Electronic Components
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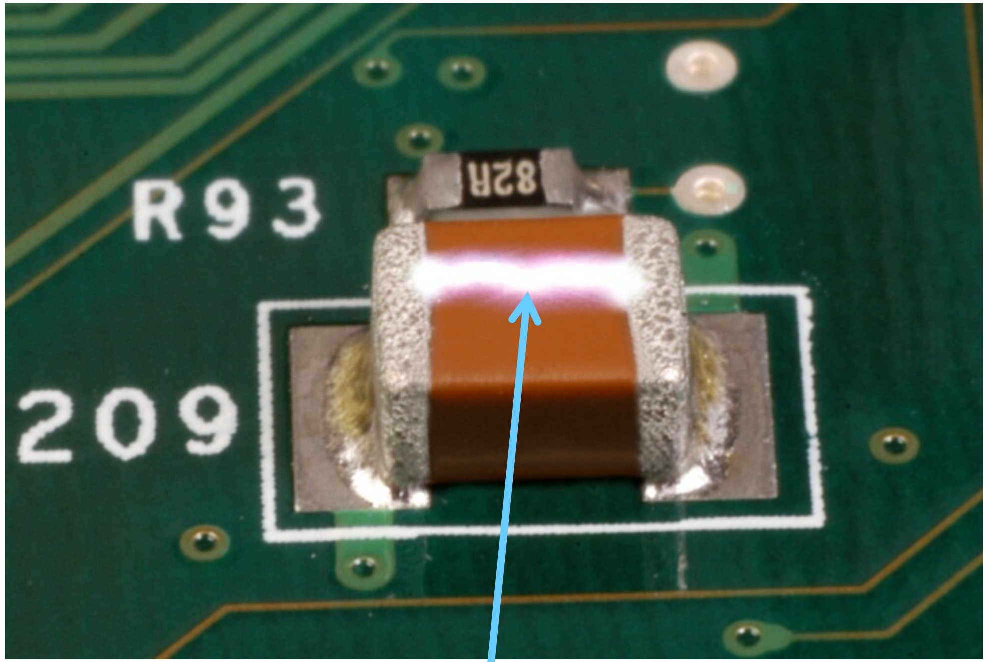
High Voltage Ceramic Capacitors (HV MLCCs)

Design and Characteristics

The Big Issue With MLCCs and HV

Destructive Surface Arcing



Surface arcing between termination surfaces on an MLCC, also known as “arc-over discharge, “flash over” or “corona discharge”.

Surface Arcing Between MLCC Termination and the Internal Electrode Structure

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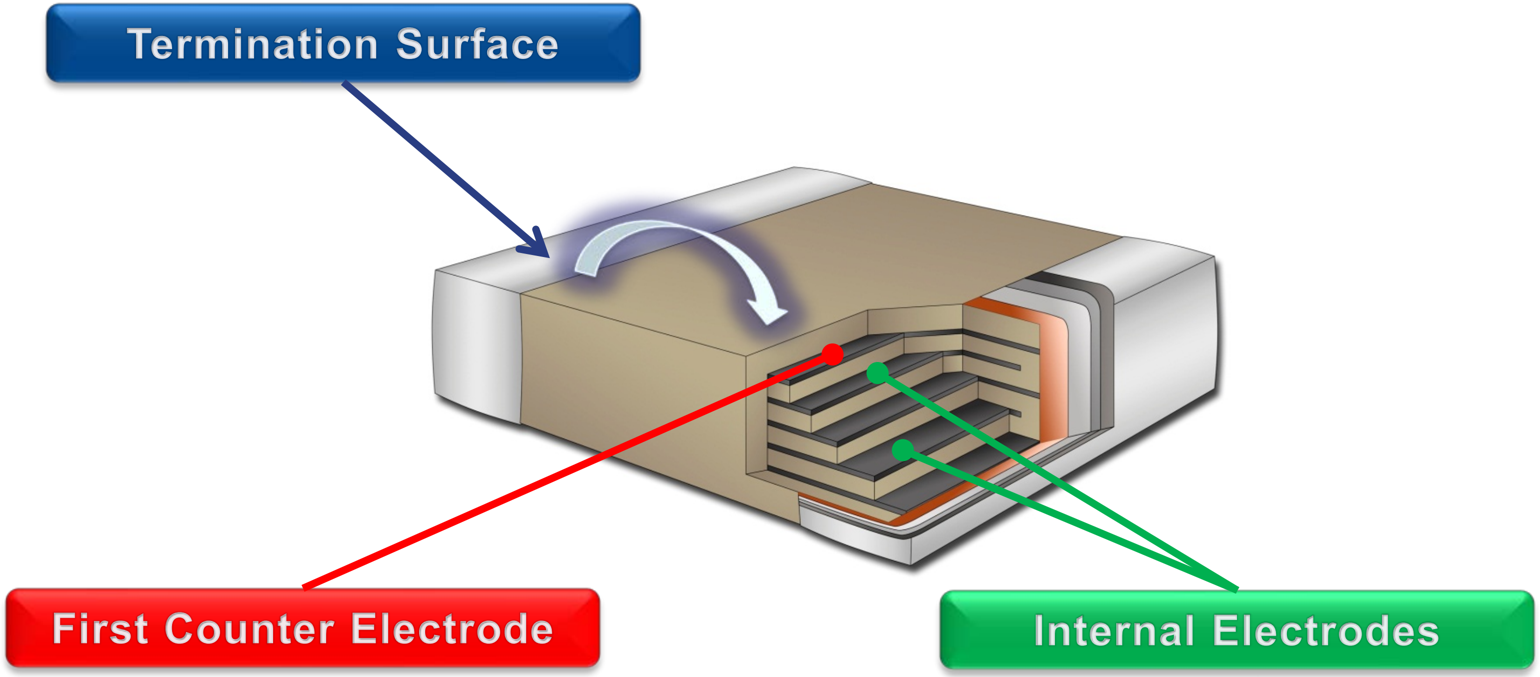
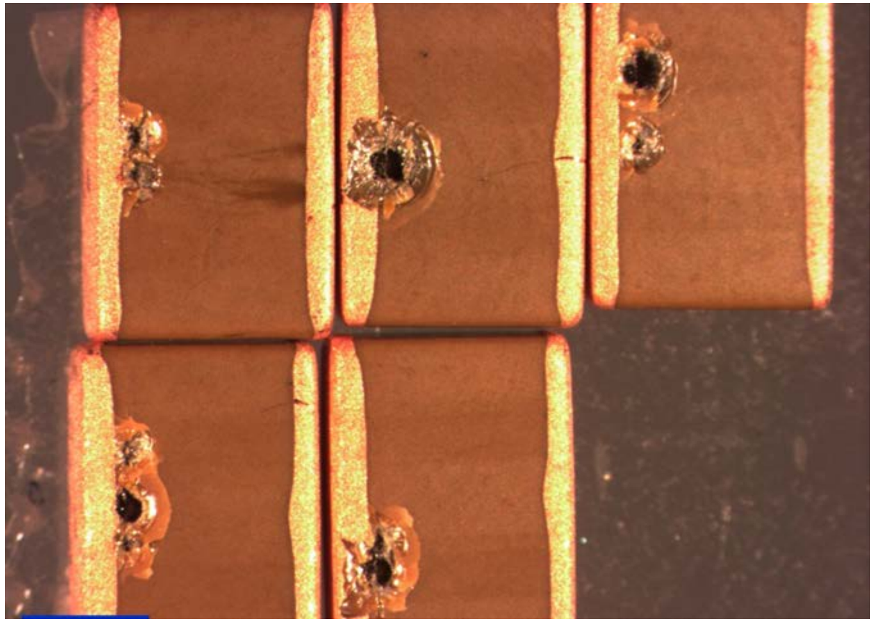


Surface Arcing Failure Modes

Terminal-to-Terminal Arcing

Terminal-to-Active Arcing



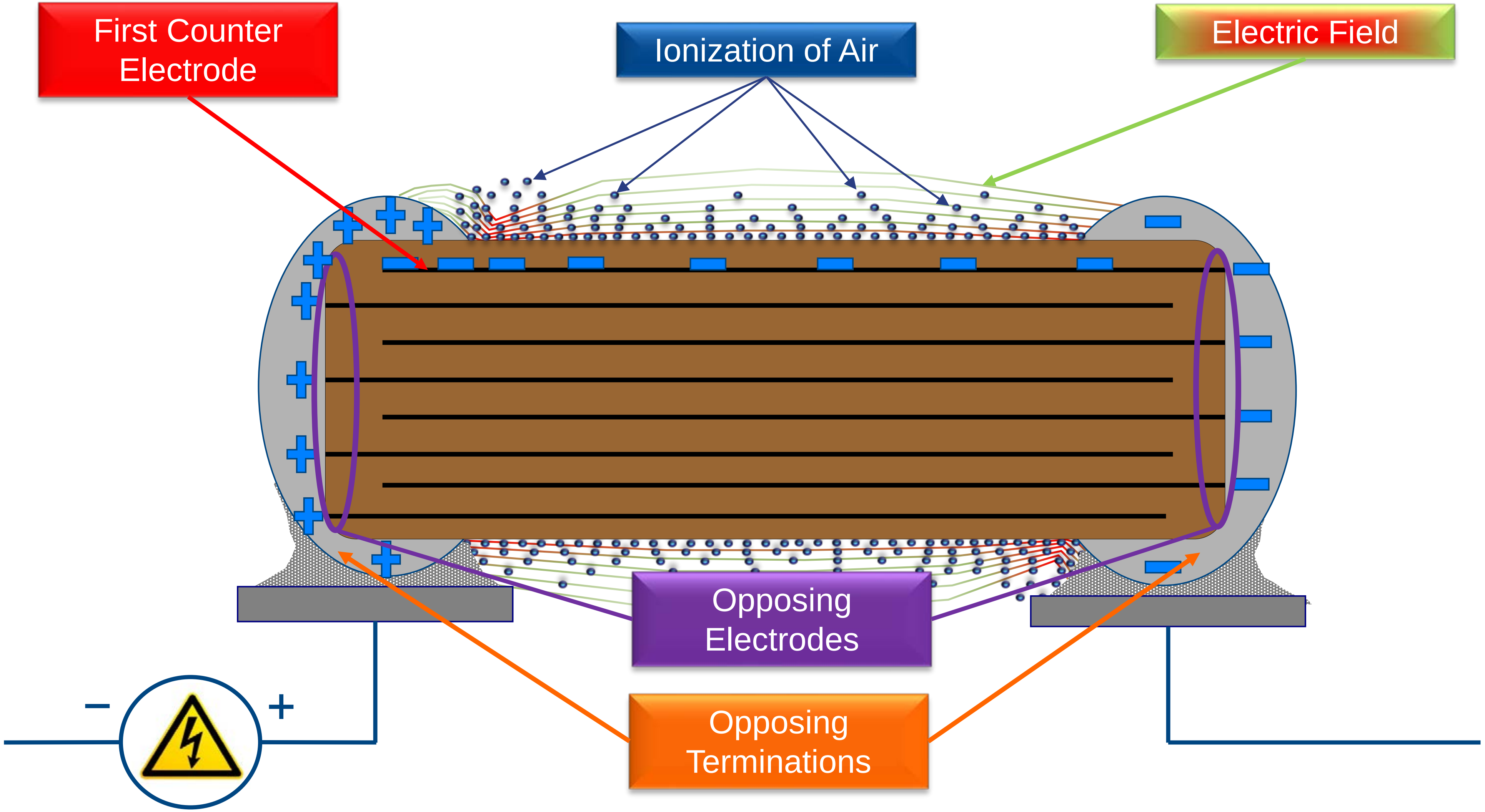
Carbon Traces

Voltage Breakdown Failures

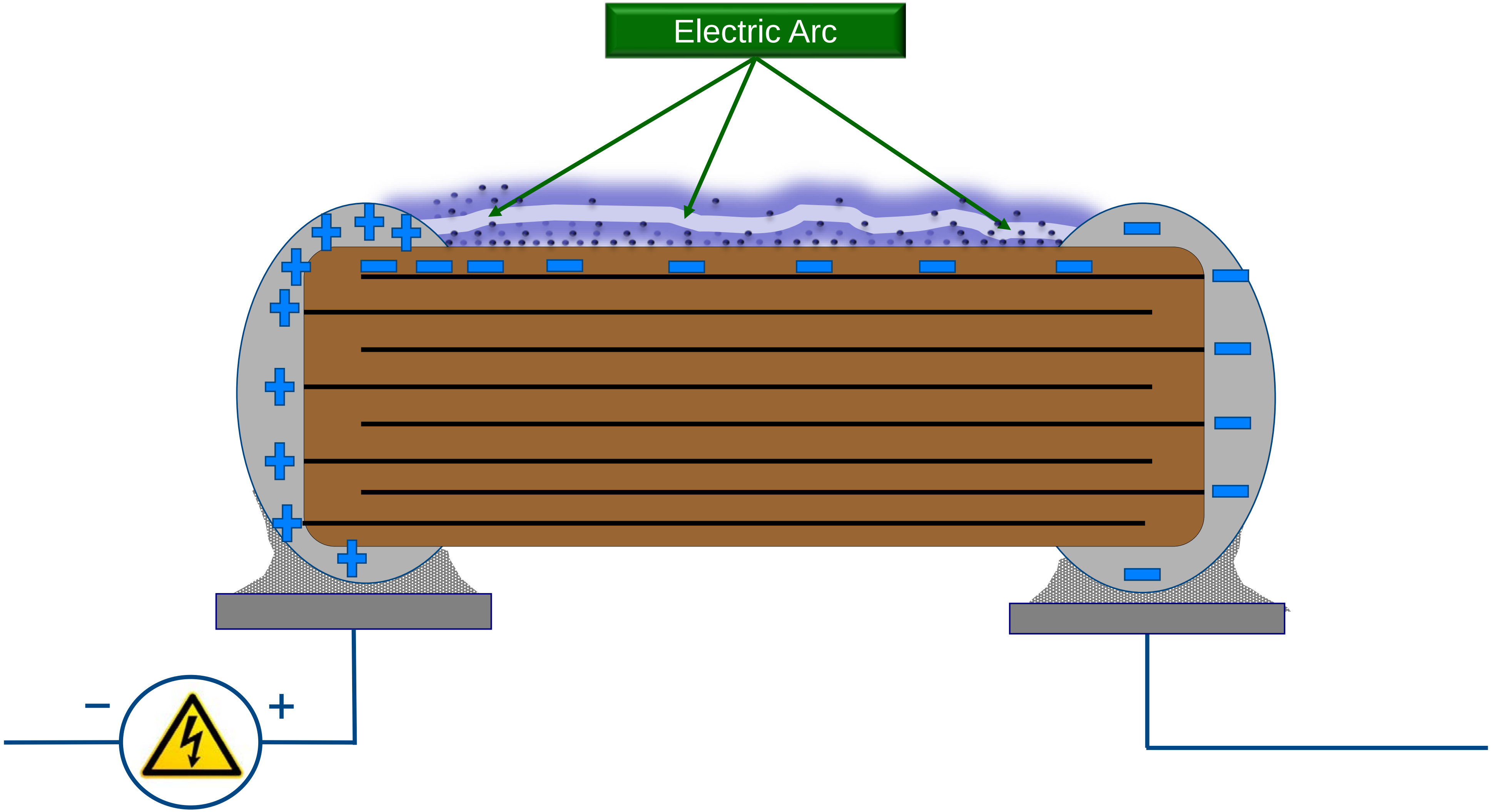
Solutions for MLCC Surface Arcing

- Surface Coatings
  - Reduce ionization of air at MLCC surface
    - Adds process step
    - Critical that there is no damage to or air gap under the coating
- Serial Electrode Designs
  - Reduce electric field strength
    - Available capacitance in an MLCC package size is lowered
    - Allows for higher voltage capability
    - Reduces the probability of MLCC failure due to flex crack
- ArcShield Designs
  - Reduce electric field strength
  - Reduce ionization of air at MLCC surface
  - Maximizes available capacitance in an MLCC package size

The Phenomenon of Surface Arcing



The Phenomenon of Surface Arcing



External Solution:
Surface Coatings

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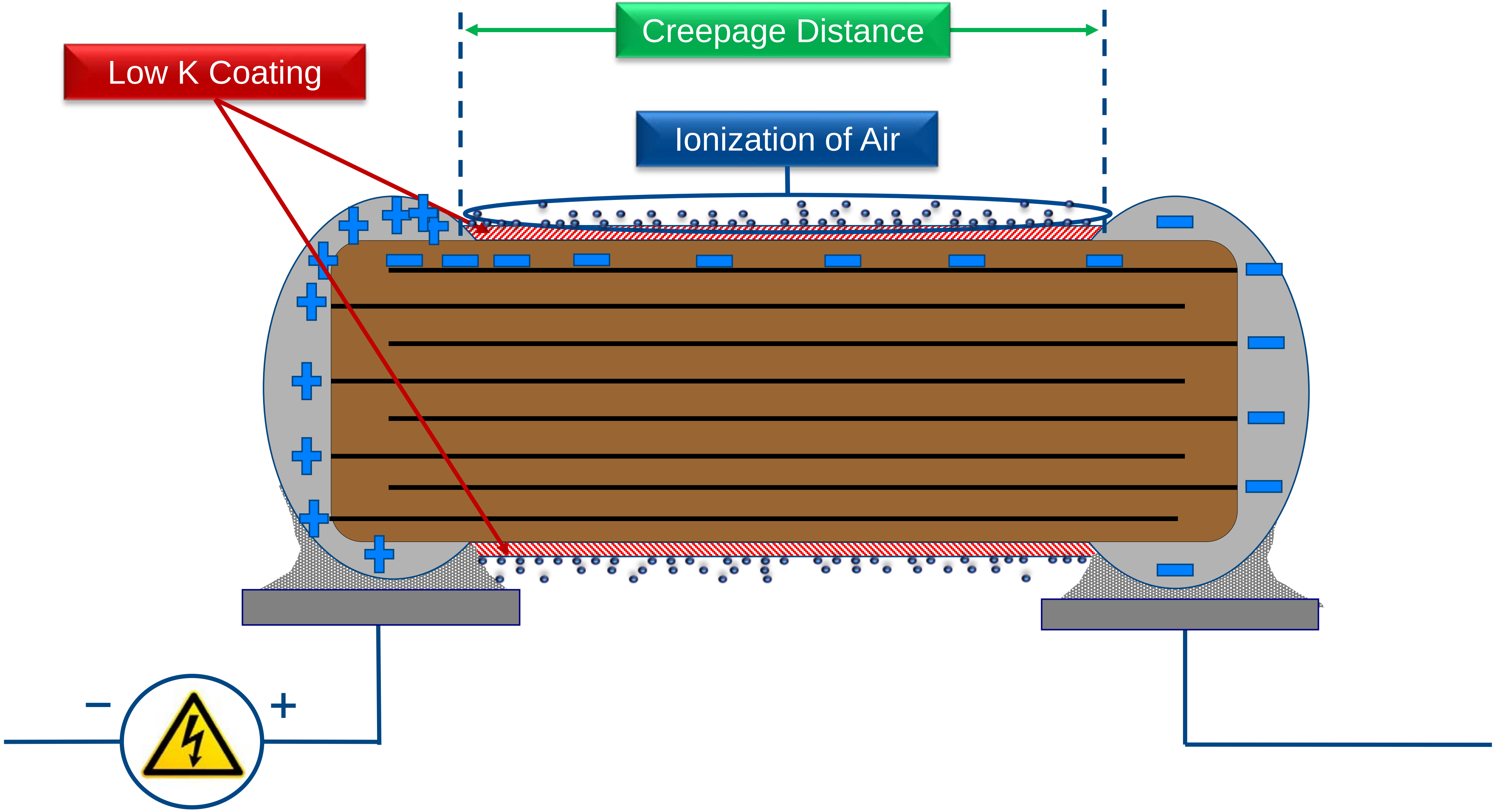
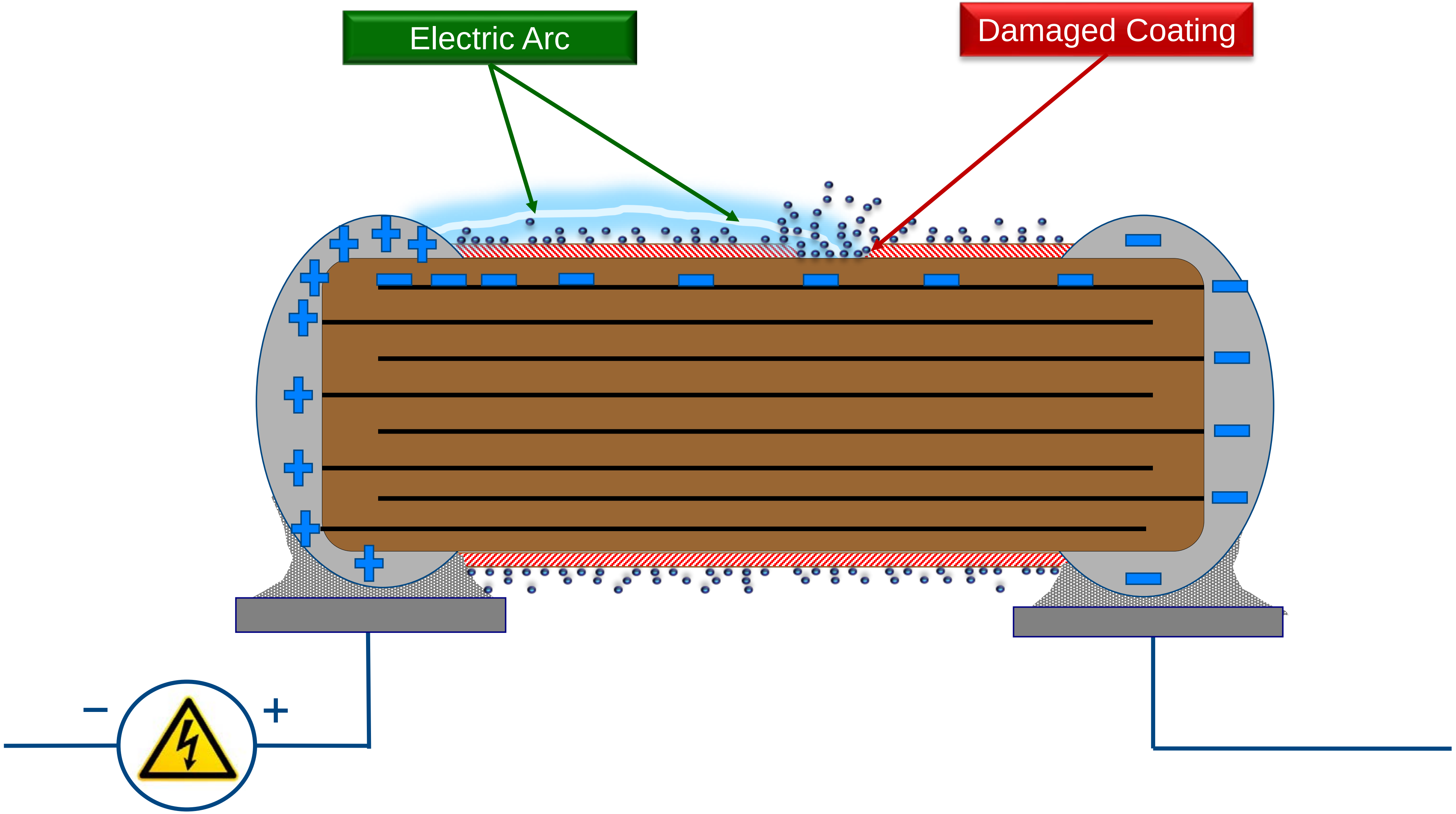


Issues With Coating Technologies



Internal Solution:
Floating Electrode Design

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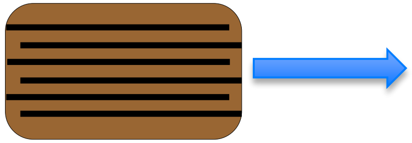
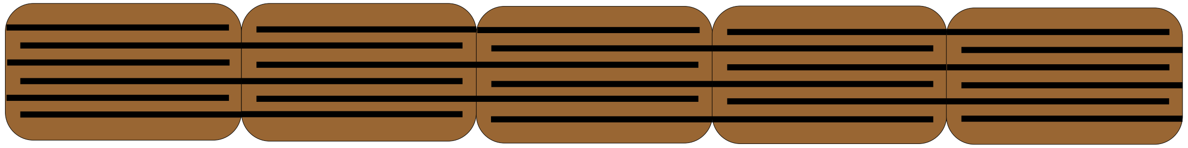
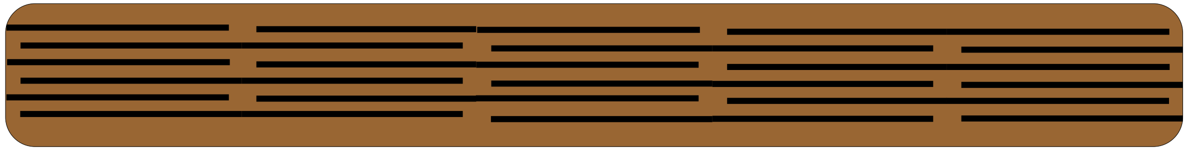


Capacitor of 1000nF and 1000V capability.



5 capacitors in series each of 1000nF and 1000V has 5000V capability and has the same total electric field as the single 1000nF capacitor. Total capacitance is 200nF.

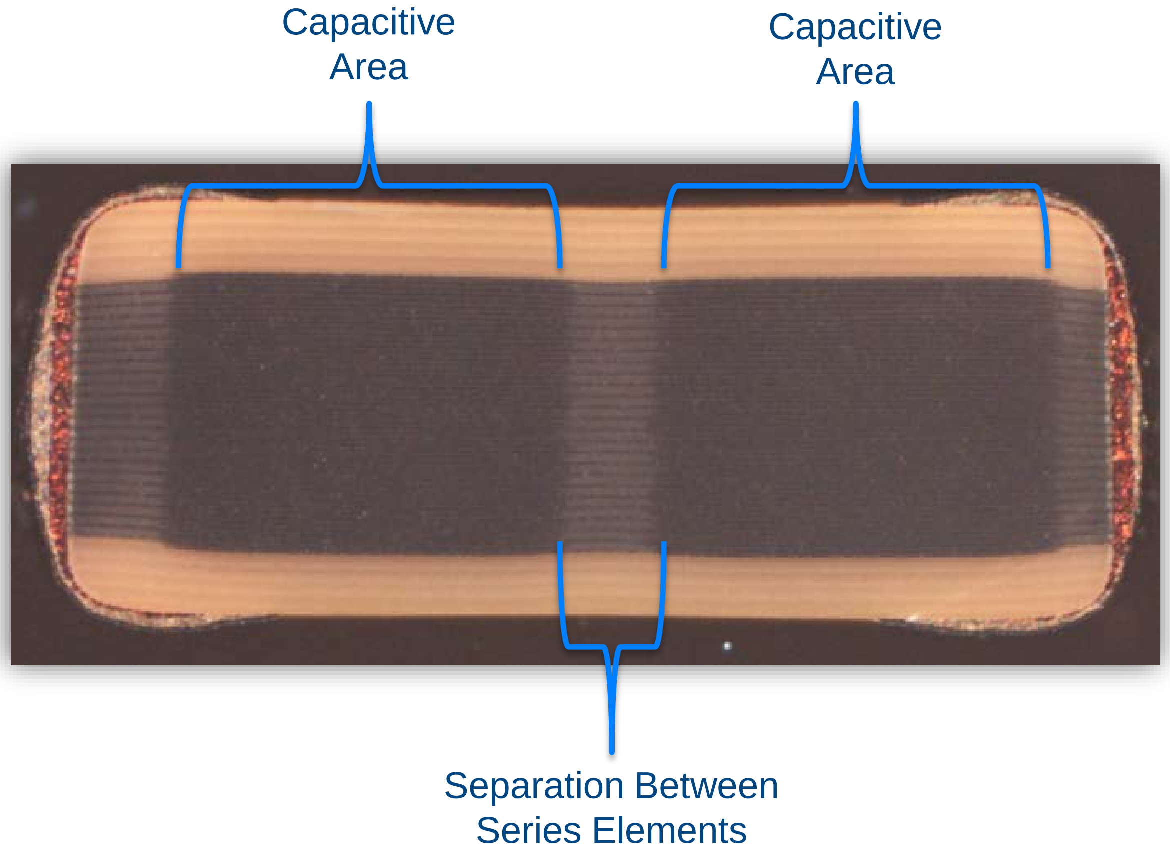


The entire block of capacitors can be placed into a single monolithic structure with the same characteristics as all 5 in series. Note where the term “Floating Electrode” comes from.

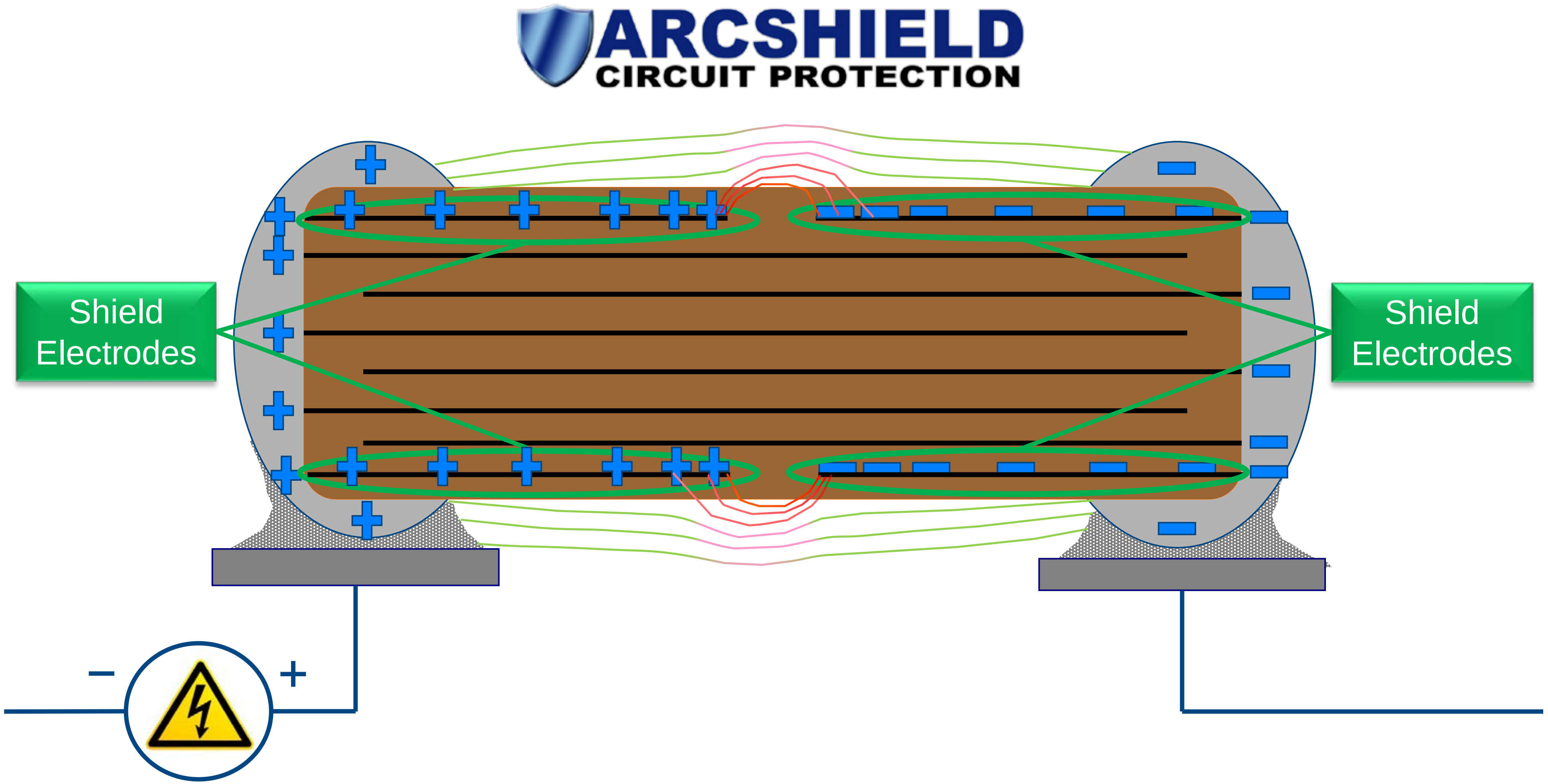
Serial Electrode Design

High-Voltage Ceramic

Also known as “Floating Electrode” or “Cascade Electrode” designs



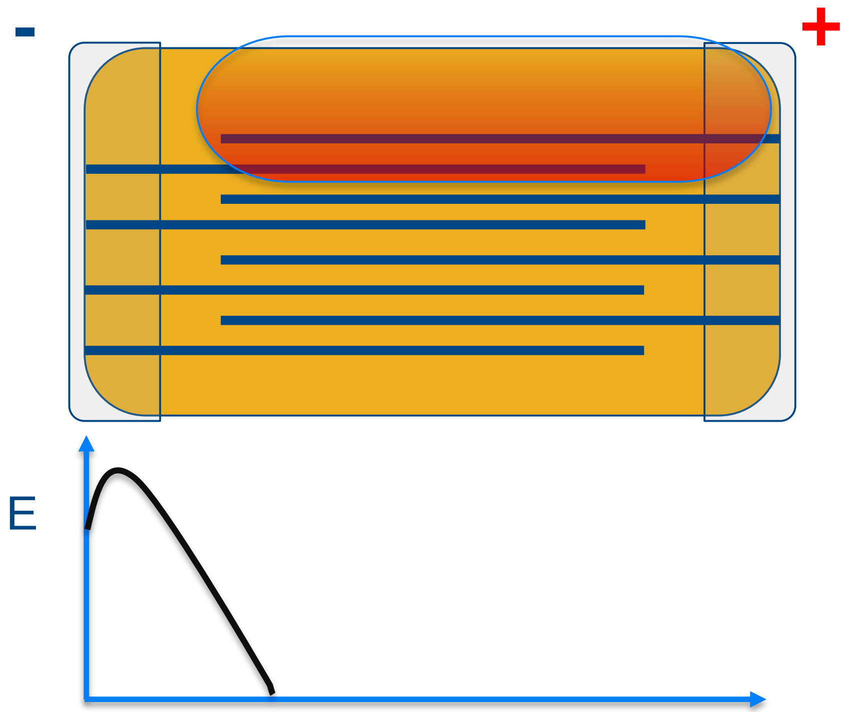
KEMET ArcShield Technology



Explanation of Shield Design
Reduction of Electric Field

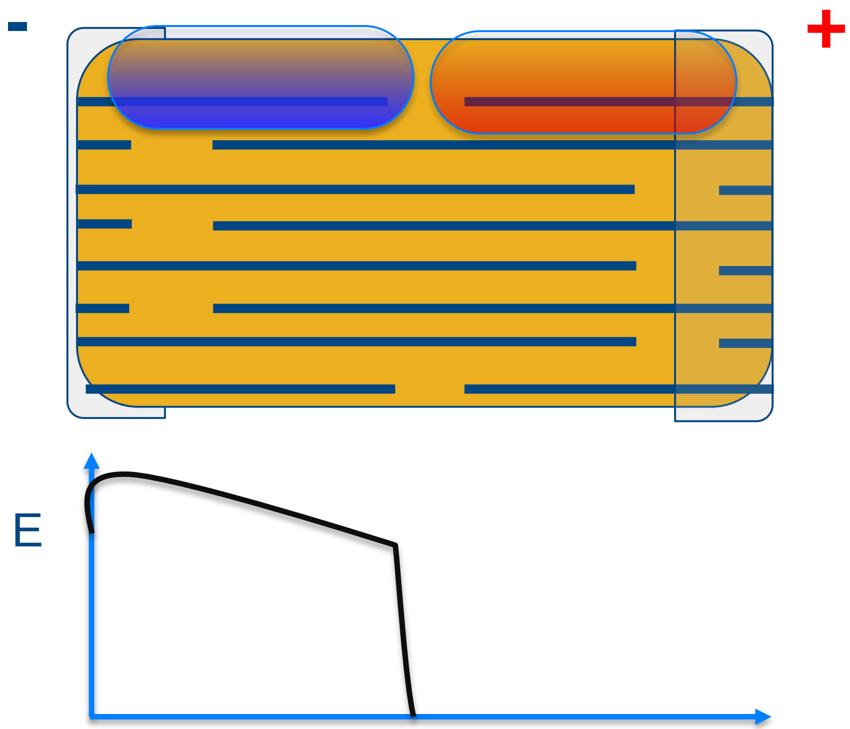
Terminal-to-Terminal Arcing
Standard Design

- Opposite Field extends close to terminal of opposed polarity so low energy barrier



Terminal-to-Terminal Arcing
ArcShield Design

- Opposite Field is longer distance from terminal of opposed polarity increasing size of energy barrier



Explanation of Shield Design

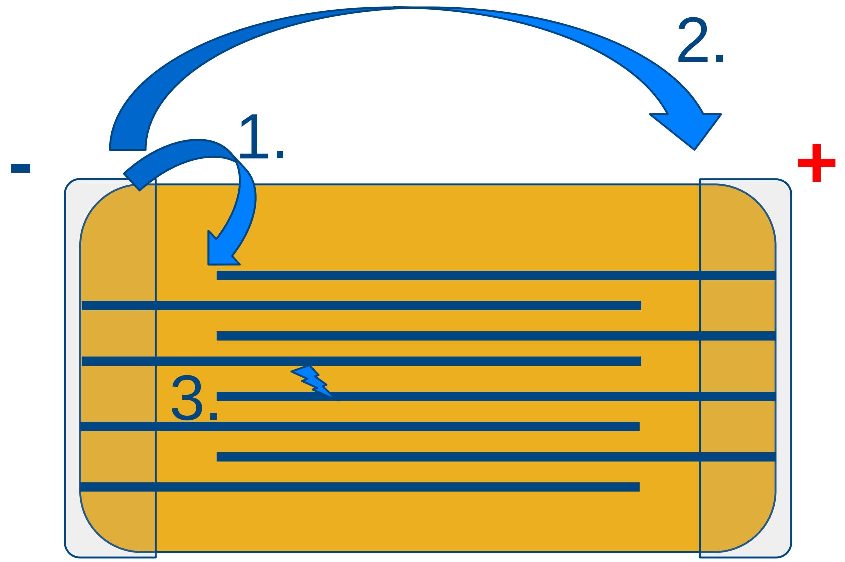
Designed for Higher Voltage

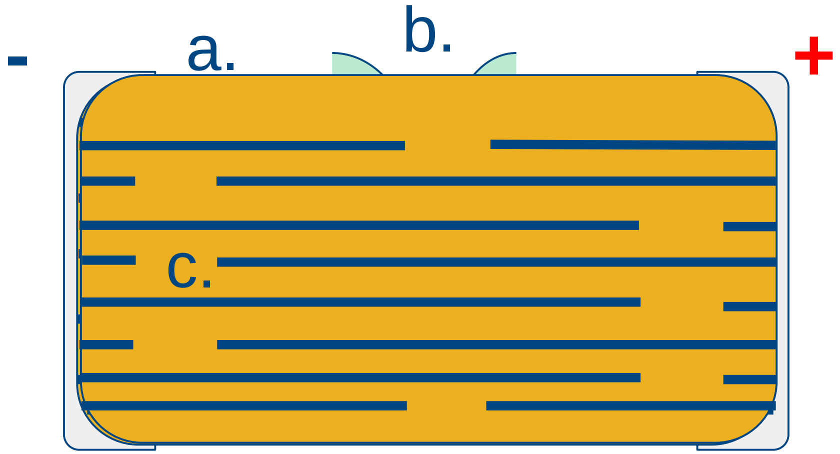
Consider a Standard Design

- In a standard overlap X7R MLCC there are 3 ways of failing high voltage:
  1. Arcing between terminal and 1st electrode of opposite polarity
  2. Arcing between terminals
  3. Internal breakdown

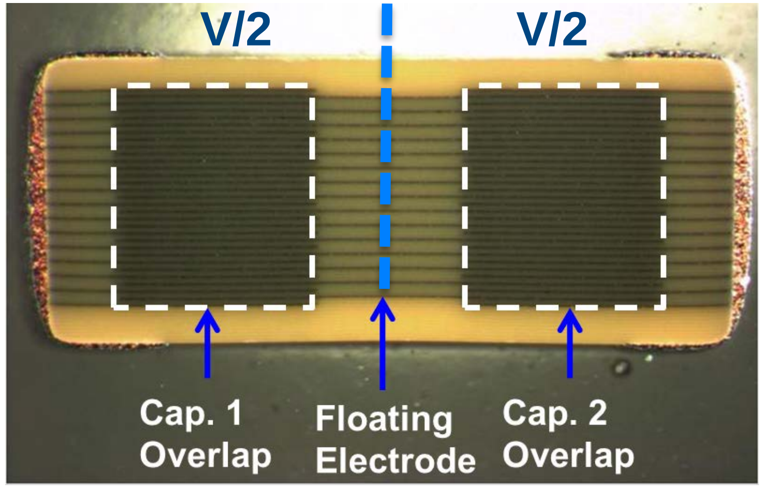
Shield designs solve these voltage breakdown issues by:

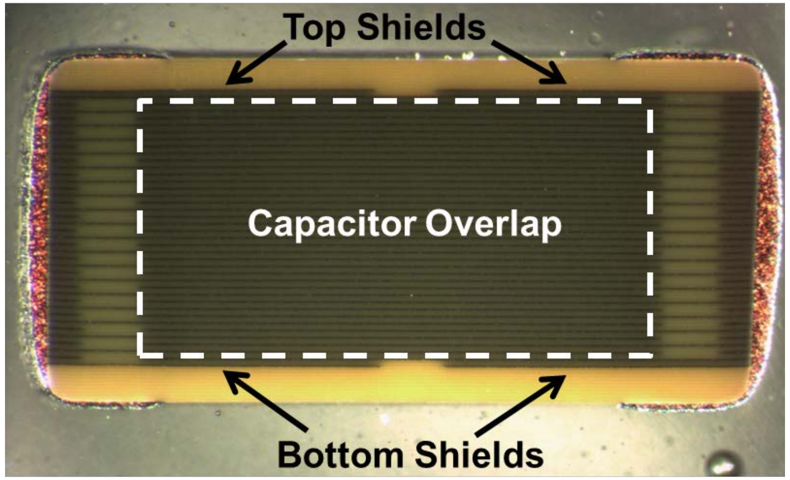
  a. Adding a shield to prevent 1.
  b. The shield also creates a barrier to 2.
  c. Thicker actives for higher breakdown 3.





“Serial” to “Shield” Design Comparison





“Serial” Design

- With capacitors (N) in series, the acting voltage on each capacitor is reduced by the reciprocal of the number of capacitors (1/N).
- Effective Capacitance is reduced:

$$1/C_{Eff} = \Sigma 1/C_N$$

“Shield” Design

- Larger electrode area overlap **A** so higher capacitance while retaining high voltage breakdown.
- Thickness **t** between opposing electrodes increased:

$$C = \epsilon \epsilon_0 An/t$$

KEMET ArcShield Technology

Summary

- Permanent protection against arc-over discharge without the need of a protective coating.

- Eliminates need for material qualification and process validation associated with coating technologies.

- Eliminates the need for expensive post assembly coating of PCBs. (Except when necessary to meet specific electrical safety standards)

- Higher breakdown voltage capability than similarly rated devices using coating technology.

- Downsizing and board space saving opportunities.

Thank You!