Multilayer Two-Line Microstrip Directional Coupler Design

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Microstrip directional couplers are widely used in radio frequency (RF) applications due to several advantages. This includes low cost, repeatability, lower profile, and easy manufacturability. The design of microstrip couplers are detailed with step-by-step procedure by Eroglu and Lee [*IEEE Trans. Meas. and Inst*., **57(12)**, 2756-2761, 2008].

One of the disadvantages associated with the microstrip couplers is their poor directivity. Poor directivity of microstrip couplers is due to unequal phase velocity of even and odd modes in the configuration because of the inhomogeneous structure that is comprised by dielectric substrate and air. There are several methods reported in the literature to improve directivity of the microstrip couplers by equalizing the even and odd mode phase velocities. This includes implementation of multilayer configurations using dielectric overlays to increase the odd mode effective dielectric constant, or capacitive and inductive compensatation techniques. Closed form relations for any microstrip directional coupler configuration are needed to realize and implement the design. However, there are no closed form relations reported in the literature according to authors' knowledge to design multilayer mirostrip directional couplers.

In this paper, we present closed form relations to design multilayer two-line microstrip directional couplers using several RF materials such as Teflon, FR-4, RO4003. Multilayer directional couplers are designed using the new formulation and the improvement in directivities are given. An interactive Matlab GUI is developed using the analytical formulation developed to design high directivity directional couplers. The design of multilayer directional coupler reflects the practice and the design requires only required coupling level, port impedances, and operational frequency. The geometry of multilayer two-line directional coupler is illustrated in Fig.1.
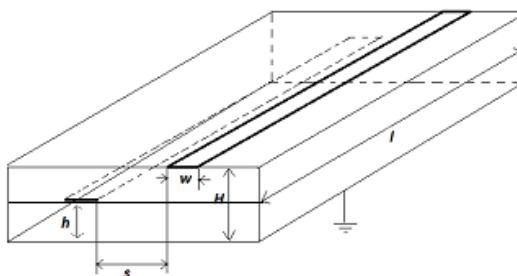

Fig. 1 - The geometry of multilayer two-line directional coupler