Crosstalk and Coupling to Printed Circuit Board Metallic Traces with Arbitrary Shapes

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***Abstract*—In realistic Printed Circuit Boards (PCBs), metallic traces are routed from one end to another, under a set of multiple constraints, leading to traces with a wide range of shapes and sizes. The shape of these traces has a significant impact on the electromagnetic coupling and the crosstalk between adjacent traces. Therefore, in this work, we study the effect of shape on the coupling and crosstalk of PCB metallic traces through an integrated computational modeling and experimental approach.

Keywords-Electromagnetic coupling, Printed Circuit Boards, Crosstalk, Coupling, Shape.

I. INTRODUCTION

The use of PCB in high-frequency applications is increasing rapidly. Moreover, the congested wireless spectrum is making PCBs more prone to coupling from external radiation. In this work, crosstalk and electromagnetic coupling to PCB traces with various shapes are studied using both computational simulations and experimental measurements. The coupling experiments are performed by exciting the trace ports through coaxial feeds or through an incident electromagnetic wave. We measure and simulate both the far end and near end coupling and we also vary the terminations at the ports of the metallic traces not connected to the Vector Network Analyzer (VNA). Finally, conclusions which correlate the shapes of the PCB metallic traces to the levels of electromagnetic coupling and crosstalk are drawn

II. PCB DESIGN

Figure 1 shows both the design and the fabrication of a PCB with two straight and parallel metallic traces. The dimensions were selected such that each individual trace will have a characteristic impedance of 50 Ω matching that of the ports of the Vector Network Analyzer. Both the near and far end crosstalk are measured with matched load or open circuit terminations attached to the ports not connected to the VNA.

III. RESULTS AND DISCUSSION

Experimental measurements and computational simulations of all the four configurations in Figure 2 are performed. The measurement and simulation result show excellent agreement validating our design, fabrication and measurement procedure. Future work will focus on repeating the previous study for realistic PCB schematics, so that practical shapes can be accurately evaluated. A systematic variation in the trace shapes and sizes is currently being performed which will be then tested both experimentally and through computational measurements. Also, a new fast method for evaluating Green’s function is under progress which will be used to speed up the simulations. Furthermore, characteristic mode analysis (CMA) will be performed to predict trace shapes that minimum or maximum the coupling.

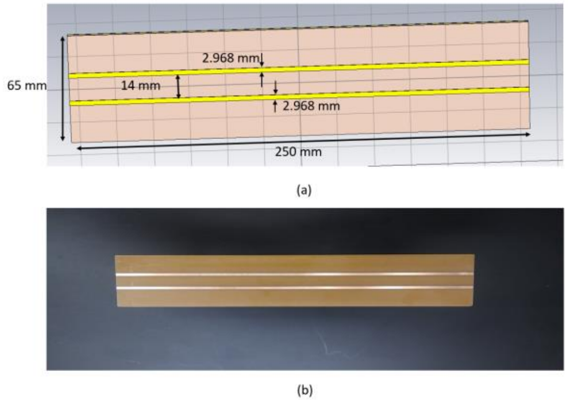

Figure 1. (a) Simulated and (b) fabricated PCB with 2 traces. The substrate used was FR-4 with a relative permittivity of 4.3, substrate thickness of 1.55 mm, and a copper trace thickness of 35 um.

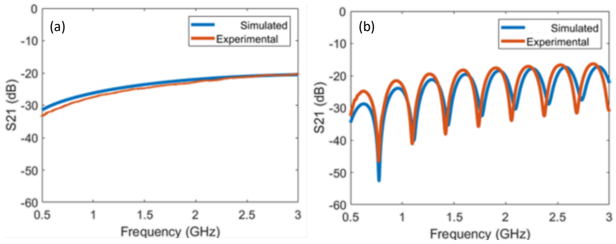

Figure 2. Plots showing a comparison between simulation and experimental data for far end coupling for (a) matched load and (b) open circuit terminations at the ports not connected to the VNA.

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