Park/Nelco

Buried Capacitance™ Substrate Materials

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Buried Capacitance™

- What is Buried Capacitance™?
- What is the current market size?
- What are the OEMs saying?
- What are some of the challenges?
  - Laminators' concerns
  - Fabricators' concerns
- What is Park / Nelco doing?

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Why Embedded Capacitance

- Improved EMI performance at high frequency
- A low inductive source
- Removal of discrete capacitors and their pads and vias
  - Eliminate parts from assembly
  - Eliminate rework of parts
  - Possible reduction in PCB size
  - Increase routing
  - Increased reliability

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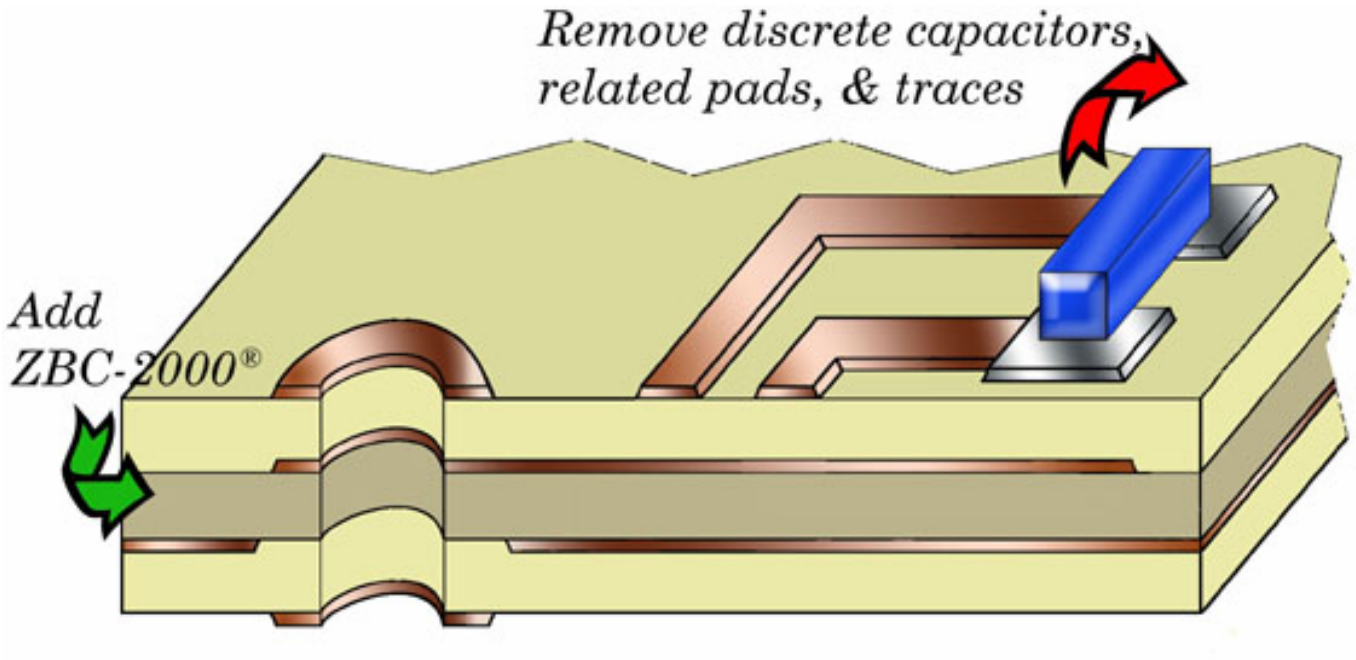
Charting Our Course

A Very Simple Idea



- Use the power and ground planes to form Buried Capacitance ™ planes within the PCB..... and remove most of the bypass capacitors. Layer count normally increases by two.

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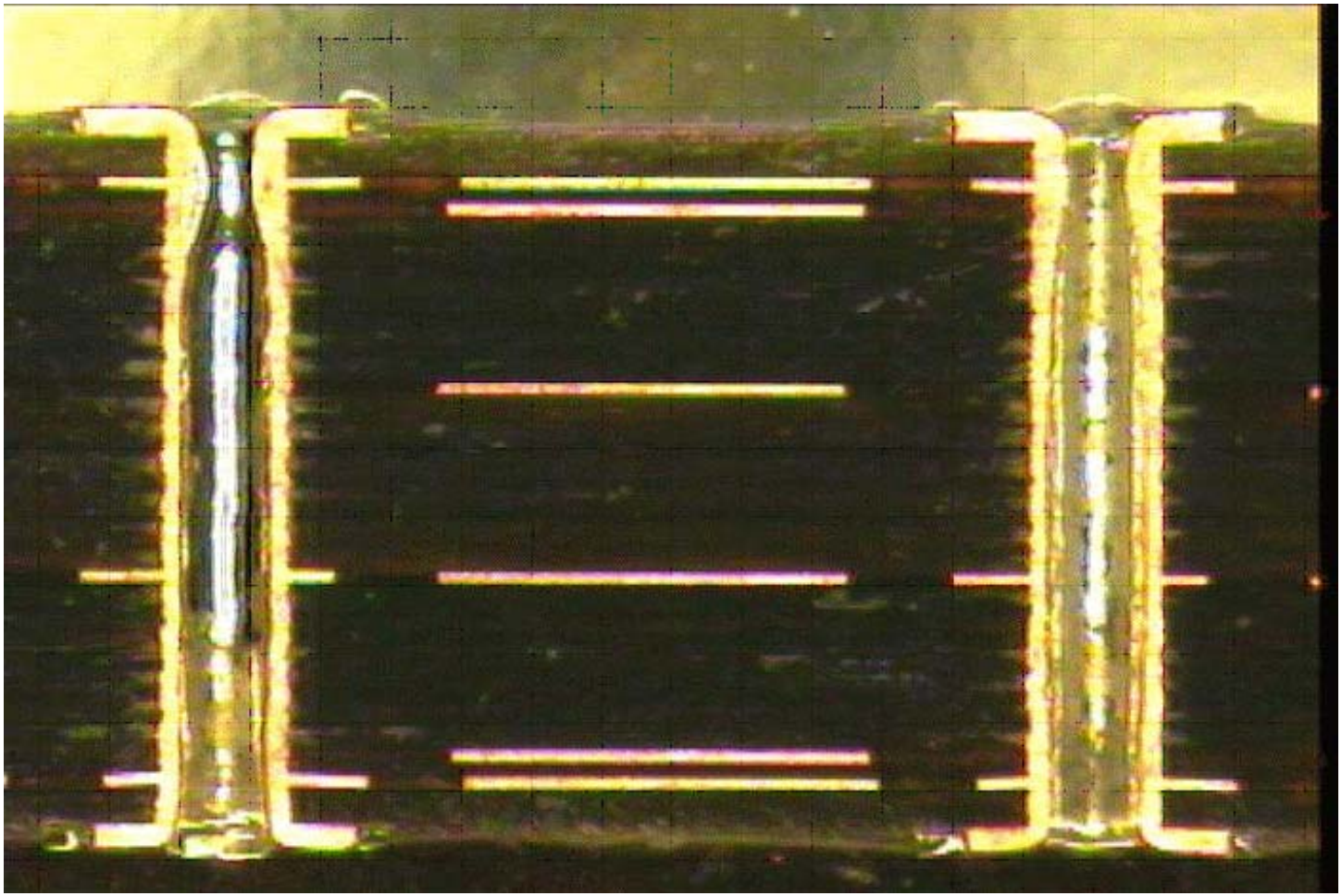
Buried Capacitance™ Cross Section



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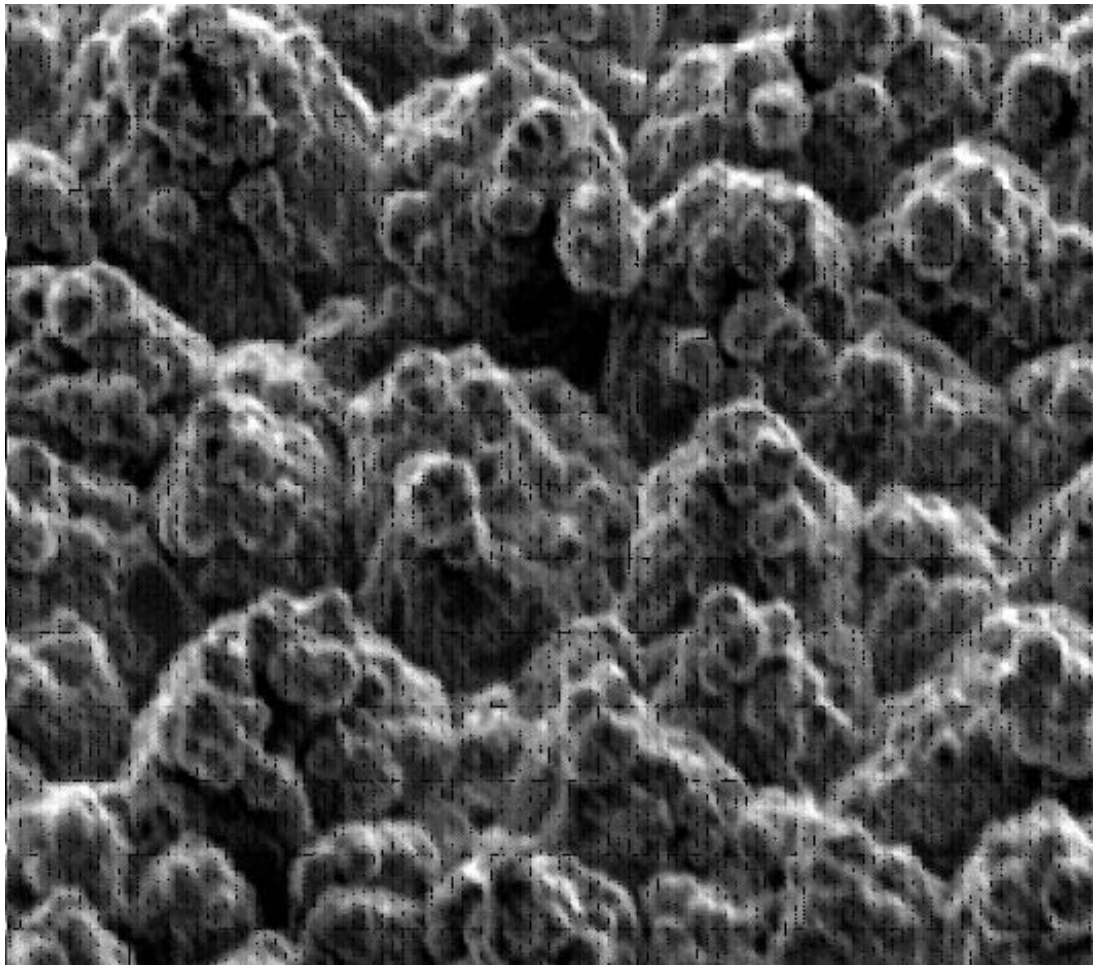
Treated Foil Matte Side



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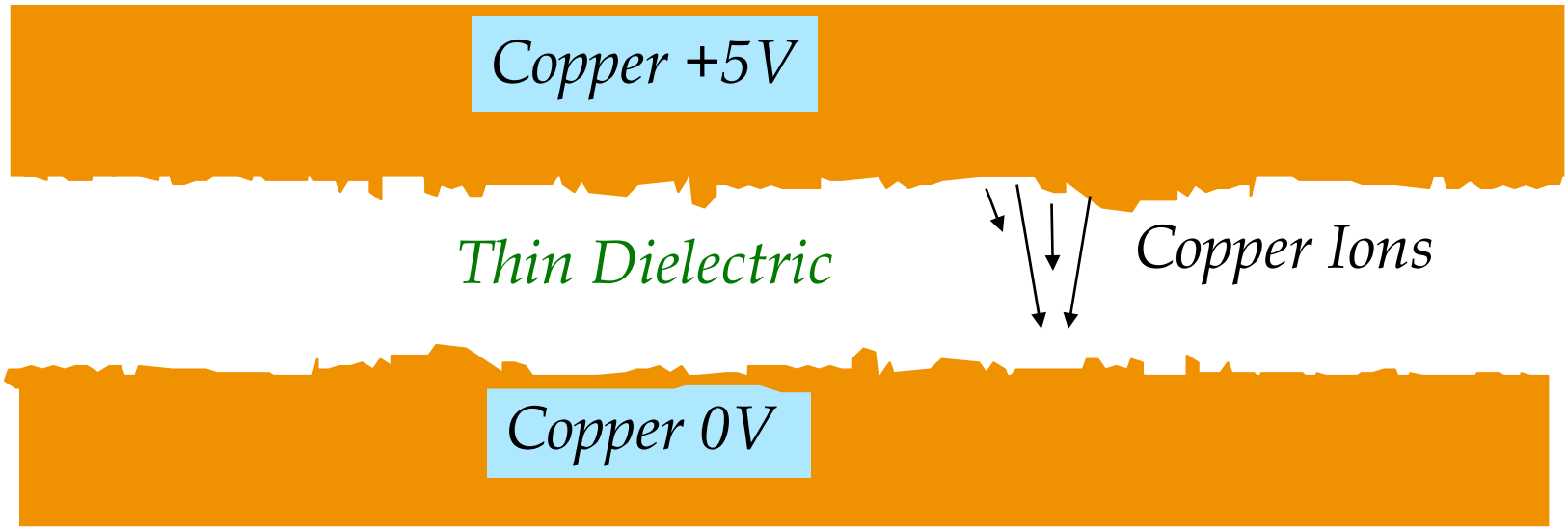
Electromigration of Copper Due to Temperature and Humidity



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Treated Foil Drum Side

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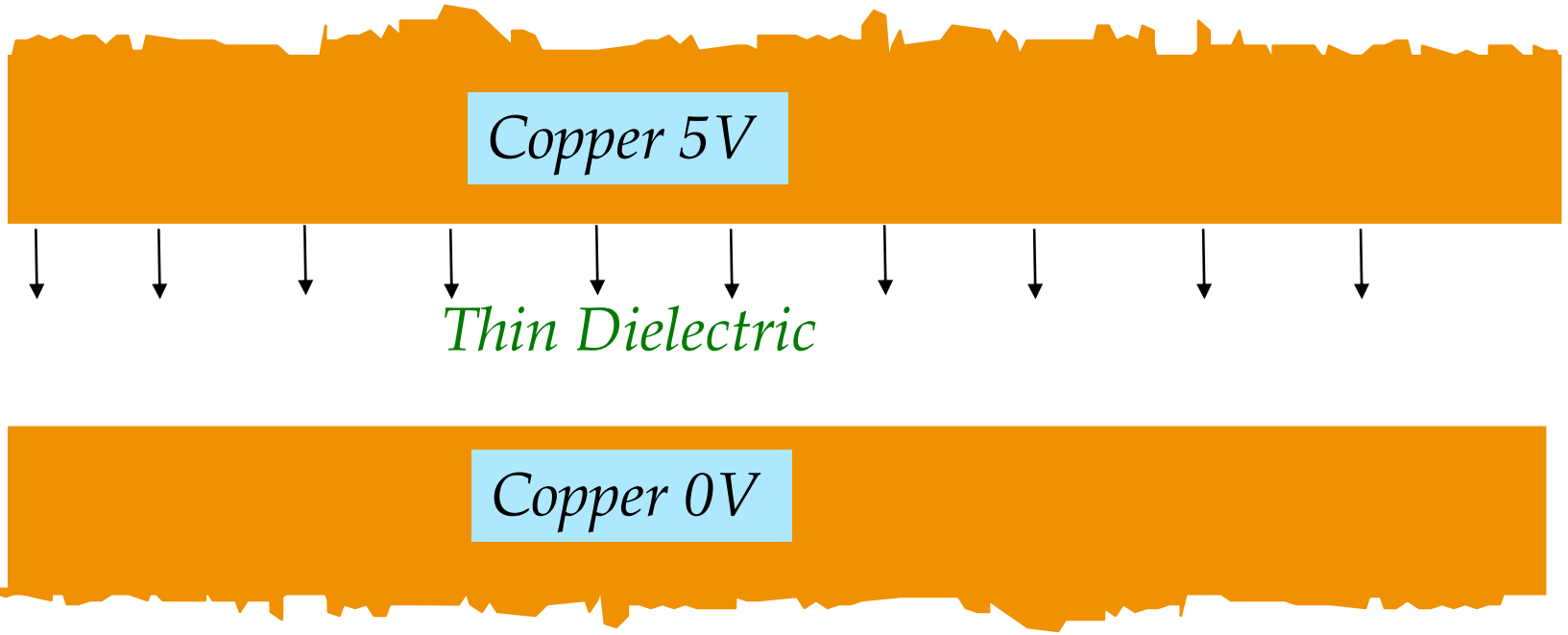
BC® has flat internal surfaces to distribute the voltage.... and is tested at 500 VDC



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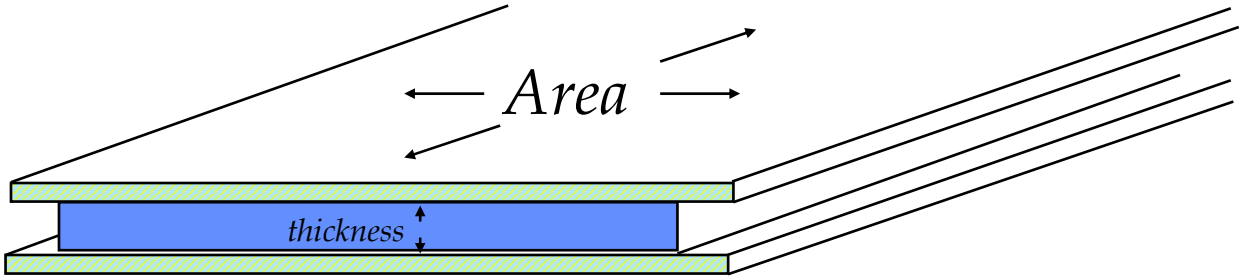
Plane Capacitance Calculation



Cp(pF) = 225*Dk*A/t

Where:

Cp= is plane capacitance

225 is a constant

Dk= is the dielectric constant of the dielectric material

A= is the area per sq. inch of the plane (or split plane) attached to the active devices

t = is the thickness of the dielectric material in mils

Example: $\frac{225*4.5*\ (10'' \times 10''\ PCB)}{2}$ *= 50,625 Picofarads, or* ***.05μF***

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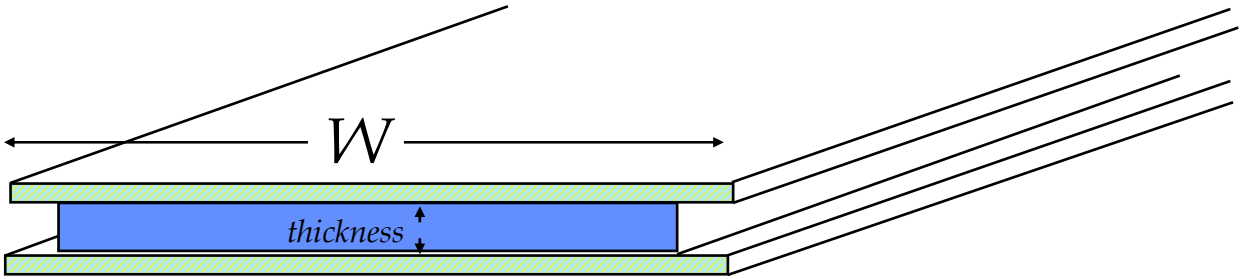
Plane Inductance Calculation



$$Lp\ (nH/in) = \mu_r * t/W$$

Where:

Lp= Plane Inductance

μ_r = relative permeability of the material

t = is the thickness of the dielectric material in mils

W = width of the plane in inches

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Discrete Decoupling Capacitor

- Provides local charge supply for switching devices.
- Must be placed close to the IC, and becomes the third inductive leg, combining with the PWB and the IC device inductance.
- Capacitor possesses resistance and inductance. As a series resonant circuit, it has a specific resonant frequency that must be matched to the frequency of the noise to bypass.

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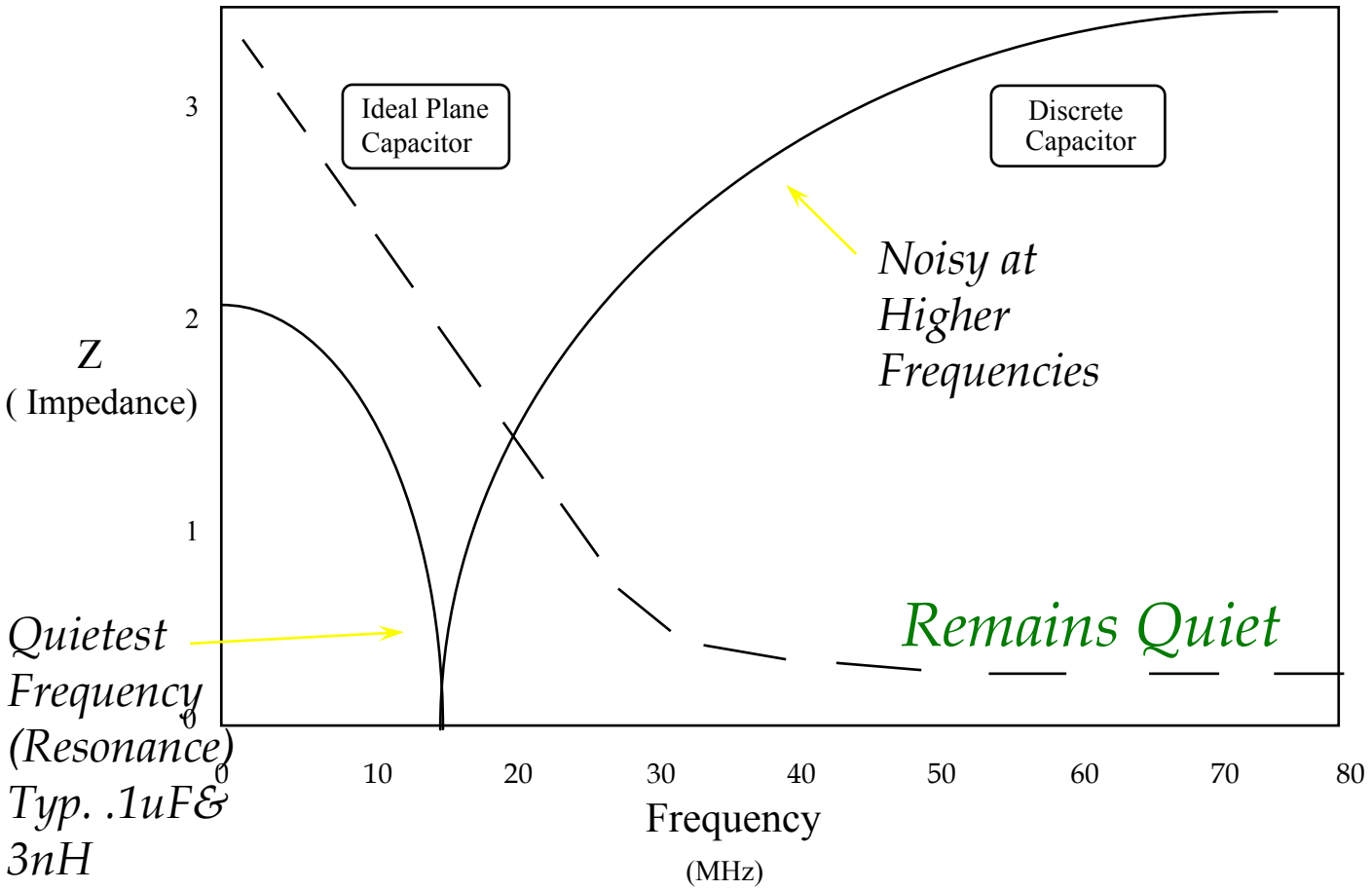
Resonant Discrete vs Nonresonant Plane Bypass Capacitor Impedance



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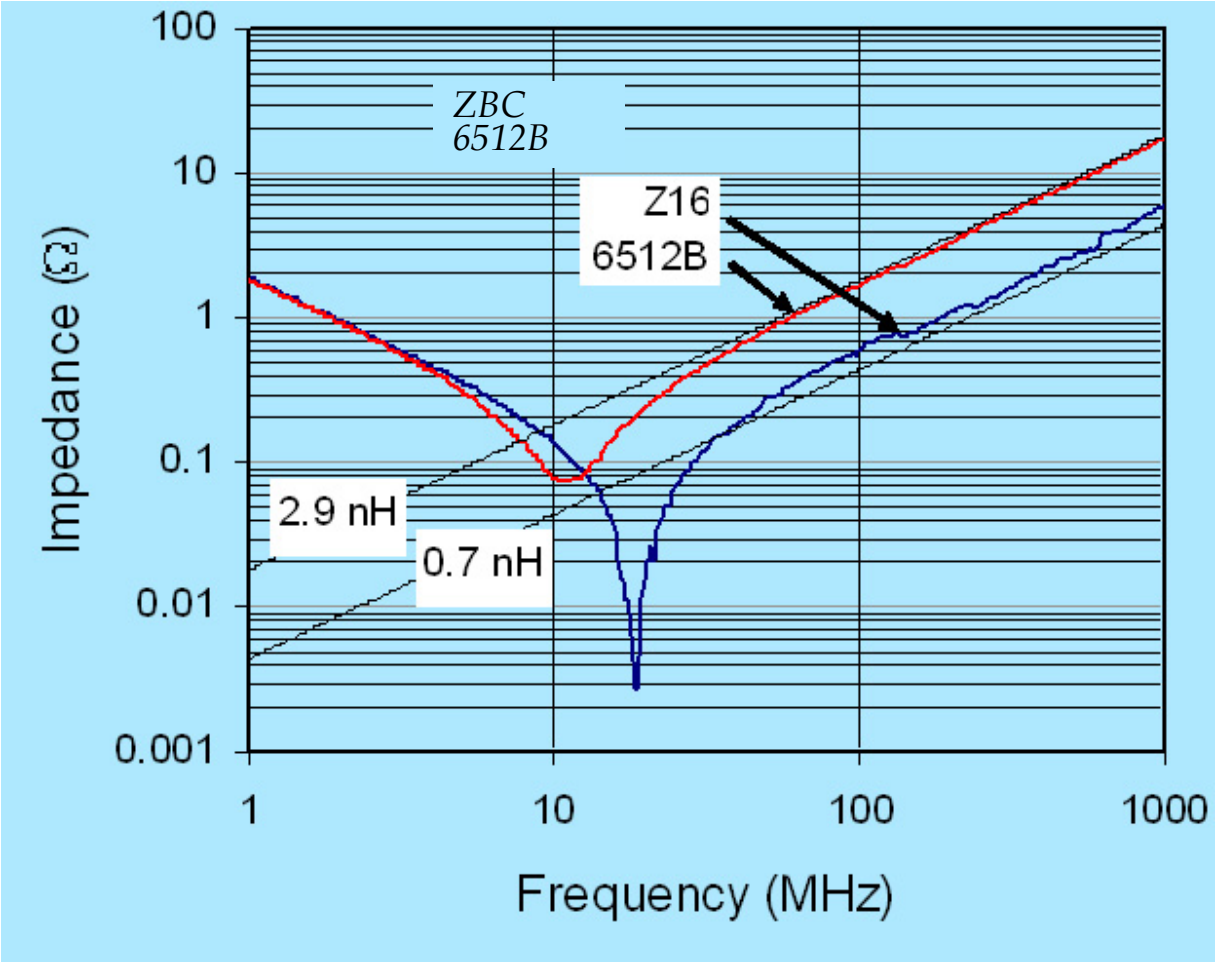
Standard Vs Buried Capacitor

baseline studies



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ZBC-2000® Market Drivers and Data

- Frequencies Above 2 GHz make discreet capacitors useless
- Many OEMs are designing in ZBC-2000® on new designs
- Market is definitely growing
  - 3-4 M sq. ft. in 2002
  - 6-8 M sq. ft. in 2003

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What OEMs are Saying About Buried Capacitance™!

- ✓ Capacitive layers provide up to 16dB of attenuation to board level radiated emissions,.. additionally, VHF resonances due to discontinuities in the power plane can be eliminated by BC®."

  Intel Corporation

- ✓ "Based on the test results....Distributed Capacitance should be accepted as a design standard for PWB's....."

  Motorola

- ✓ "50 % of all new builds will utilize ZBC 2000™ cores" !

  Cisco Systems

- ✓ "Lowering the inductance is more important than increasing the capacitance. Lower inductance increases switching speed and improves the signal integrity."

  Sun Microsystems

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Realization of Benefits

- Case study findings*:
  - First pass yield (FPY) up 4,700 ppm
  - Mean time before failure (MTBF) up 5.5 yrs
  - Material cost reduced US$1.96 / assembly
  - Feeder cost reduced by US$360/ line
  - Cycle time reduction of >1min

* Taken from case studies reported in Motorola/Codex Evaluation

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Buried Capacitance™ Challenges

- Laminators
  - 100 % testing required on thin cores
  - Thinner laminates needed to increase capacitance and lower inductance
  - Handling after lamination
  - Educating customers on the difference between hipot testing and electrical breakdown
  - Passing on the royalty fees

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Buried Capacitance™ Challenges

- Fabricators
  - 100 % testing required on thin cores after etching
  - RTF preferred over DT copper
  - Handling throughout innerlayer process
  - Educating customers on the difference between hipot testing and electrical breakdown
  - Licensing fee to get started

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Park / Nelco's Strategies

- Current
  - Implementation of AQL on panels from every lot of ZBC-2000® product
  - Increased automation to eliminate handling related hipot failures at lay-up and breakdown
  - Web cleaners and magnets on treaters to remove metallic particles that come in on the glass

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Park Nelco's Strategies

- Future
  - 100 % pre-testing of all thin cores
  - Thorough characterization of how glass finishes and glass manufacturers affect hipot failures
  - Implement the use of AOI to better characterize FM that may cause hipot failures
  - Use proprietary technology to produce void free prepregs
  - Qualify BC-1000™ one mil dielectric material

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Nelco ZBC-2000™ Product Offerings

- Current offerings are based on the reliability and proven record of Nelco's existing N4000-6 (FC) and N4000-13 resin systems
- N4000-6 (FC) BC® and N4000-13 BC® use the resin and reinforcement of their standard counterparts, processing and performing similarly
- Copper foil available in flip double treat or RTFoil®

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Getting Started

- ZBC-2000® laminates are produced under license from Sanmina-SCI
- Fabricators using a one or two mil dielectric for buried capacitance applications will require a license
- Sanmina-SCI maintains a list of Buried Capacitance™ Licensed PCB Fabricators
- Designers will need to be familiar with the methods outlined in the Sanmina Buried Capacitance™ Design Guide or comparable resources.

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Ordering ZBC-2000™ from Park / Nelco

- ZBC-2000® material is available now in approved configurations to licensed fabricators
- ZBC-2000® material is available in North America, Asia, and Europe
- Lead times are comparable to standard materials
- Park / Nelco is required by Sanmina-SCI to collect a per square foot fee on each order of material used for BC® applications
- This fee can be waived upon receipt of appropriate written correspondence indicating the use of material for applications other than BC®
- Contact a Nelco representative for pricing and details

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Technical Data

- Most data available on line
- www.parknelco.com
- Users can register as a “web customer”
- Web customers have a unique password
- Web customers can access all data such as MSDS, processing guidelines and technical data as it becomes available
- Designers corner

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