A Brief History of Volumetric Efficiency

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Development of increasingly sophisticated electronics in smaller packages continues to accelerate at a rapid pace in all industries: computers, telecom, automotive, medical, military, and space. This growth has created a demand for improvements in volumetric efficiency in capacitors that began with the transition from through-hole to surface mount technology in the mid-1990's and has continued since. While all capacitor types have had increases in their volumetric efficiencies, tantalum-based capacitors are known for their characteristically high charge density (CV/cc) properties, and their ability to store a high charge (CV) within a small form-factor is unrivaled by any other current capacitor material.

Improvements in volumetric efficiency have been propelled by advancements in anode, dielectric, cathode, and packaging efficiency. Specifically for the anode and dielectric, the use of F-Tech and simulated breakdown screening (SBDS) developed by KEMET produces a high-reliability (HRA) capacitor with "no wear-out" and less voltage de-rating required than conventional technology. With F-Tech and SBDS, an alternative exists to using commercial tantalum capacitors with 50% de-rating, which may ultimately be more expensive, less reliable, and less efficient than HRA parts with no/low de-rating, especially at higher application voltages. The development and improvements made in the polymer-based cathode brought new increases in volumetric efficiency over standard MnO_2-based tantalum capacitors. Other developments focused on the packaging and form-factor of the capacitor itself. Compared to conventional leadframe packaging, facedown termination has allowed for more space to be dedicated to the active capacitor element and thus increasing volumetric efficiencies over 100% in certain case sizes. Collectively, these improvements allow the designer greater flexibility when creating circuitry in smaller spaces. This presentation will take a brief look at the history of these developments and outline some recent advancements and upcoming technologies that aim to maximize the volumetric efficiency in applications that strive for increasing miniaturization.