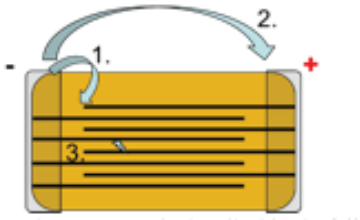
Arc Resistant High Voltage X7R MLCC

by Dr. John Bultitude

The last few years has seen a significant advancement in the design of high voltage X7R MLCC with higher capacitance that are resistant to arcing. The purpose of this paper is to explain how these work and their benefits. To do this we must first consider the different failure modes that can occur in X7R MLCC above 200V:

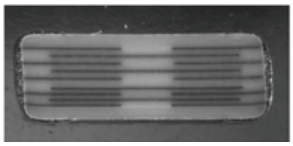


Failure Modes in High Voltage X7R

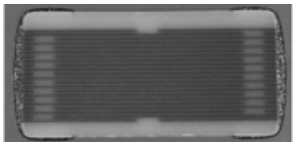
These failure modes and actions to prevent the occurrence is described in the following table:

Mode	Failure Description	Lowest Inception Voltage	Prevention Actions
1	Terminal Arc to First Internal Electrode	250 V	Use Shield Electrodes
2	Terminal to Terminal Arc	1200 V	Increase Separation
3	Breakdown of Active Dielectric Between Internal Electrodes	Dependent on dielectric withstanding voltage	Increase Active Thickness

Using the prevention actions noted in this table KEMET developed a range of 500 through 1000V rated X7R MLCC. Prior to this development high voltage X7R MLCC were designed as 2 capacitors in series. The serial MLCC is compared to the shield MLCC for 1206 case size 1000V ratings:



1206, 1000pF, Serial



1206, 22000pF, Shield

In the 1000pF there are 2 capacitors (N) in series so the acting voltage on each capacitor is reduced by the reciprocal of the number of capacitors (1/N) = ½ in this case but the Effective Capacitance (CEff) is also reduced:

$$\frac{1}{C_{Eff}} = \sum \frac{1}{C_n}$$

So to achieve the 1000pF value each of the 2 capacitors in series are 2000pF.

The 22,000pF shield MLCC has a much larger overlap with no reduction in effective capacitance so higher capacitance can be realized whilst retaining high voltage breakdown. Shield designs facilitate further miniaturization of MLCC since higher capacitance can be achieved in a similar volume. Furthermore shield MLCC so do not require coating in the assembled circuit to prevent arcing.

For more information on this product go to http://www.kemet.com/arcshield or scan the QR code: