



APEC 2009

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Identifying and Correcting Corona Problems in AC Applications

Early Lifetime failures are a risk if Corona is allowed
To exist inside the capacitor

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Introduction



⚡ ASTM defines Corona as:

⚡ *Any electrically detectable field intensified ionization that does not result immediately in complete breakdown of the insulation electrode system in which it occurs.*



Introduction



- ⚡ From Electrostatic field theory the law of electric flux says, it can only emanate or terminate on an electric charge .
- ⚡ The electric field gradient (volts/mil) in air perpendicular to a dielectric will be greater than the electric field gradient in the dielectric by the relative dielectric constant unless there is a surface charge on the dielectric.



Dielectric Constants



⚡ Corona inception values (CIV or Onset) vary with dielectric types. Dielectric constants of Typical plastics are:

Polyester = 3.3

Polypropylene = 2.2

Water = 81

Air = 1.00059

Vacuum = 1.00000



Typical Corona onset values



⚡ Polyester F-F

⚡ 1 section: 275 Vrms

⚡ Polypropylene F-F

⚡ 1 section: 315Vrms

⚡ Affected by

⚡ Humidity

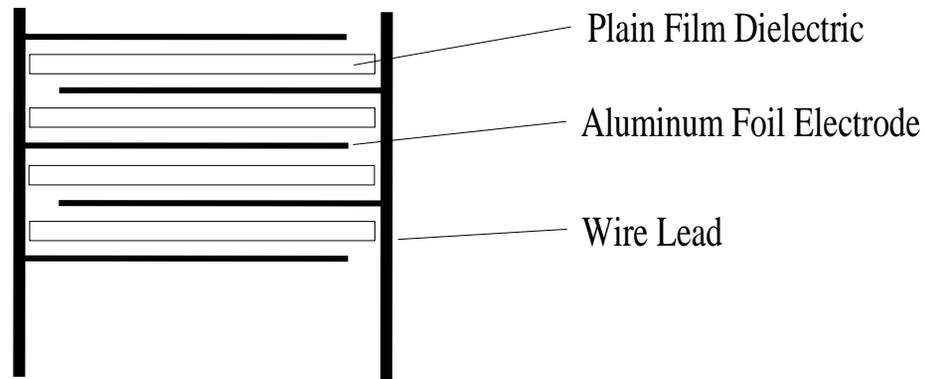
⚡ Dielectric thickness



Capacitor Construction Review



⚡ Film/Foil construction:

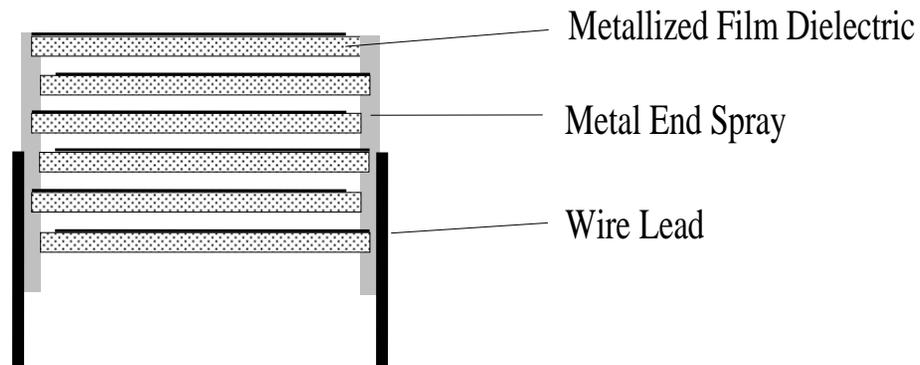




Capacitor Construction Review



⚡ Metallized Film construction





Multi-Section Cap Design



- ⚡ 2-Section Series Metallized
- ⚡ CIV – 2 x Single section
- ⚡ Cap Value $\frac{1}{2}$ Single Section
- ⚡ Voltage 2 x Single section
- ⚡ 2-Section Series ff-Metallized Hybrid
- ⚡ SBE 715P, etc.



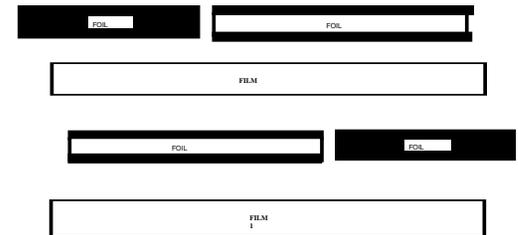
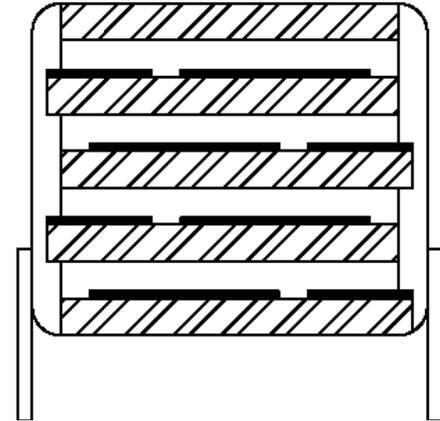


Multi-Section Design



- ⚡ 3 Section metallized design
- ⚡ Total Cap 1/3 of Single
- ⚡ CIV 3 x single
- ⚡ Voltage = 3 x Single

- ⚡ 773P is 3 section FF-Met hybrid





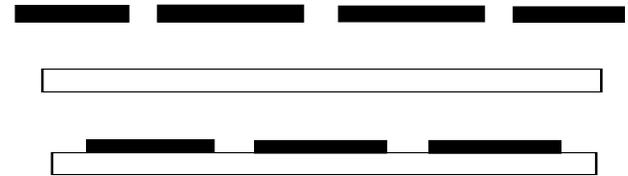
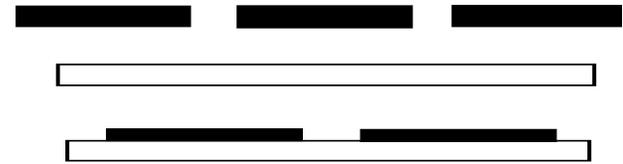
Multisection Design



⚡ 4 Section Series FF-Metallized Hybrid

⚡ 717P series

⚡ 6 Section Series FF-Metallized Hybrid





Corona Damage



- ⚡ Constant Bombardment along electrode edge erodes dielectric away.
- ⚡ Damage is cumulative, whether continuous or pulse, eventually eats through dielectric causing catastrophic failure
- ⚡ Approximately 8 hours of continuous bombardment will fail cap. Varies with construction.



Corona Damage



- ⚡ Example #1 of Damage
- ⚡ Track on plain film





Corona Damage



- ⚡ Example #2
- ⚡ Corona damage through Metallized area



Corona damage line through metallized area



Corona Damage



- ⚡ Example #3
- ⚡ Corona track on edge of Metallized layer

Corona track at electrode edge on Metallized layer





Corona Damage



⚡ Example #4 Catastrophic failure induced by Corona damage





Avoiding Corona



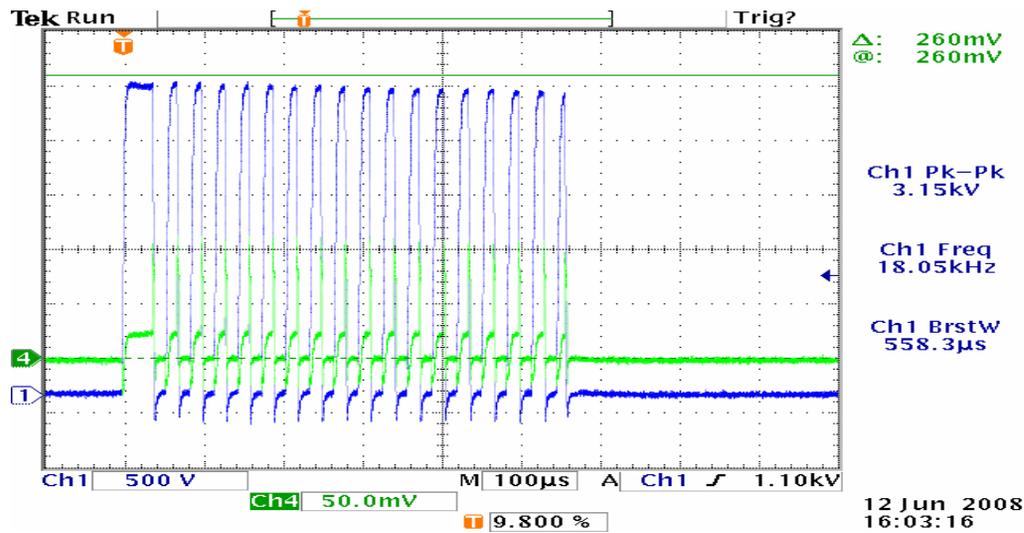
⚡ Voltage limits

- ⚡ Whenever voltage exceeds $250V_{rms}$ or $707V_{p-p}$ you need multiple sections
- ⚡ Non-sinusoidal waveforms need to be evaluated for CIV since rms values might not give reading.
- ⚡ Evaluate pulse waveforms using Peak-to-Peak values.

Avoiding Corona



- ⚡ 3150 Vp-p Pulse waveform behaves same as 3150Vp-p Sine Wave (CIV)
- ⚡ $3150\text{Vp-p} = 1113\text{Vrms}$. Thus need at least 5 sections to be corona free. (I.e.- $250 \times 5 = 1250\text{Vrms}$)





Avoiding Corona



- ⚡ There are many other design considerations such as dv/dt , RMS current, temperature considerations special packaging that all go into selecting the proper design that is Corona free and gives satisfactory long life.



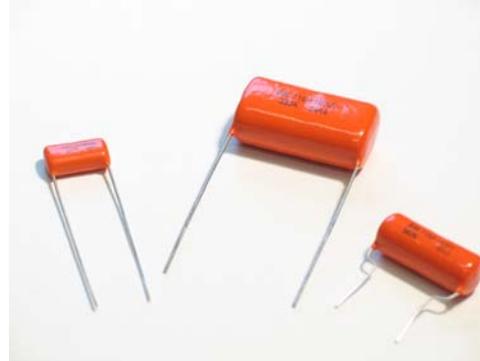
Avoiding Corona



⚡ SBE Engineering is well versed in Corona and Corona free designs and would like to discuss your design and recommend one of our many products or develop a specialized part to solve your design problem



SBE, Inc.



**Thank you for your time
And Attention**