Studying Crosstalk Trends for Signal Integrity on Interconnects using Finite Element Modeling

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Introduction: High-speed digital design involves strong electromagnetic coupling between adjacent transmission lines. Crosstalk as it is called, has repercussions on signal integrity. The objective is to analyze its effect on victim and observe its trends with changes in sub-domain properties.

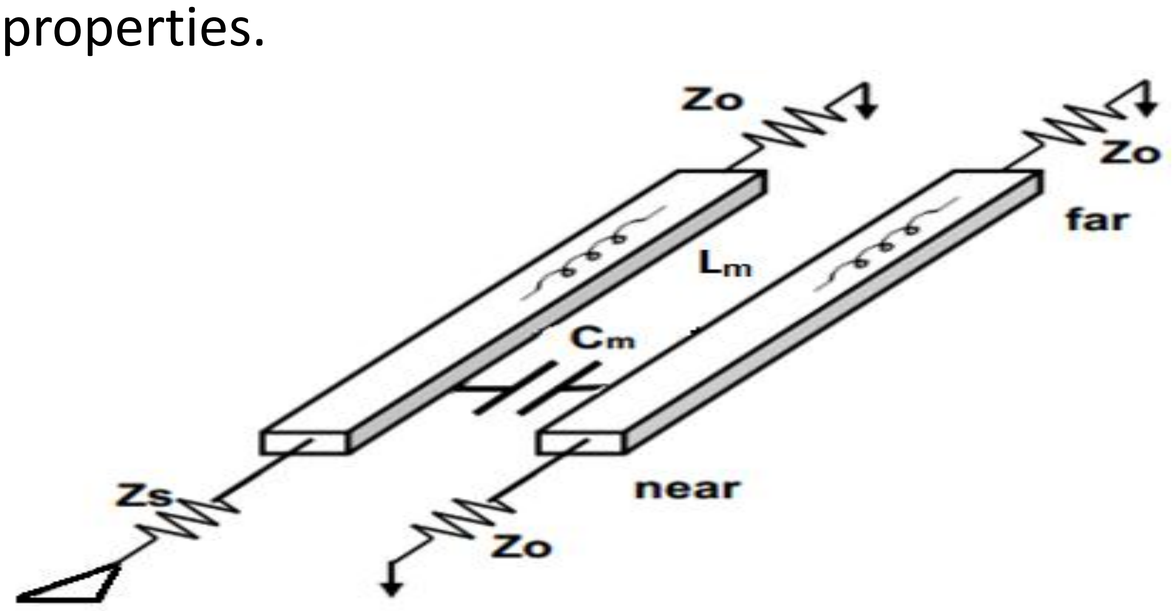

Figure 1. Transmission Lines with Electromagnetic-Coupling

Computational Methods: Modeled the interconnects using COMSOL Multiphsysics 3.5 AC/DC Module. Extracted per-unit length impedance matrices. Crosstalk magnitudes given by :

$$A_{near\_end} = \frac{V_{input}}{4}\left[\frac{L_M}{L} + \frac{C_M}{C}\right]$$

$$B_{far\_end} = -\frac{V_{input}\, X\sqrt{LC}}{2T_r}\left[\frac{L_M}{L} - \frac{C_M}{C}\right]$$

Geometry: Two transmission lines sitting on a dielectric with dimensions as shown. Both the line have a length of 10 cm each which goes into the plane.

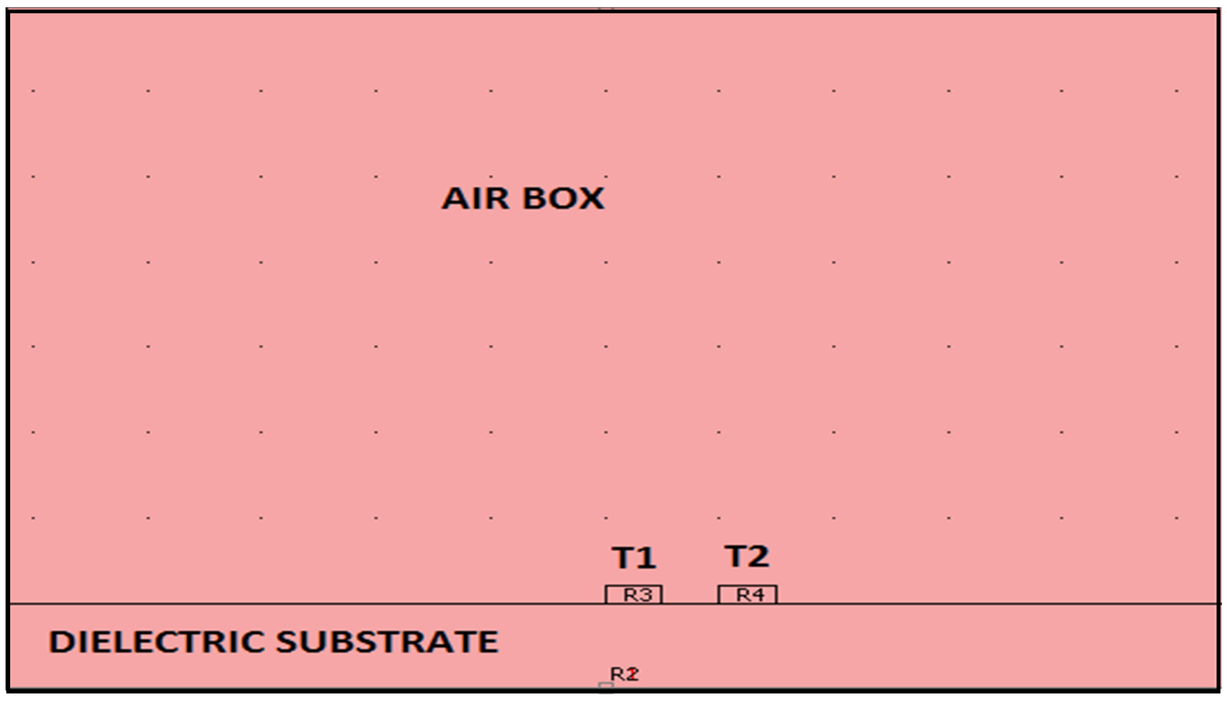

Figure 2. Single Level Interconnections for crosstalk analysis

Results: Crosstalk trends were observed with respect to 4 parameters – Dielectric Constant of substrate, Height of Substrate, Pitch-Ratio and Ground Planes.

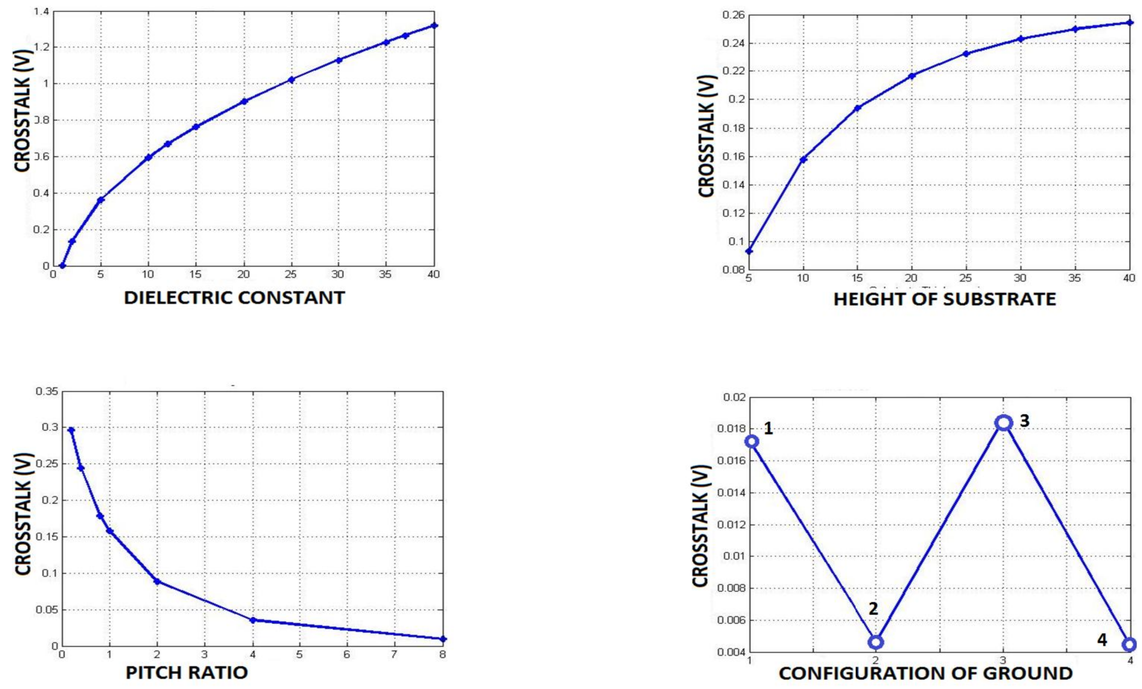

Figure 3. Crosstalk variation with Dielectric Constant, Height of substrate, Pitch-Ratio and Grounding Arrangement

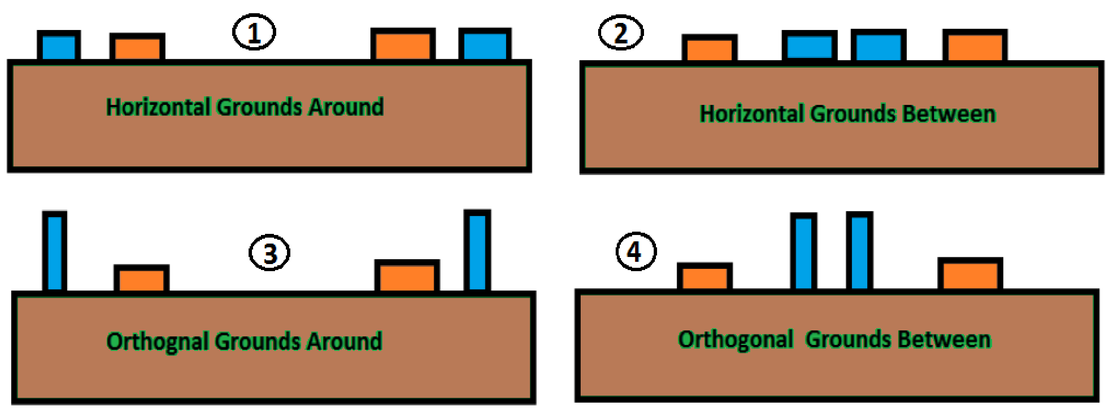

Figure 4. Grounding arrangements. Blue denotes the ground.

Conclusions: To minimize the crosstalk, we must use a low-k dielectric and thin substrate for stronger coupling with ground. Further larger pitch-ratio and orthogonal grounds inserted between the transmission lines ensure substantial reduction in crosstalk because of the shielding and weak coupling.

References:

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