perform under severe circuit application conditions. In applications where the ESR of the capacitor is low and there is a large available current from the power bus, high inrush currents to the capacitor may be experienced.

For these reasons, many solid tantalum capacitors (especially those with low-ESR / high-capacitance, high-voltage ratings) are 100 % surge tested with at least three cycles of surge current, and with at least the rated voltage applied through a low-impedance circuit. Surge current testing ensures that potentially weak capacitors are eliminated by providing a level of inrush current that is higher than what would be found in even the most stressful applications.

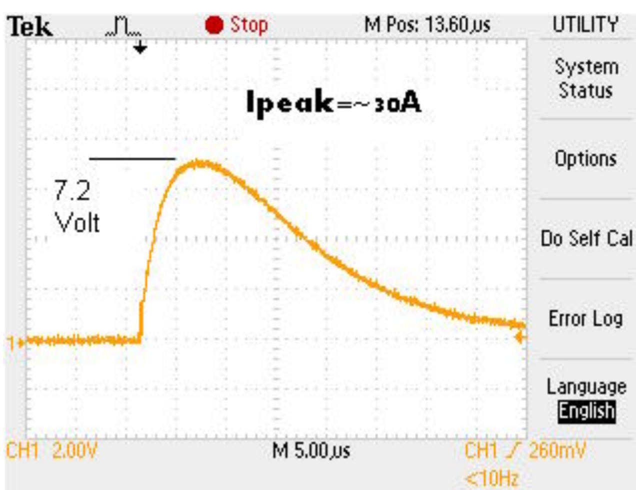
For example, SCT was performed on molded Vishay tantalum TR3 15 μF / 35 V D case. The Vishay surge current tester applied three cycles of current surge to the parts.

An oscilloscope was used to monitor the current during SCT (see image below). As the capacitors were being tested, a 240 mΩ resistor that is placed in series is used to monitor the voltage drop across the resistor.

The current flow was calculated based upon the voltage drop across the resistor.

The peak current was calculated by Ohm's law: I_{peak} = 7.2 V / 240 mΩ = 30 A. The scope image below demonstrates the 30 A surge capability for a TR3 15 μF / 35 V D case.

Refer to the applicable Vishay datasheet for more details about tantalum surge current screening and optional SCT cycles available. For Vishay surface-mount MIL and Hi Rel COTS solid tantalum capacitors, surge current testing / screening is also offered at -55 °C and +85 °C in addition to the standard 25 °C, per the surge test specification described in MIL-PRF-55365.



Q: What is Weibull grading?

A: Weibull grading is a method for failure rate (FR) prediction, based on representing sample behavior study. It is noteworthy that Weibull grading is used for components that have a decreasing failure rate over time. Calculations are based on failed parts counting when these parts are subjected to accelerated temperature and voltage conditions. The process conditions and the mathematical calculations are described in specifications MIL-PRF-39003 and MIL-PRF-55365. The Weibull G failure rate (applicable for M39003 capacitors only) equates to a 1.0 % per 1K unit-hour base failure rate; Weibull B equates to a 0.1 % per 1K unit-hour base failure rate; Weibull C equates to a 0.01 % per 1K unit-hour base failure rate; and Weibull D equates to a 0.001 % per 1K unit-hour base failure rate.

Q: What is the major difference between tantalum $Mn0_2$ and tantalum polymer capacitors?

A: The construction of polymer tantalum capacitors is basically the same as solid electrolyte tantalum capacitors. The major difference is in the material used to create this solid electrolyte. For regular capacitors this is multilayer MnO_2, possessing the conductivity typical of semiconductors, while for polymer capacitors, highly conductive polymer materials are used. As a result, polymer capacitors have a much lower ESR. Another feature of polymer capacitors is the absence of an ignition failure mode due to less oxygen content.