The influences of the shielding conductor on the propagation characteristics of a multiconductor microstrip transmission

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ABSTRACT

During the past three decades, the areas of microwave integrated circuits(MIC)and microwave monolithic integrated circuits (MMIC) have made significant advances. More and more components made of MIC''s and MMIC''s are replacing the conventional microwave components, such as power generators, isolators, mixers, and filters, etc.. Compared to the conventional microwave components, the MIC''s and the MMIC''s have the benefits of wider bandwidth capability,reduced size and weight, easiness of mass production, and higher system reliability, to name only a few. Over the years, many transmission-line structures that employe d the MIC''s and MMIC''s techniques have been proposed as a means ofconnecting different microwave components. Microstrip transmission line, withor without top perfect electric conducting (PEC) plane or even entirely enclosed by a metallic box, is one of the interconnects that habeen quite popular. Our object in this report is to investigate the microstrip transmission line with a top PEC plane.In practical development of MIC''s, people lay out the circuits on a grounded substrate first. Because of the absenc of the top PEC plane, it is easy to do post-manufacturing tweaking and readjusting the circuits, if the performance of the circuits are not within the designers'' specifications. In order to prevent interfering with nearby circuits to electromagnetic radiations, it is sometimes inevitable to put the to-be-finished MIC components in a metallic box. However, to simplify the manufacturing process, we have another choice, i.e., putting another PEC plane above the circuits to prevent radiatons. If the additional PEC plane is too closto the circuit board, the behaviors of the circuits of the characteristics of the open-type microstrip transmission line may deviate too much from what was originally designed or tuned to be. Therefore, there is a need to investigate the effects of the top PEC planeon the behaviors of the circuits and the characteristics of the transmission lines. In this report, only the propagation characteristics of microstrip transmission lines are considered. Many procedures have been successfully applied to obtain the propagation characteristics on openand shielded structures of microstrip transmission lines. The quasi-TEM model provides a good solution only at low frequency limit, but becomes increasingly inaccurate as the operating frequency is raised. The spectral domain analysis (SDA) has beenfound to be rigorous and accurate even at high frequencies, but can handle conducting strips of zero thickness only. The space domain electric field integral equation (EFIE) is also considered rigorous and can handle conducting strips of arbitrary cross section. However, the Green''s functions used in EFIE are highly singular when the source points and the observation points are close to each other, thus making the numerical integration not efficient. To overcome the problem of highly singular Green''s function, a rigorous mixed potential integral equation (MPIE) formulation was proposed and applied to various microstrip patches and microstrip transmission lines by Michalski and Zheng. In this report, we use the MPIE formulation to investigate the effects of the top PEC planes on the propagation characteristics of a multiconductor transmission line, where the conductors are of arbitrary cross section. Computed dispersion curves and modal currents are presented and, when possible, are compared with data available in the literature.The numericalresults presented here include the propagation constants of the eigenmodes in both the bound regime and in the leaky regime. The results will help the circuit designers to determine where to put shielding ground plane above the open transmission line system in the final stage of the MIC'' s fabrication process.

Keywords : propagation constant ; green''s function ; bound mode ; leaky mode

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