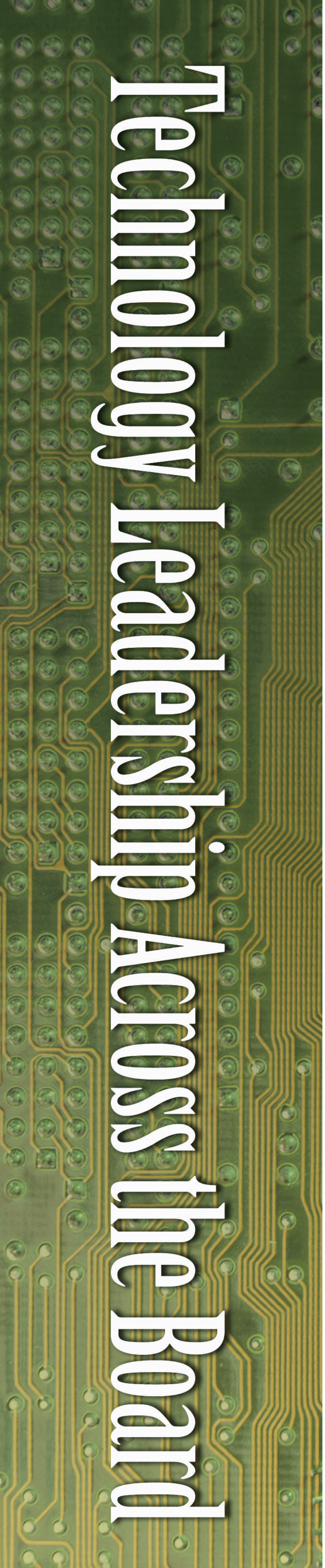

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AVX TWA Series Wet Tantalum Capacitors – DSCC 93026 & Beyond

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ABSTRACT

Wet tantalum capacitors have been utilized for many years in high energy storage applications where volumetric efficiency and high reliability are essential requirements.
This paper describes the next generation of high CV (capacitance / voltage) wet tantalum technology which is enabling higher efficiency and higher reliability capacitor designs, extending application capabilities.

Introduction

Wet tantalum capacitors have been utilized for many years in high energy storage applications where volumetric efficiency and high reliability are essential requirements. The next generation of high CV (capacitance / voltage) wet tantalum technology enables higher efficiency and higher reliability capacitor designs, extending application capabilities.

Traditional wet tantalum capacitors use a sleeve of pressed and sintered tantalum powder for the cathode system. Devices manufactured in this manner are qualified to the military specification 39006. The key to higher efficiency wet tantalum capacitor technology, such as those manufactured to the military drawing 93026, is the use of a more volumetrically efficient cathode system, which in turn enables a larger internal capacitor element (referred to as “anode”) to be used. Traditionally, for the cathode system, a metal oxide such as ruthenium oxide or a carbon cathode such as a carbon palladium system has been used. With the introduction of AVX’s new proprietary cathode system, higher energy densities can be obtained.

Basic Construction

Basic wet tantalum construction starts with the electrochemical manufacture of the capacitor element itself. Extremely fine particle size, high purity tantalum powder is pressed into a cylindrical pellet, at the same time embedding a tantalum riser wire into the center of the pellet. The pellet is then sintered, causing neighboring tantalum particles to fuse together into a continuous matrix with very high internal surface area. A tantalum pentoxide dielectric is formed over this surface by immersing the body of the pellet in acid, making electrical contact via the riser wire and applying current & voltage. So far, the process to make the formed pellet (often called the anode, as the riser wire forms the positive contact) is identical to that of solid tantalum anode construction.

The remaining stages of the process are to contact the dielectric surface with an electrolyte (which forms the negative contact) and then establish an external electrical contact layer. For solid tantalums, the formed anode is impregnated with manganese dioxide (solid electrolyte), which then has an external carbon / silver coat for external epoxy or solder contact. As the name implies, wet tantalums use a wet electrolyte system, typically sulfuric acid. To establish an external negative contact, this anode is placed into a cylindrical case which holds the electrolyte solution. The housing is typically made of either tantalum and itself becomes part of the cathode of the capacitor. To increase the effective area of the cathode, thereby increasing the capacitance, additional cathode material is set inside the case surrounding the anode of the can.

To complete the assembly of the device, an insulated mount is inserted into the case providing internal support for the anode. The anode is inserted and the electrolyte solution dispensed, then a hermetic insulated seal is applied to the top of the case allowing the positive riser to exit, and a lead attached to the other end to make the negative lead. Once this assembly is complete, the top of the case is welded providing a hermetic seal.

Background

The first wet tantalum capacitors were developed 40 years ago, and comprised a tantalum anode surrounded by an electrolyte inside a silver case with an epoxy end seal. This design was problematic in that it could be prone to leakage of the electrolyte through the epoxy seal. It also had a limited ability to withstand any reverse voltage. The silver case material was later replaced with tantalum, which proved more stable over a range of applications. The use of a tantalum case made it easier to construct a tantalum base to metal end seal that could be laser welded to the tantalum can; thus making a hermetic capacitor. This better addressed the risk of fluid leakage from the part and improved overall reliability. The process also included the use of a porous tantalum sleeve inside the case to increase the area of the cathode system.

A military specification, MIL-STD-39006, was generated to define qualification testing (based on MIL-STD-202 tests) for the various families of wet tantalum that were developed A representation of the construction is shown in Figure 1a.

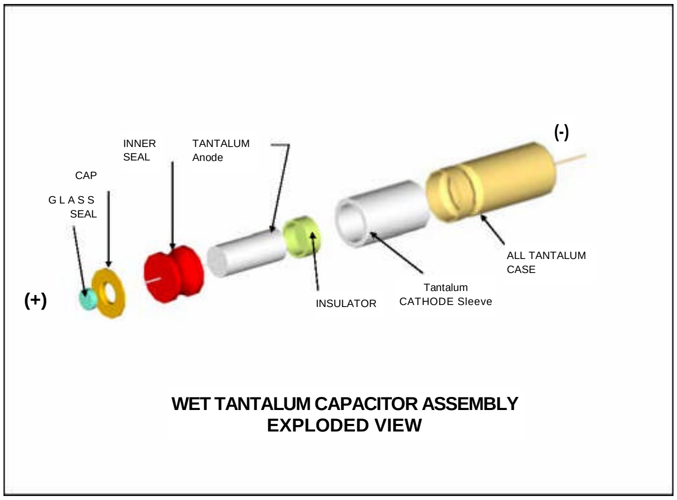

Figure 1a: Conventional Wet Tantalum Construction

Because the bulk of the capacitance attainable is strongly dependant on the area of the cathode, alternative cathode systems using metal oxides were developed which significantly increased available capacitance.
The ratings achieved with this design surpassed those available within the existing MIL-STD-39006, and a new DSCC drawing was created to define the available range – DSCC 93026.

The current TWA series wet tantalum developed by AVX has taken the expansion of the cathode system one step further. Using new proprietary cathode material, the cathode system has been sintered directly to the interior of the tantalum can. This system not only increases the area of the cathode, but also increases the internal volume available for the anode, thus significantly increasing the potential CV ratings available in any given case size. The construction is shown in Figure1b.

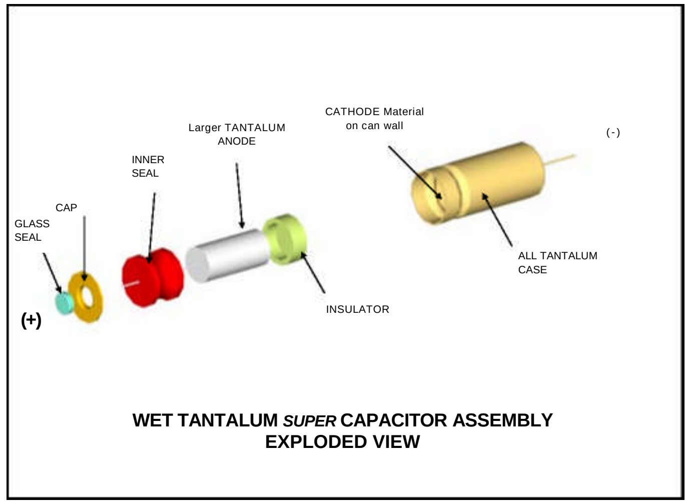

Figure 1b: AVX TWA Series Wet Tantalum Construction

Electrical Properties

The resulting system gives very high capacitance (7000 mF/cc), and there is the potential to increase capacitance (to 30,000 mF/cc) by reducing the thickness of the cathode layer.

Current voltage ratings range from 25V to 125V and only require a 20% derating below 85°C. Because the new cathode system also gives improved ESR performance, they are capable of operating under high ripple currents and are currently qualified for use up to 125°C, as well as able to withstand reverse voltages up to 1.5V.

In terms of CV ratings available, previously the largest capacitor value in the largest T4 case size at 25V was 1800uF; 2200uF is now attainable. Another example is in the 60V range where the available capacitance has almost been doubled from 560uF to 1000uF.

Reliability

The AVX TWA series wet tantalum is fully qualified to DCCC 93026, the current revision of which has been updated to include the additional ratings described above. The DSCC drawing references a number of qualification tests taken from Mil-Std-202 to establish component reliability, including but not limited to:

Seal Integrity:
Tracer gas test for nominal sensitivity of 10-8 atm3/s

Shock:
100g DC rated V applied during test

Vibration, High Frequency:
20g for 8 hours in (2) perpendicular directions

Surge Voltage:
1000 cycles @ 85°C

Life Testing:
The capacitors shall be capable of withstanding a 10,000 hour life test at 85°C at rated voltage, or a 2,000 hour life test at 125°C test at $^{2}/_{3}$ rated voltage

The new cathode system also adds extra mechanical reliability. The proprietary material mitigates oxygen migration to the can wall which can cause embrittlement. This is critical for the crimping operation.

Also the sintered cathode on the can wall, along with a larger anode, will better resist against mechanical strain during extreme vibration. Previously this may have been an issue in some space applications which may now find additional applications for the wet tantalum.

Applications

Tantalum dielectric has excellent temperature characteristics and reliability (no wear-out mechanism) and the wet electrolyte system has many advantages over solid technology – because it has a more efficient, continual self-healing mechanism, it can support higher voltage ratings (up to 125v compared to 50v maximum typical for most solid capacitors), and lower leakage current. This extends the application suitability far beyond the 28v bus. Wet tantalum capacitors are also an ideal solution specifically where size and weight are major concerns. Qualification to DSCC 93026 makes TWA series an ideal fit for commercial avionics - currently these components are widely used in avionic power & engine control (including FADEC – Full Authority Digital Engine Control applications).

From avionics to industrial applications, the most common usage is for power supply input and output filtering. The major benefit of wet tantalum is their high bulk capacitance and extended voltage range, for use in high power designs where solid tantalum capacitors are not always suitable.

Their combination of high bulk capacitance and low ESR provides high joule discharge capability, ideal for pulse power applications ranging from radar to jet engine (or ejector seat) ignition and high power burst-mode transmission.
In DC applications they can also be used for a wide range of voltage hold-up and timing applications.

There are also new application opportunities for axial modules. Wet tantalums in a modular format can help reduce required layout size, component count, component weight, and even add additional reliability. By using a module the ESR of the individual components can be matched and the unit can be tested as a whole to ensure optimum performance and reliability. Please contact the factory for custom design needs.

Summary

In conclusion, the new AVX TWA series of DSCC 93026 qualified wet tantalum capacitors has been introduced, which utilizes the intrinsic capability of a proprietary cathode system to provide a source of high CV wet tantalum capacitors. This series targets not only existing (legacy) designs, but by continual development of higher CV options, will support emerging avionic & industrial applications.