

Power Bus Noise Radiation Algorithm

Subroutine: *power_bus_noise_radiation()*.

Purpose of Algorithm

Estimates the direct radiation from the power bus in a board with power planes.

Basic Description of Algorithm

The maximum intensity of radiated emissions from a rectangular power bus structure can be derived based on an analytical cavity-resonator model. The effect of components mounted on the board is modeled by modifying the propagation constant of the waves within the power bus structure. The radiated field intensity is calculated using the equivalent magnetic current around the edges of the power bus structure together with the modified propagation constant [1, 2].

$$|E| = \frac{120I_i}{\varepsilon_r \min(a,b)} \cdot \frac{h}{r} \cdot Q(f) \quad (1)$$

where I is the current drawn from the plane, a and b are the equivalent width and length of the power planes, h is the spacing between the plane pair, r the distance from the board to the measurement point, and $Q(f)$ is the quality factor of the resonance in the power bus structure. $Q(f)$ is determined by the dielectric loss, conductive loss and component loss of the power bus and is given by:

$$Q(f) = \left(\tan \delta + \frac{\delta_s}{h} + \frac{N_c R_c}{\omega C_0 (R_c^2 + \omega^2 L_c^2)} \right)^{-1} \quad (2)$$

where $\tan \delta$ is the dielectric loss tangent, δ_s is the skin depth of the plane conductors, N_c is the number of the components connected to the planes, C_0 is the inter-plane capacitance, R_c is the average resistance of the components (Default = 300 ohms) and L_c is the average connection inductance of the components (Default = 5 nH). The defaults for the average resistance and the inductance of the components can be defined in the EMC Personality File.

Assumptions

1. The power bus consists of two nearly rectangular solid planes
2. The spacing between the two planes is assumed to be electrically small.
3. The length and width of the planes are much greater than the dielectric thickness.

References

- [1] Hwan Woo Shim, "Development of Radiated EMI Estimation Algorithms for PCB EMI Expert System", Ph.D Dissertation, University of Missouri-Rolla, 2004.
- [2] H. Shim, Y. Fu and T. Hubing, "Radiated Emissions from Populated Printed Circuit Boards due to Power Bus Noise," *Proc. of the 2004 IEEE International Symposium on Electromagnetic Compatibility*, Santa Clara, CA, USA, August 2004, pp. 396-400.