Use of Cavity Perturbation Techniques to Characterize Via-Plate Behavior

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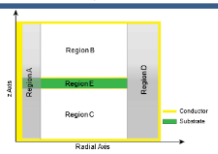
STATUS QUO

Characterize Via-Plate EM fields and capacitance

- ✓ Static EM solvers used to characterize behavior
- ✓ Combination of network theory and electromagnetic analysis used to derive equivalent circuit representation
- ✓ Impact of outer conductor boundaries not considered in these types of analysis
- ✓ Visualization of electric and magnetic fields for via-plate assemblies hasn't been reported.

NEW INSIGHTS



Short Circuited Coaxial Structure with PCB at center

- ✓ Identification of even and odd mode behavior in via-plate assemblies.
  - ➢ Odd TEM mode facilitates calculation of capacitance
  - ➢ Even TEM mode facilitates calculation of inductance
  - ➢ Identification of parallel plate resonance
- ✓ Model impact of outer conductor on equivalent capacitance

DESCRIPTION

$$E_z^i(r,z) = \sum_{n=0}^{N} a_n R_0^i\left(k_n^i r\right)\cosh\left(\gamma_z^i(z+z_i)\right)$$

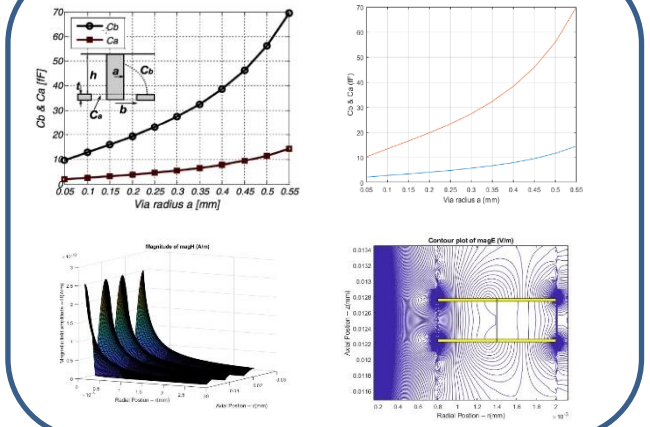
$$H_\phi^i(r,z) = \sum_{n=0}^{N} a_n \left(\frac{j\omega\varepsilon}{k_n^i}\right) R_1^i\left(k_n^i r\right)\cosh\left(\gamma_z^i(z+z_i)\right)$$

$$E_r^i(r,z) = \sum_{n=1}^{N} a_n \left(\frac{\beta_z^i}{k_n^i}\right) R_1^i\left(k_n^i r\right)\sinh\left(\gamma_z^i(z+z_i)\right)$$

Assuming an infinite set of TM0n modes an EM analysis of the structure can be performed using mode matching techniques

- ✓ Axial Mode Matching
  - ➢ Inner region consists of a multi-layer dielectric, wave numbers, in each region, need to be determined in each subregion.
- ✓ Radial mode matching
  - ➢ Perform field expansion at radial boundaries where axial discontinuities occur
  - ➢ This leads to a square matrix which can be used to calculate resonance behavior
- ✓ Singular Value Decomposition (SVD)
  - ➢ After formulation of a square matrix, resonant frequency and field coefficients can be determined using SVD techniques
- ✓ Determination of Capacitance
  - ➢ From Gauss' law and the calculated field coefficients, equivalent capacitance of the via-plate can be determined.

QUANTITATIVE IMPACT



PROPOSED CONCEPT GOALS

Resonant analysis technique for characterizing via plate behavior

- ✓ Identification and analysis of even, odd and parallel plate resonance modes.
- ✓ Determination of coaxial and barrel capacitance for via-plate.
- ✓ Characterization of impact on electrical conducting boundaries on via capacitance.
- ✓ Analysis with additional metal and dielectric layers and fringing capacitance can be performed using modified method.