

EIA-809

EIA STANDARD

Solid Tantalum Capacitor Application Guideline

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ELECTRONIC INDUSTRIES ALLIANCE

**Electronic Components, Assemblies, Equipment & Supplies
Association**



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(From Project Number 3938, formulated under the cognizance of the P-2.5 Electrolytic Dielectric Capacitors Subcommittee.)

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CONTENTS

	Page
Foreword	iii
Clause	
1 Introduction	1
2 Characterization	3
2.1 Primary parameters	3
2.1.1 Temperature range	3
2.1.1.1 Operating range	3
2.1.1.2 Storage temperature range	3
2.1.2 Rated capacitance	3
2.1.2.1 Tolerances	3
2.1.2.2 Method for measuring capacitance	4
2.1.2.3 Temperature characteristics of capacitance	4
2.1.2.4 Voltage characteristics of capacitance	4
2.1.2.5 Frequency characteristics of capacitors	5
2.1.3 Dissipation factor (DF)	5
2.1.3.1 Measurement of dissipation factor	5
2.1.3.2 Temperature characteristics of dissipation factor	5
2.1.3.3 Voltage characteristics of dissipation factor	6
2.1.3.4 Frequency characteristics of dissipation factor	6
2.1.4 Equivalent series resistance (ESR)	7
2.1.4.1 Method for determining ESR	7
2.1.4.2 Temperature characteristics of ESR	7
2.1.4.3 Frequency dependence of ESR	8
2.1.5 Impedance (Z)	8
2.1.5.1 Method for measuring impedance	8
2.1.5.2 Temperature characteristics of impedance	8
2.1.5.3 Frequency characteristics of impedance	8
2.1.6 DC leakage current	8
2.1.6.1 Method for measuring leakage current	8
2.1.6.2 Temperature dependence of DC leakage current	9
2.1.6.3 Voltage characteristics of leakage current	9
2.1.7 Voltage	10
2.1.7.1 Operational voltage	10
2.1.7.2 Surge voltage	10
2.1.7.3 Reverse voltage	10
2.2 Secondary parameters	11
2.2.1 Self resonant frequency (SRF)	11
2.2.2 Inductance	11
2.2.3 Dielectric absorption	11
2.2.4 Sensitivity to electrostatic discharge (ESD)	12
3 Circuit configurations	12
3.1 Configured in parallel	12
3.2 Nonpolar configuration	13
3.3 Configured in series	13
3.4 Parallel and serial combinations	14
3.5 Fused applications	15
4 Reliability	15
4.1 Reliability characteristics and failure modes	15
4.2 Reliability under steady state conditions	15
4.2.1 Derating guidelines	15
4.2.2 Relative failure rate vs stress	16
4.3 Reliability under dynamic conditions	18
4.3.1 Effect of ripple current/ripple voltage	18

4.3.2	Effect of surge voltage and surge current	18
5	Mechanical properties and handling considerations	19
5.1	Mechanical properties: overview	19
5.2	Handling and process considerations	19
5.2.1	Wave solder	19
5.2.2	Gluing	20
5.2.3	Solder immersion	20
5.2.4	Cooling	20
5.3	Infrared (IR) solder reflow	20
5.4	Vapor phase solder reflow	21
5.5	Resistance-to-board-cleaning	22
Tables		
1	Maximum surge voltage limits	10
2	Maximum reverse voltage limits	11
3	Voltage derating recommendations	16
4	Component encapsulation styles	19
Figures		
1	Cross-section of a molded surface mount solid tantalum capacitor	2
2	Cross-section of an axial-mounted solid tantalum capacitor	2
3	Cross-section of a radial-dipped solid tantalum capacitor	3
4	Typical variance of capacitance with temperature	4
5	Frequency characteristics of capacitance	5
6	Typical temperature variation of dissipation factor	6
7	Frequency characteristics of dissipation factor	6
8	Temperature characteristics of ESR	7
9	Frequency characteristics of ESR and impedance	8
10	Typical variation of leakage current with temperature	9
11	Voltage characteristics of leakage current	10
12	Typical dielectric absorption characteristics	12
13	Parallel configuration	12
14	Nonpolar configuration	13
15	Series configuration	14
16	Series and parallel configurations	14
17	Typical fusing schematic	15
18	Effect of voltage on failure	17
19	Effect of temperature on failure rate	17
20	Effect of series Z on failure rate	18
21	Typical wave solder temperature-time profile	20
22	Typical IR reflow temperature-time profile	21
23	Typical vapor phase solder temperature-time profile	21

Foreword

This applications guideline was prepared by the P-2.5, Committee on Electrolytic Capacitors of the Electronic Industries Alliance's sector Electronic Components, Assemblies, Equipment & Supplies Association (EIA/ECA)

1 Introduction

Solid electrolytic tantalum capacitors are those devices having a sintered tantalum anode that incorporates a solid electrolyte counter-electrode layer.

They are polar devices, having distinct positive and negative terminals, and are offered in a variety of styles that include both molded and conformal coated versions of radial, axial and surface mount configurations.

These devices typically offer capacitance values from 0.1 μF to 1000 μF in voltage ratings from 2 V to 50 V (with a maximum capacitance-to voltage combination of approximately 22 μF @ 50 V for leaded styles or 22 μF @ 35 V for surface mount). Prime characteristics include excellent temperature stability, volumetric efficiency and compatibility with all automated assembly systems.

The capacitor element, usually referred to as the "anode", is of the same basic construction for all body styles.

Taking high-purity tantalum powder and pressing into an appropriately shaped pellet makes the anode. The pellet is generally cylindrical for axial and radial capacitors, and rectangular in cross-section for surface-mounted capacitor. A pure tantalum wire (the anode connection) is attached either by insertion into the pellet before sintering, or welding after sintering.

The sintering operation (where the anodes are heated up to 2000 °C under a high vacuum or inert atmosphere) causes the individual tantalum powder particles to interconnect and form a single electrode of extremely high surface area in a very small volume.

Tantalum is a valve metal whose amorphous oxide called tantalum pentoxide (Ta_2O_5), can be formed to an extremely uniform thickness over the entire anode surface by electrolysis.

Although the tantalum pentoxide dielectric constant is high for an electrolytic capacitor, it is much lower than achieved by ceramic technologies. However, the relative thinness of the dielectric (about 0.02 micrometers per volt) and the high surface area (typically 250 cm^2 for a 22 μF /25 V rating) results in highly volumetric-efficient devices, as expressed in equation 1:

$$C = \frac{\epsilon_r A}{t} \quad (1)$$

where

- C is the capacitance in farads (F);
- ϵ_r is the product of absolute permittivity and dielectric constant,
- t is the dielectric thickness in meters (m),
- A is the surface area in square meters (m^2) of electrodes.

The negative plate of the capacitor consists of solid electrolyte, usually crystals of manganese dioxide, that are grown by thermal decomposition over all the internal and external anode surfaces, directly on top of the dielectric layer. Final outer coats of graphite and silver are usually applied at this stage to facilitate subsequent cathode termination.

Welding to the anode wire and either soldering or bonding with conductive epoxy to the counterelectrode commonly terminates the finished capacitor elements. At that stage, encapsulation into the final body style is completed.

Examples of the main product styles are shown in figures 1-3

EIA-809
Solid tantalum capacitor application guide
Page 2

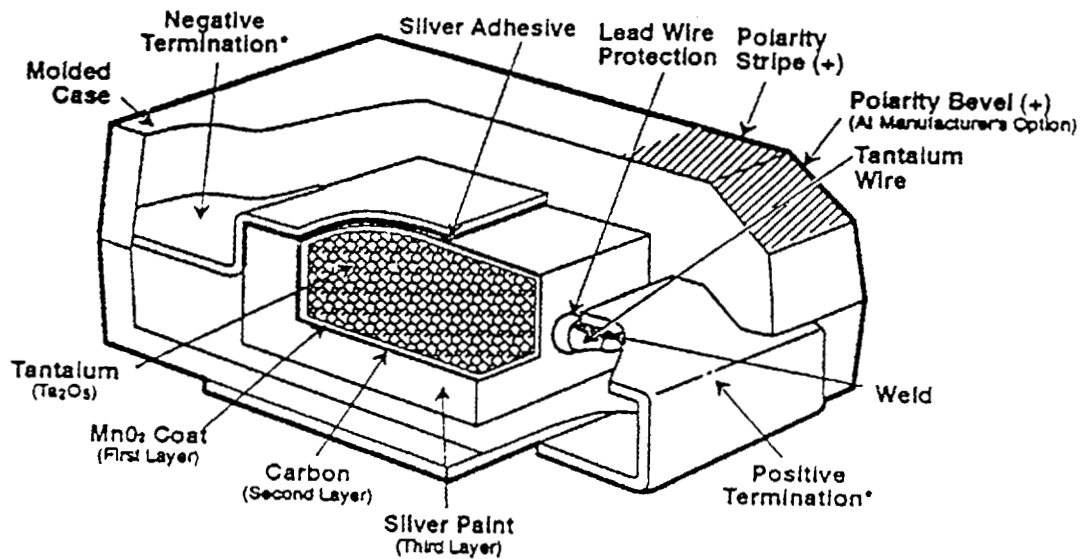


Figure 1—Cross section of typical surface-mounted solid tantalum capacitor

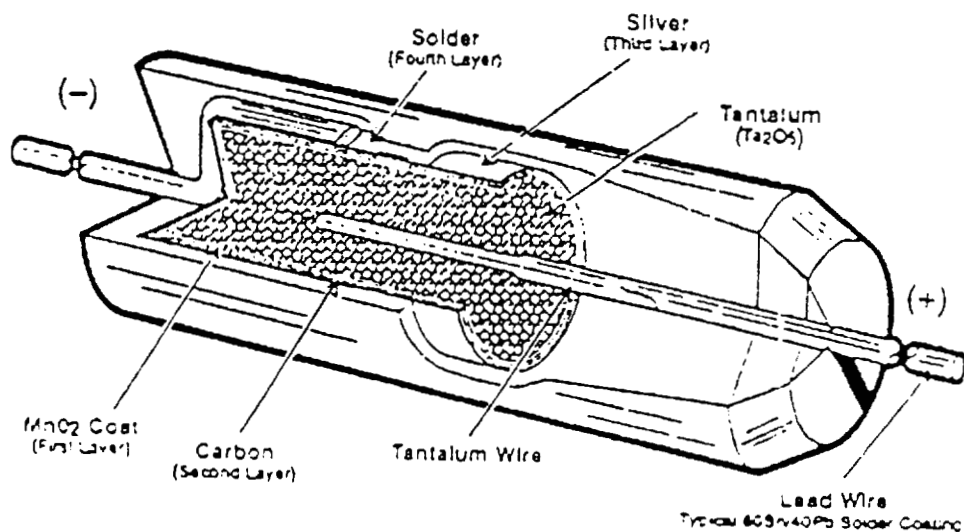


Figure 2—Cross section of typical axial-molded solid tantalum capacitor

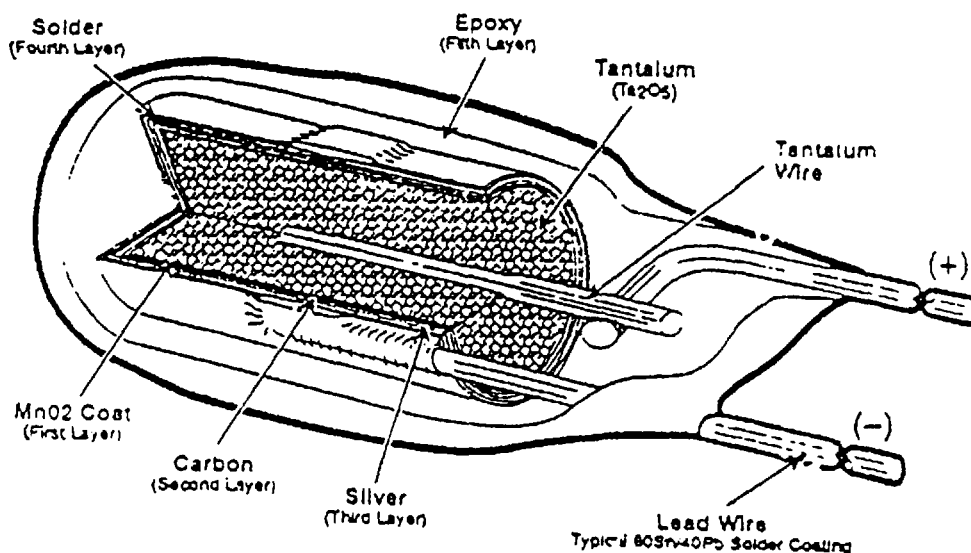


Figure 3—Cross section of typical radial-dipped solid tantalum capacitor

2 Characterization

2.1 Primary parameters

2.1.1 Temperature range

2.1.1.1 Operating range

This is the temperature range over which the part will function, when electrified, within the limits given in the sectional specification

- 55 °C to 85 °C at rated voltage;

+ 85 °C to 125 °C with linear voltage derating (to 2/3 rated voltage at 125 °C, see 2.2.6.3.

2.1.1.2 Storage temperature range

This is the temperature range at which the part can be subjected unbiased, and retains conformance to specified electrical limits.

- 55 °C to 125 °C

NOTE—Limited excursions to 150 °C totaling less than 4 hours are allowable, e.g., for subsequent board level encapsulation.

2.1.2 Rated capacitance

2.1.2.1 Tolerances

The capacitance of a tantalum capacitor varies with temperature. This variation itself is dependent to a small extent on the rated voltage and capacitor size. Maximum limits at high and low temperatures are given in each sectional specification; typical characteristics are shown in figure 4 below.

M ($\pm 20\%$) and K ($\pm 10\%$) have standard availability, with M tolerance being the more usual for standard decoupling and bypass applications. It should be noted that, by definition, K tolerance parts meet M tolerance requirements and are readily substitutable. J ($\pm 5\%$) tolerances may also be available in certain series, consult supplier for details.

EIA-809

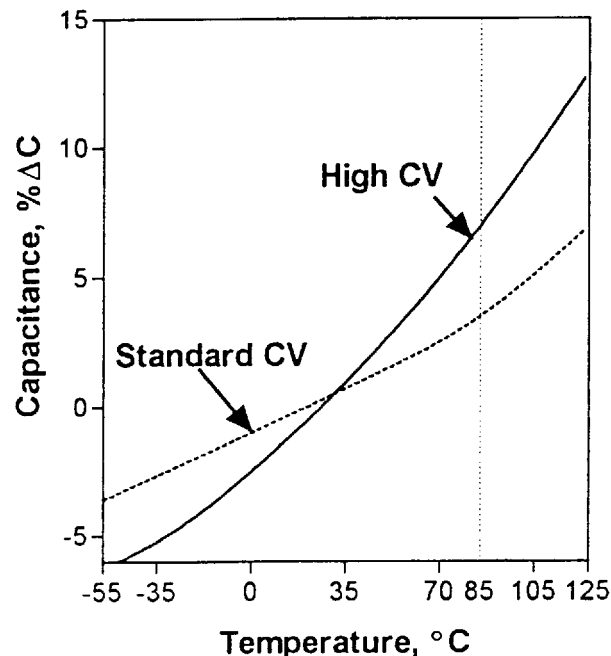
Solid tantalum capacitor application guide

Page 4

2.1.2.2 Method for measuring capacitance

For solid tantalum capacitors, the rated capacitance is measured as the capacitance of the equivalent series circuit at 25 °C in a measuring bridge supplied by a 120 Hz source free of harmonics with maximum AC signal voltage of 1 V rms and forward-biased with 2.2 Vdc max.

Typical capacitance change with temperature



NOTE—Low capacitance-voltage (CV) ratings show less variance than high CV ratings.

Figure 4—Typical variance of capacitance with temperature

2.1.2.3 Temperature characteristics of capacitance

The capacitance of a tantalum capacitor varies with temperature. This variation itself is dependent to a small extent on the rated voltage and capacitor size. Maximum limits at high and low temperatures are given in each sectional specification; typical characteristics are shown in figure 4.

2.1.2.4 Voltage characteristics of capacitance

Capacitance shows only small variations as a function of applied voltage. The effect is virtually unobservable at standard temperatures and voltages, although a 1% to 2% change due to voltage may be seen at maximum operating temperature if low bias voltage is applied.

2.1.2.5 Frequency characteristics of capacitors

The effective capacitance decreases as frequency increases as shown in figure 5. Beyond 100 kHz the capacitance continues to drop until resonance is reached (typically between 200 kHz – 500 kHz depending on rating). Beyond this the device becomes inductive. The termination style (i.e., chip or leaded) will influence the inductive characteristics.