HVArc Guard® Surface-Mount Capacitors for Low-Power Voltage Multiplier Applications

By Steve Vonick

Voltage multipliers can generate very high voltages due to an inverter circuit that feeds a step-up transformer, which is connected to the multiplier circuit. An example of a typical voltage multiplier, which is simply a circuit comprised of capacitors and diodes that charge and discharge in alternating half cycles of the applied AC voltage, is shown in the diagram below.

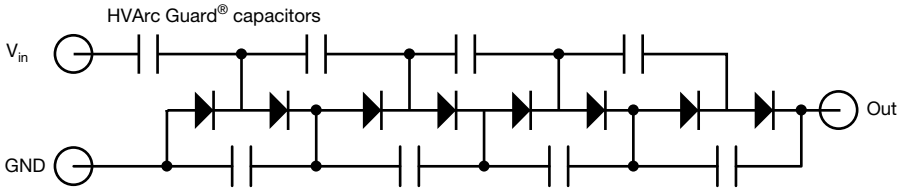


Fig. 1 - Series multiplier for HV applications

Cascading voltage doubler cells, as shown in the circuit, result in a high-voltage output. Applications for voltage multipliers include flyback converters, where a high voltage is produced from a low battery or supply voltage in medical X-ray systems, air ionizers, and oscilloscopes, and instrumentation requiring a high-voltage power supply.

SURFACE ARC-OVER PROBLEMS IN HIGH-VOLTAGE APPLICATIONS

When a high voltage potential is applied at > 1000 V, the risk of an arc-over between the capacitor terminals increases. To eliminate any arc-over, an overcoating can be applied to the board, or additional board layout spacing can be added to isolate the high-voltage section from other sections of the board. Although coatings add cost to the process and the design, they are required in some applications to meet electrical safety standards.

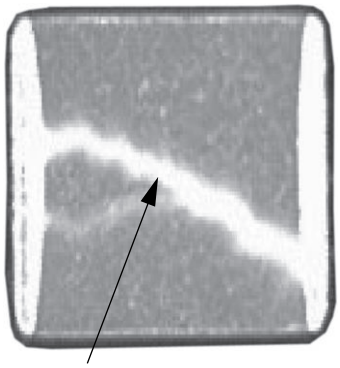


Fig. 2 - Standard high voltage MLCC with voltage applied causing surface arc-over between terminations

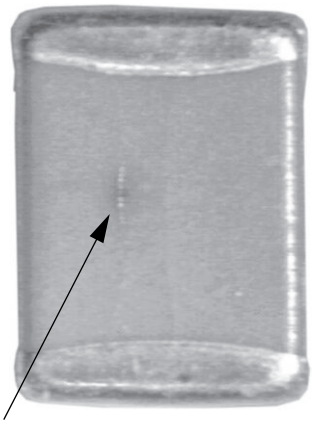


Fig. 3 - Standard high voltage MLCC surface typical arc-over failure site

APPLICATION NOTE

HVArc Guard® Surface-Mount Capacitors for Low-Power Voltage Multiplier Applications

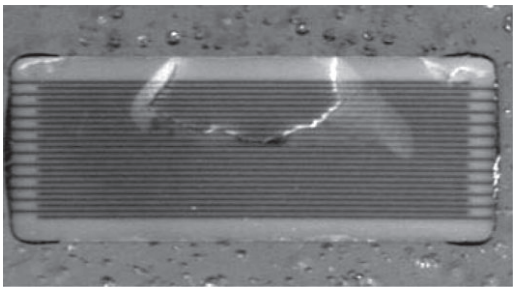


Fig. 4 - Example of typical surface arc-over failure site in an 1812-case-size X7R, 100 nF, 500 V_{DC} rated MLCC and a post-test cross section showing surface cracking

To avoid having to overcoat the components, coated disk capacitors or conformal coated leaded through-hole capacitors are commonly used in voltage multiplier sections, but they take up a large amount of board space.

HVArc Guard surface-mount capacitors offer designers a space-saving alternative. Because of their special worldwide-patented internal construction technology, Vishay's HVArc Guard surface-mount capacitors eliminate the need to conformal coat the part or over-coat the circuit board to prevent surface arc-over. In addition, HVArc Guard surface-mount capacitors offer cost savings by eliminating the costly manual insertion processes associated with through-hole devices.

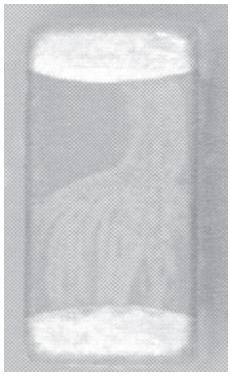


Fig. 5 - Carbon traces from surface arc-over on a typical standard high voltage MLCC

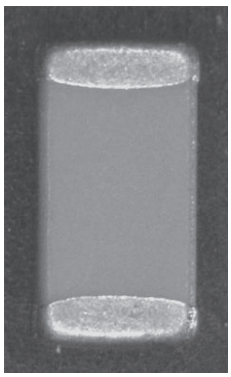


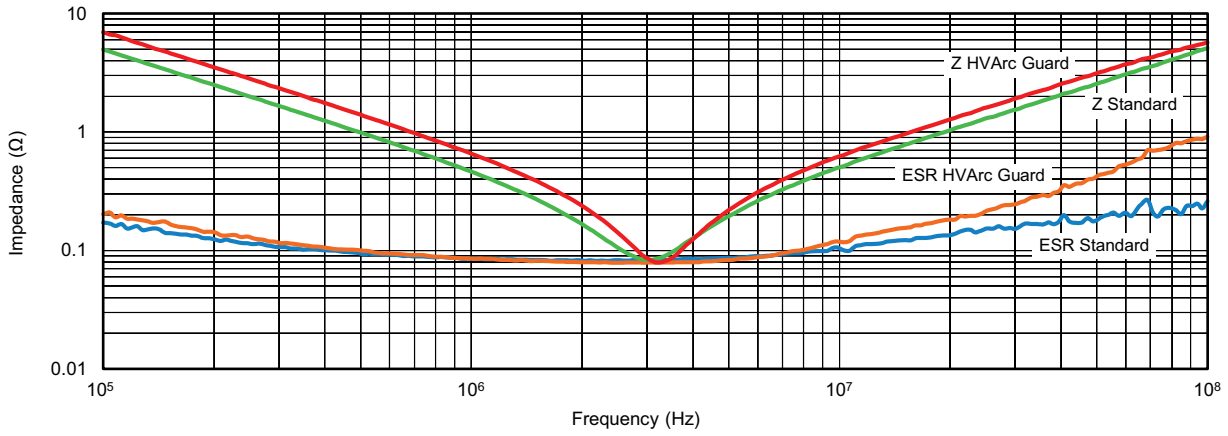
Fig. 6 - Vishay HVArc Guard without surface arc-over

IMPEDANCE OF HVArc Guard SURFACE-MOUNT CAPACITORS FOR VOLTAGE MULTIPLIER APPLICATIONS

The basic voltage multiplier is termed capacitive since the circuit can hold and store a charge. By series-connecting HVArc Guard surface-mount capacitors, low-power voltage multipliers can be designed so that the output voltage increases as the number of cascaded stages increases.

When selecting an HVArc Guard surface-mount component, careful attention must be paid to the voltage breakdown characteristics.

HVArc Guard® Surface-Mount Capacitors for Low-Power Voltage Multiplier Applications



The graph above compares the impedance vs. frequency, ESR, and impedance of a standard commercial 500 V, X7R capacitor in the 1206 case and an HVArc Guard surface-mount capacitor with the same ratings. As demonstrated in the graph, the impedance of the HVArc Guard is similar to standard high-voltage surface-mount capacitors.

Specific details regarding the impedance of specific HVArc Guard surface-mount capacitors are available upon request through your local Vishay sales office.

HVArc Guard SURFACE-MOUNT CAPACITORS ORDERING INFORMATION

HVArc Guard surface-mount capacitors are available in both NP0 and X7R dielectrics, and in a variety of popular surface-mount EIA-standard case sizes.

HVArc Guard Ordering Code

ORDERING INFORMATION (4)

VJ0805	A	101	J	X	G	A	T	5Z (2)
CASE CODE	DIELECTRIC	CAPACITANCE NOMINAL CODE	CAPACITANCE TOLERANCE	TERMINATION (5)	DC VOLTAGE RATING (1)	MARKING	PACKAGING	PROCESS CODE
0805 1206 1210 1808 1812 2220 2225	A = C0G (NP0) Y = X7R	Expressed in picofarads (pF). The first two digits are significant, the third is a multiplier. **Examples** 102 = 1000 pF 223 = 22 000 pF	J = ± 5 % K = ± 10 % M = ± 20 %	X = Ni barrier 100 % matte tin plate finish F, E = AgPd (3) B = polymer 100 % matte tin plate finish (4)	P = 250 V E = 500 V L = 630 V G = 1000 V R = 1500 V O = 2500 V	A = unmarked	T = 7" reel / plastic tape R = 11 1/4" / 13" reel / plastic tape	5Z = HVArc Guard®

Notes

(1) DC voltage rating should not be exceeded in application. Other application factors may affect the MLCC performance. Consult for questions: mlcc@vishay.com

(2) Process code has to be added

(3) Termination code “E” is for conductive epoxy assembly, contact mlcc@vishay.com for availability

(4) Please contact factory for polymer termination availability

(5) Other termination options contact mlcc@vishay.com for availability

APPLICATION NOTE