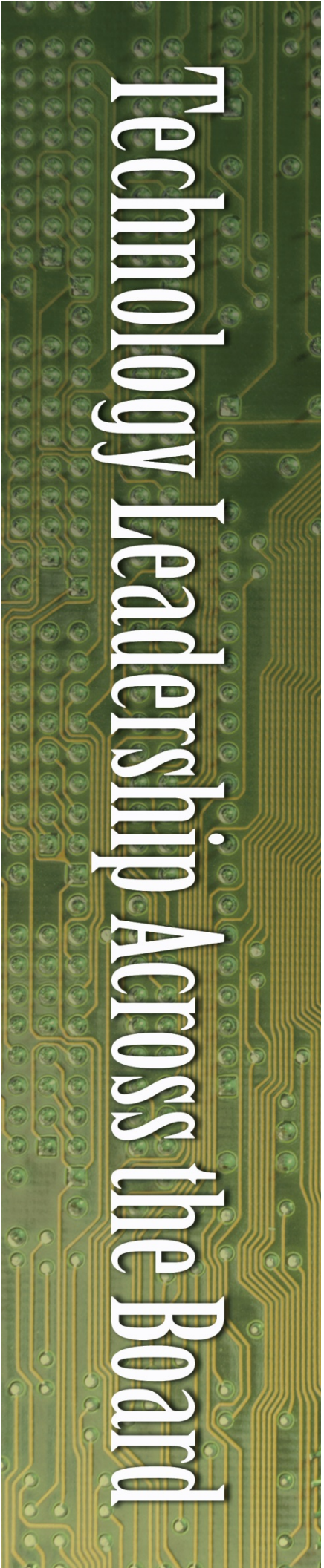

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Dielectric Absorption of Multilayer Organic (MLO™) Capacitors

Edgardo Menendez

Field Applications Engineer, AVX, 1 AVX Blvd., Fountain Inn, SC 29644, USA

Tel: 864-967-2150, e-mail: edgardo.menendez@avx.com

What is Dielectric Absorption and why is it Important?

Capacitors with Dielectric Absorption (DA) recover some of their charge even after the capacitor has been fully discharged (see Figure 1). (Ref. 2) It is expressed in percentage and it is based on the measured voltage after discharging and charge recovery divided by the maximum voltage that was originally applied (see Equation 1).

$$DA = \frac{V2}{V1} * 100\%$$

Equation 1: Dielectric Absorption Equation,
Where V1=Max Applied Voltage, V2=Voltage after Discharging

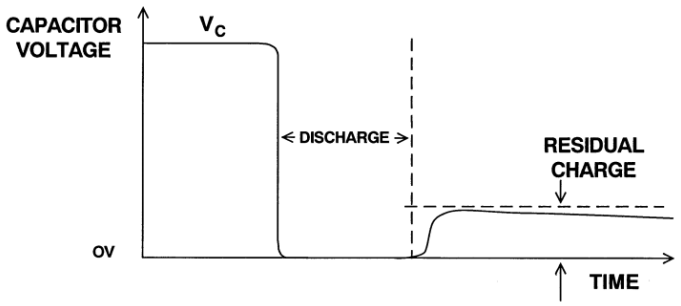

Figure 1: Dielectric Absorption
Source: Ref 2.

Dielectric absorption differs for a variety of dielectric materials. Generally, dielectrics with low permittivity tend to have a lower DA than those with a higher permittivity constant.

Dielectric absorption poses a problem in sample/hold circuits. During the hold time of the S/H circuit the voltage across the capacitor is assumed to be a specified predetermined number. Because of dielectric absorption this may not be the case. Depending on the length of the hold period, as the capacitor is left in open mode, it will recover some of its charge causing a voltage error to appear at V_{out} of the S/H circuit. (Ref. 1) This is where capacitor selection should be considered carefully as some capacitors will exhibit higher dielectric absorption than others (see Table 1).

MLO™ capacitors have been shown to exhibit the lowest dielectric absorption with 0.0015% versus other technologies like NP0 ceramics who's DA can be as high as 0.6%.

Measurement Techniques – MIL-C 19778

Dielectric absorption measurements were performed on MLO capacitors under the test set up shown in figure 1. The test was based on MIL- C 19778. The conditions for the test were as follows: a 2"x2" laminate which serves as the core of the MLO device was charged for 1 hour charging at 250V and discharged using a 5ohm resistor. The thickness of the dielectric core is 25um. The voltage across the capacitor was measured 15 minutes after discharging the resistor.

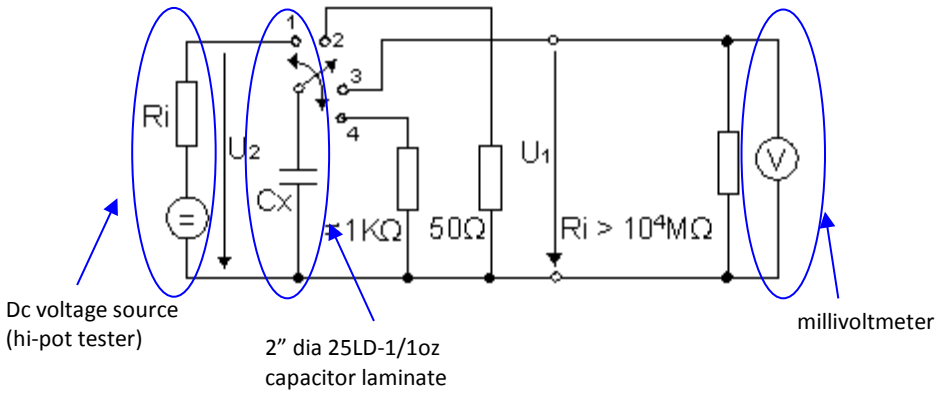

Figure 2: Source from http://www.wima.com/EN/absorption.htm

For a 5 ohm resistance we measure a dielectric absorption of 0.0015% for the MLO dielectric. (Testing was performed by Oak-Mitsui.)

Comparison between MLO™, ceramic dielectric, and glass dielectric shows that MLO exhibits the lowest dielectric absorption (see Table 1).

Dielectric Material	Dielectric Absorption (%)
MLO ™	0.0015%
NP0 Ceramic	0.6%
Stable	2.5%
High K Ceramic	N.A.
Ceramic Discs	Same as Multilayers
Internal Barrier Layer	N.A.
Reduced Titanates	N.A.
Multi-Layer Glass	0.05%
"T" Characteristic	0.1%
"U" Characteristics	0.1%
"V" Characteristics	1.3%
Teflon	<0.01%
Mica	0.3% - 0.7%
Polyester	0.5%
Poly-Carbonate	0.35%
Poly-Propylene	0.05%
Polystyrene	0.05%
Solid Tantalums	N.A.
Aluminum Electrolytics	N.A.

Table 1: Dielectric Absorption Comparison
Chart by Dielectric

The MLO™ Material System

MLO™ materials are thin, low loss, organic dielectrics with low permittivity that exhibit exceptional high frequency characteristics. The MLO technology utilizes large area fabrication techniques and unique lumped element design topologies to achieve high Q, low loss RF components, including capacitors, inductors, diplexers, couplers and crossovers, among others. A unique alternative to traditional fired components, such as LTCC and ceramics, the MLO material system provides stable, low loss performance from DC well into microwave frequencies.

In addition to low loss operation across a wide frequency range, MLO components have numerous physical advantages. A non-fired technology, MLO materials provide several design, manufacturing, and processing advantages over traditional LTCC and ceramic solutions. For example, MLO devices, which can be made as thin as 0.45mm, are typically thinner and lighter than competing technologies. Additionally, due to its material performance and ability to create heat pipes using a variety of via structures, MLO technology exhibits superior thermal performance when compared with competing technologies, as well as features a coefficient of thermal expansion that is matched to most FR4 circuit boards (CTE approximately 16 to 18 ppm/^{o}C). Consisting of one or more RF dielectric layers embedded between layers of other laminates, MLO components also shield internal electrodes and traces and provide routing and bonding pads for SMT placement. Moreover MLO materials allow for only the most minimal moisture uptake, typically <0.04%.

Summary

Capacitors with dielectric absorption recover their charge after being completely discharged. Dielectric absorption can vary from 0.001% to more than 10%, with low K dielectrics exhibiting the lowest DA. MLO™ capacitors have been shown to exhibit exceptionally low DA of about 0.0015%, making them highly suitable for sample and hold circuits, where DA can cause errors at the output.

References:

1. Pease, R. A. “Understanding Capacitor Soakage to Optimize Analog Systems,” EDN, October 13, 1982, p.125
2. Analog Circuits, “MT-090 Tutorial: Sample and Hold Amplifiers”, http://www.analog.com/static/imported-files/tutorials/MT-090.pdf, p.10