

## Practical Design of Three-Line Microstrip Directional Couplers

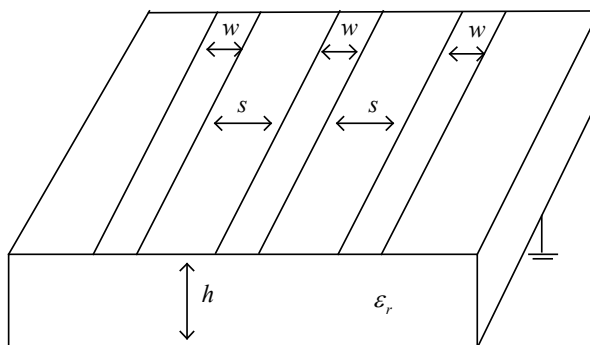
Sathwik Madishetti, and Abdullah Eroglu\*

Department of Engineering, Indiana University – Purdue University Fort Wayne  
Fort Wayne, IN 46805 USA

Three line six-port microstrip directional couplers can be used for several purposes in radio frequency (RF) applications including voltage, current, impedance, and standing wave ratio (VSWR) measurements. As a result, six port microstrip directional couplers are cost effective alternatives to existing reflectometers. The design and performance of six-port reflectometers based on microstrip type couplers has been analyzed and given by El-Deeb [*IEEE Trans. On Microwave Theory Techniques*, **31**(7), pp.509-514, 1983].

The method described by Eroglu and Lee [*IEEE Trans. Meas. and Inst.*, **57**(12), 2756-2761, 2008] gives the complete design method of two-line symmetrical directional couplers with closed form relations using the synthesis technique. The method used by Eroglu and Lee reflects the design practice since physical dimensions of the coupler are not known prior to design of the coupler. Their design procedure requires only knowledge of port impedances, desired coupling level and operational frequency. The physical dimensions of the coupler including width of the trace, spacing between them and the thickness of the dielectric substrate are then determined using the closed relations based on the given three design requirements. However, in the literature, there is no similar approach reflecting engineering practice with closed form relations to design three line microstrip couplers shown in Fig. 1.

In this paper, we present closed form relations to design three-line microstrip directional couplers using the method implemented in practice. The design method proposed in this paper requires knowledge of only coupling level, port impedances, and operational frequency. A three-step design procedure with accurate closed formulas is given to have a complete design of symmetrical three-line microstrip directional couplers at the desired operational frequency. The physical dimensions of the coupler including the physical length are obtained with the method presented and the coupler performance is compared with the planar electromagnetic simulators such as Sonnet and Ansoft Designer. It is shown that the results are in close agreement and the method can be used for applications that require accuracy.



**Fig. 1** - The geometry of three-line microstrip directional coupler