Capacitance Change with Applied DC Voltage

CONCLUSION

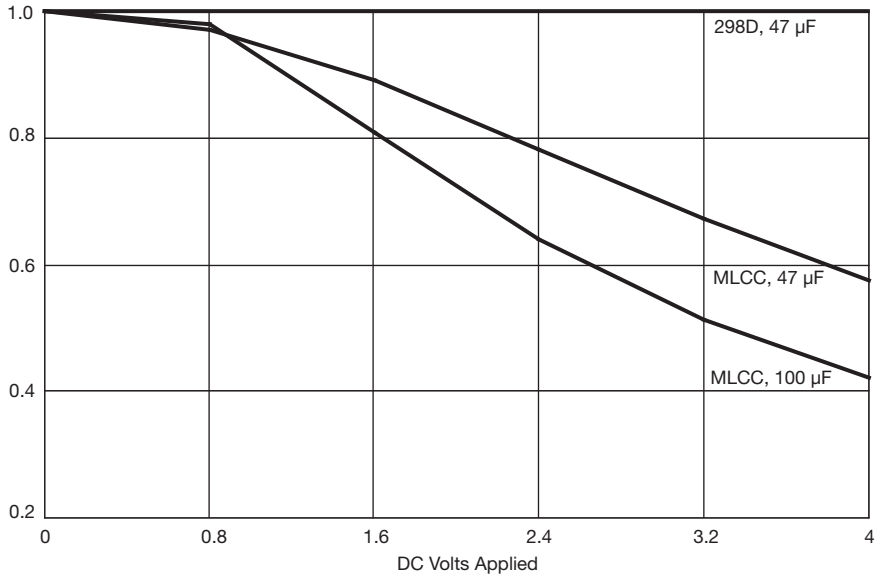
Vishay's MicroTan™ capacitor is a better choice than a multi-layer ceramic capacitor (MLCC) when a circuit's proper operation depends on stable capacitance over a range of applied voltage.

BACKGROUND

Tantalum capacitors in general - and Vishay's 298D/TR8/TM8 MicroTan tantalum capacitors in particular - demonstrate very stable performance over the DC voltage (bias) applied in an application. At the same time, the majority of capacitors utilizing ceramic or polymer dielectrics (monolithic ceramic, disc ceramic, MLCC, polyester, film, etc.) demonstrate significant shift in both directions - sometimes 40 % to 50 % or higher. Refer, for example, to:

http://www.cliftonlaboratories.com/capacitor_voltage_change.html or:
http://powerelectronics.com/passive_components_packaging_interconnects/packaging/705PET21.pdf

The major reason for such a difference is that a ceramic's dielectric constant significantly changes under applied electrical field strength variations, while the tantalum dielectric (oxide film Ta2O5) is not sensitive to such changes. The capacitance change in ceramic capacitors can also be caused by AC voltage.



Typical Voltage Coefficient of Capacitance: Tantalum 298D vs. MLCC

APPLICATION NOTE

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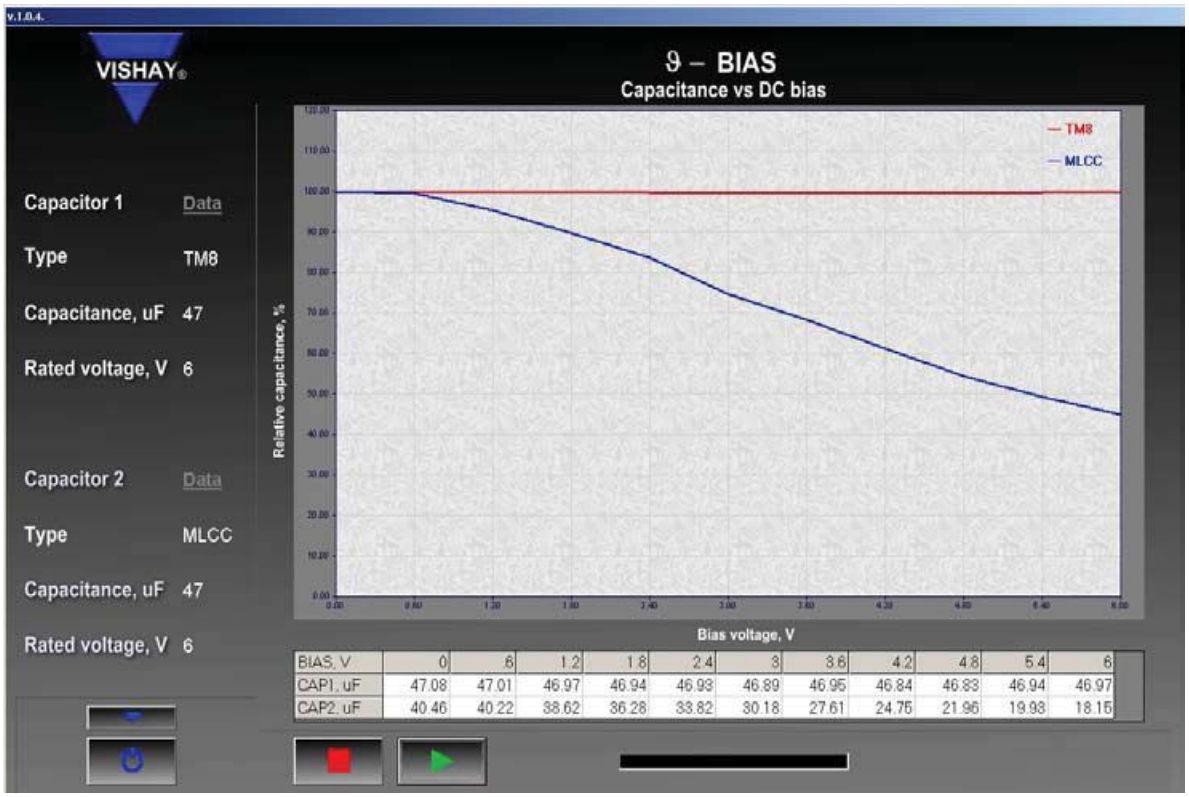
This difference in performance was demonstrated at the Electronica 2010 exhibition. Unlike the MLCC device, the tantalum capacitor maintains its rated capacitance over the entire rated voltage range.

DEMONSTRATION

In the following demonstration, side-by-side testing is conducted on an MLCC and Vishay's MicroTan tantalum capacitor. Starting at 0 V, the tester applies successively higher bias voltages and measures the effective capacitance of each component. Each measurement is normalized (calculated ratio of measured capacitance vs. initial capacitance) and the ratio is plotted against the applied voltage.



Vishay's MicroTan capacitor maintains its rated capacitance (100 % measured capacitance to initial capacitance) over the voltage range, while the capacitance of the MLCC device decreases significantly as voltage increases - down to below 50 %. As capacitance is the primary performance measure of a capacitor, designers of electronic circuits must account for this loss of capacitance in the MLCC. Therefore, Vishay's MicroTan is a better choice than an MLCC when a circuit's proper operation depends on stable capacitance.

Note

- It should be also taken into account that ceramic capacitors demonstrate some level of piezo-effect under mechanical stress. The higher the dielectric constant of the ceramic is, the higher the effect level.

APPLICATION NOTE