Attributes and Challenges of Polymer Electrolytic Capacitors in High Reliability Applications

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Course Summary

Tantalum electrolytic capacitors utilizing conductive polymer have nearly two decades of history in commercial applications and remain a choice of designers for a variety of applications given their many attributes. Ultra low ESR is of course the most widely known of these characteristics, but higher voltage capability and a more benign end of life mechanism are also attractive advantages. Their adoption into higher reliability applications was inevitable for these same performance benefits, but with these advantages come challenges that should be considered and well understood.

Conductive polymer is an organic material unlike traditional solid electrolyte systems, and is therefore more susceptible to degradation mechanisms, specifically moisture and oxidation. The presence of excessive moisture and/or longer-term exposure to high temperatures can result in a loss of conductivity and eventual open-circuit condition. Measures must be taken by the manufacturer to minimize the effects of these degradation mechanisms through design enhancements, but it is also the responsibility of the user to understand these limitations, especially for high reliability and safety critical systems. The recent introduction of automotive grade Polymer capacitors, which employ these design enhancements and are capable of complying with the harsh requirements of AEC-Q200, is encouraging and relevant to aerospace and defense applications.

This discussion will center on the measures undertaken to mitigate the degradation factors. These approaches vary from enhanced sealing techniques, processes and material selections, to the adoption of additional hydrophobic nanocoatings and even consideration of the polymer chemistry itself. The very structure of the capacitor as well as the selection of packaging materials are key to limiting moisture egress and oxidation under high humidity and/or prolonged high temperature operation. In addition, efforts to development a more resistant and robust polymer cathode system, which of course includes the conductive polymer itself, is paramount and must consider interactions with the dielectric, the external connecting layers, and even the lead frame materials and assembly processes.

All this is with the intention of expanding the use conditions and service lifetime of the device, but in parallel, the user should understand how to design for such a degradation potential, especially in high reliability or safety critical applications. The key is to be aware of the environmental and operating conditions, and to limit these degradation factors as much as

reasonably possible. It is especially critical to consider the end of life criteria necessary to meet the intended service lifetime and to further understand the actual usage profile, which has long been the methodology within the automotive industry. The environmental conditions of aerospace would seem ideal given the absence of moisture and oxidation effects, but an understanding of these potential degradation factors and their effects will better aid the designer to assure a long and trouble free service life.

Instructor Bio

Mitch Weaver is the Technical Manager for the Electrolytic division of AVX Corporation, Fountain Inn, SC USA. His expertise is in the area of electrolytic capacitors serving as divisional manager of Research and Development, Application Engineering, Process Engineering, and Quality Assurance for over 30yrs in the industry. He holds ten patents. He received his BSc. from Appalachian State University in 1987 in Computational Physics.