Planar Surface Wave Power Routing Guides

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***Abstract*—Modern communication systems have increased the need for creative circuit configurations and low-profile antenna solutions that can offer high-quality performance at a low cost. The microwave and millimeter-wave frequency ranges have shown much promise allowing for increased data transmission rates while also offering smaller and compact designs. However, classic feeding techniques for planar structures can be problematic. Losses can be observed in conventional feeding schemes due to unwanted surface wave (SW) excitation. This can lead to reduced circuit and antenna efficiencies. However, it has been shown that by the use of planar SW sources, or surface-wave launchers, innovative and efficient feed systems are possible. With appropriate conditions SWs can also be bound and guided for field channeling and power routing. Applications include couplers, transition sections, as well as new planar circuits for power dividing/combining. To the author's knowledge, similar techniques have not been previously studied which allow for such controlled SW propagation.**

Project Outline

SURFACE WAVES (SWs) were always looked upon as an adverse and parasitic effect that can cause undesired power losses for planar structures and increased electromagnetic coupling between metallic circuit elements. Conversely however, these SWs can actually be harnessed for efficient and bound propagation along a planar grounded dielectric slab [1]-[3]. For instance some situations exist when the main objective is to efficiently excite such SWs with the least possible leakage, or radiated power. Such techniques for efficient SW excitation can be applied to new directional couplers, novel antennas, and quasi-optical power distribution systems [2]-[6].

It should be stressed that experienced engineering practitioners try to avoid such electromagnetic SWs when designing planar circuits and antennas for the microwave and millimeter-wave frequency range. However, this is physically not possible when using standard printed circuit board materials. This is due to the existence of the fundamental TM_0 SW mode, and thus, SWs can pose a very relevant concern at microwave and millimeter-wave frequencies. A common design strategy to minimize these SWs is to reduce the substrate height. Materials with relatively low dielectric constant values may also be used to lessen SW effects but at the cost of increased circuit size. Furthermore, existing design approaches for SW suppression can increase fabrication costs and structure complexities.

By using an alternative design approach, as examined in this research project, SWs can actually be utilized in an efficient manner. Essentially, by using surface-wave launchers (SWLs) to feed new planar waveguides, SWs can be controlled in a simple way for directive power routing and channeling [4]-[6]. In particular, by the addition of two metallic top plates and reduction in the ground plane, appropriate conditions are achieved for SW confinement. Moreover, by the inclusion of a simple medium to surround the efficiencly excited SWs, propagation can be controlled and TM field strength values can be increased along the air-dielectric interface and in the desired direction of propagation. Hence, improved through powers can be observed between SWL transmit and receive elements and thus increased performances are possible for the examined planar circuits and antennas.

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Final Thoughts of the Primary Author

It has been an absolute privilege and honor to have my Ph.D. research project, *Planar Surface Wave Power Routing Guides*, be recognized by the IEEE Microwave Theory and Techniques Society (MTT-S) and to have been awarded a Graduate Fellowship. Receiving this fellowship has helped me to realize and appreciate the importance of this research. Attending the 2013 International Microwave Symposium through the support of this fellowship produced positive and productive discussions about the work with other academic and industrial researchers. These important discussions inspired new ideas and encouraged me to further pursue this research topic in an academic setting. Thank you MTT-S!

Acknowledgment

The authors would like to thank the IEEE MTT-S Education Committee for their time and commitment to the many scholarships and fellowships available to students who have a keen interest in microwave theory and its many applications.

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