Reliable Full-Wave EM Simulation of a Single-Layer SIW Interconnect with Transitions to Microstrip Lines

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Abstract

Substrate integrated waveguides (SIW) can be used to achieve ultra-high speed interconnections. These structures are relatively easy to implement, their manufacturing cost is low and they can achieve high operational performance using low cost dielectric substrates. In this work, we implement a SIW structure using COMSOL Multiphysics® software focusing on two critical configuration settings: simulation bounding box and meshing scheme. The SIW structure implemented in this work is taken from [1] and it is illustrated in Figures 1-2.

The simulation bounding box should not modify the inherent EM response of the structure under analysis. In our case, the distances from the SIW metals to the lateral and upper box walls can interfere and modify the structure EM response if they are too short. Distances from metal to simulation box are illustrated in Figure 3. From the technique proposed in [2], we set the initial simulation box dimensions to Hair = ygap = xgap = 5H, and gradually increase each simulation box dimension until the model EM responses practically do not change.

A fine mesh size delivers accurate responses but also consumes more computational resources and time. A simulation using a coarse mesh size is fast but the model response is not accurate. To solve this trade off, a meshing scheme by zones is proposed in [2], using different mesh sizes for different domains in the model, as required. We use a coarse mesh size in large size regions and a fine mesh size in small size regions. Additionally, we take into consideration the wavelength on each domain to establish a suitable mesh size. For the SIW EM simulation, we divide the model into five meshing regions, as illustrated in Figure 4. To find the appropriate minimum and maximum element sizes for each region, we simulated different resolution schemes, by gradually increasing the coefficients in Figure 4 until resolution convergence is achieved.

Finally, using the best simulation box dimensions and best meshing scheme, we perform a parametric study to explore the effects of the tapered line transition on impedance matching between the SIW and the microstrip feeding lines.

Reference

1. J. E. Rayas-Sánchez and J. A. Jasso-Urzúa, "EM-based Optimization of a Single Layer SIW with Microstrip Transitions using Linear Output Space Mapping," in IEEE MTT-S Int. Microwave Symp. Dig., Boston, MA, Jun. 2009, pp. 525-528.

2. Z. Brito-Brito, J. E. Rayas-Sánchez, J. C. Cervantes-González, and C. A. López, "Impact of 3D EM Model Configuration on the Direct Optimization of Microstrip Structures," in proceedings from COMSOL Conference 2013, Boston, MA, Oct. 2013, pp. 1-5.

Figures used in the abstract

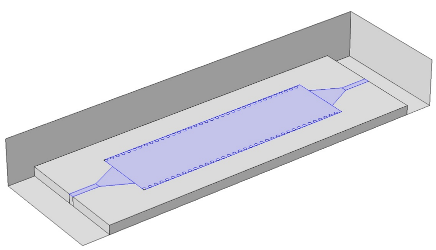

Figure 1: SIW structure geometry as implemented in COMSOL Multiphysics.

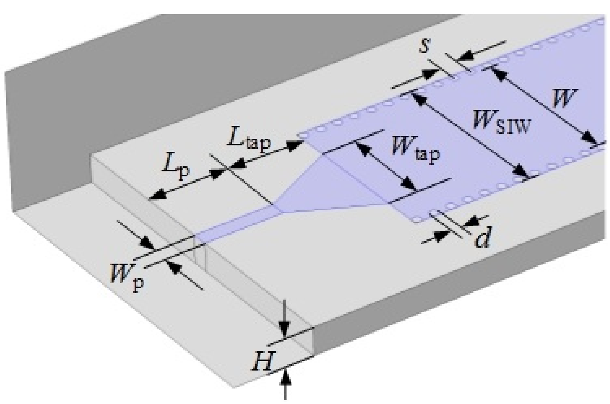

Figure 2: Design parameters for the SIW interconnect with transitions to microstrip lines.

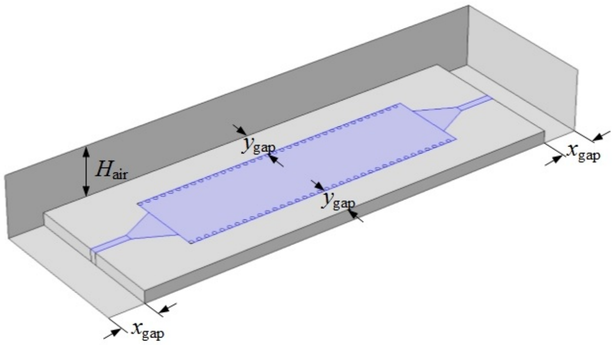

Figure 3: Simulation bounding box dimensions used for SIW implementation in COMSOL Multiphysics.

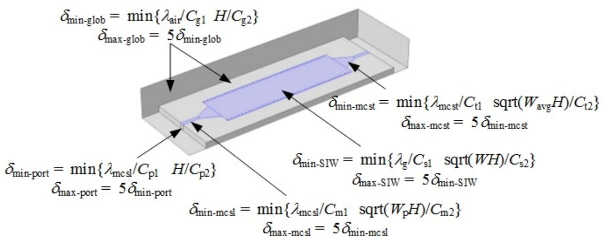

Figure 4: Meshing scheme implemented for the SIW model simulation (see Fig. 2). The meshing scheme uses the minimum value between a fraction of the wavelength in the region and a fraction of the smallest geometrical dimension in the region. Coefficients are used to vary the mesh resolution.