

A Broad-Band Coplanar Waveguide To Slotline Transition

Thinh Q. Ho and Stephen M. Hart

Abstract—A novel approach for designing a broad-band coplanar waveguide (CPW) to slotline transition is presented. A slotline hollow patch creates open circuit conditions on one arm of the CPW and resonates the transition so that maximum power transfer may occur. Excellent performance is observed over a 5:1 bandwidth.

I. INTRODUCTION

THE MAJOR effort until now has been directed at optimizing the microstrip to slotline transition [1]; however, the same emphasis has not been expended on a broad-band CPW to slotline equivalent [2], [3]. This letter discloses a very broad-band CPW to slotline transition. One important advantage of this type of transition is that both the CPW and slotline are printed on the same side of the substrate. Since the transition is uniplanar, no via-holes are needed for ground connections; it is therefore much easier to fabricate and to perform the integration with other circuitries. Another important advantage of this type of transition is that low insertion loss and excellent match over a bandwidth of more than 5:1 are considered achievable.

II. DESIGN DESCRIPTION

Fig. 1 shows the geometry and the equivalent network of a CPW to slotline transition. For CPW, the spacing between the center conductor of width W_c and the adjacent ground planes is S_c , while for the slotline the gap width is S_s . The power transfer between the two transmission line configurations is realized through a CPW single arm open circuit and an impedance matched slotline. The input and output characteristic impedances (Z_c, Z_s) were computed using the spectral domain technique [4], [5] and were selected to be 50 Ohms. The bandwidth of the transition is greatly enhanced, since the design has a broad-band open circuit. With this topology, the hollow patch of radius R_s represents a very wide-band open circuit at the junction. The dimensions of the hollow patch are experimentally determined for a given frequency band.

III. RESULTS

Testing was done on the complete circuit composed of two transitions in a back to back configuration. In the actual layout, $W_c = 5.0$ mils, $S_c = 2.0$ mils, and $S_s = 2.1$ mils were chosen

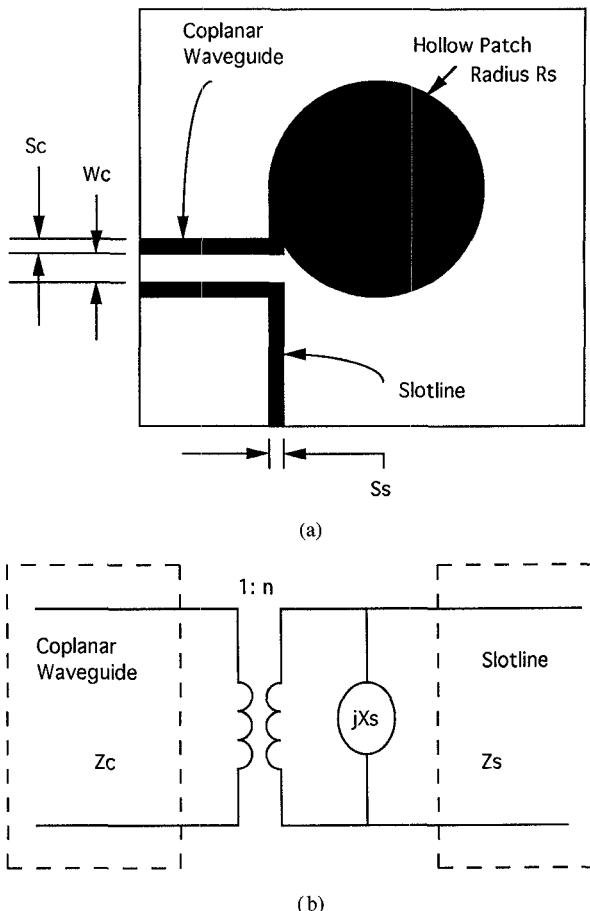


Fig. 1. Coplanar waveguide to slotline transition. (a) Geometry. (b) Equivalent network.

for a 50-mil thick substrate with dielectric constant of 10.0. Fig. 2 displays the resulting data with R_s equal to 62.5 mils. The input return loss has a two-pole response with minimum values of 32.0 dB and 27.0 dB at frequencies of 9.96 GHz and 4.31 GHz, respectively. An input return loss of 17.5 dB was measured at the center of the frequency band. Additionally, this figure shows the overall insertion loss of the circuit; a total insertion loss of about 0.35 dB was observed over most of the bandwidth. Note that the two transitions are separated by 350.0 mils and the printed circuit board was tested using Wiltron's Universal Test Fixture and Vector Network Analyzer. The response of the transition when R_s was 75.0 mils is also plotted in Fig. 2 for comparison. Rather intuitively, it was observed that as the radius of the hollow patch becomes larger, the frequency response shifts downward and vice versa.

Manuscript received June 25, 1992.

The authors are with NCCOSC, RDT & E Division, Code 753, San Diego, CA 92152-5000.

IEEE Log Number 9203257.

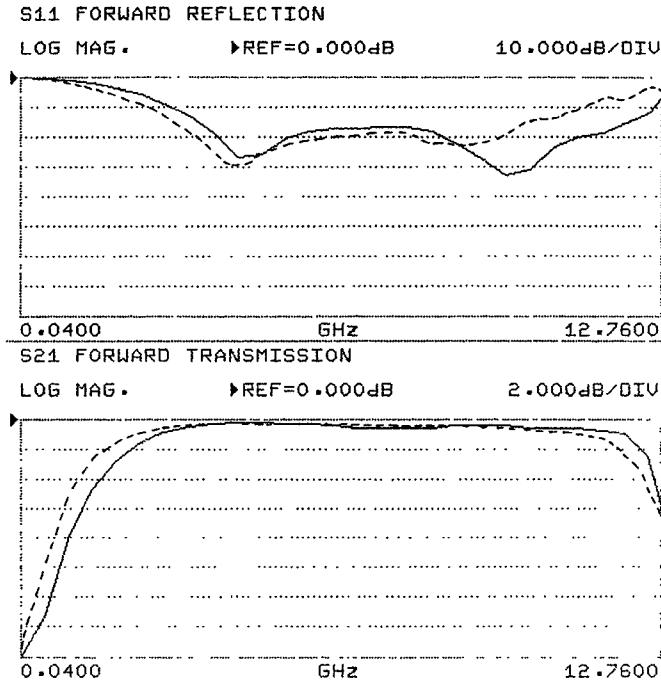


Fig. 2. Measured input return loss and insertion loss of two transitions in a back-to-back configuration with $W_c = 5.0$ mils, $S_c = 2.0$ mils, $S_s = 2.1$ mils, $h = 50.0$ mils, $\epsilon_r = 10.0$. Solid line: $R_s = 62.5$ mils. Dashed line: $R_s = 75.0$ mils.

IV. CONCLUSION

An experimental CPW to slotline transition has revealed the usefulness of the hollow patch to extend the bandwidth of inter-media power transfer. This design is simple to implement and allows easy insertion. Because of its excellent bandwidth, it is immediately recognized as a viable method for transferring power between the two transmission line media. Also, in applications involving printed circuit antennas, this transition could be invaluable for integration of wide-band printed circuit antennas excited by a balanced arm feed printed on the same side of the substrate.

REFERENCES

- [1] K. C. Gupta, R. Garg, and I. J. Bahl, *Microstrip Lines and Slotlines*. Norwood, MA: Artech House Inc., 1979, pp. 231-294.
- [2] M. Muraguchi, T. Hirota, A. Minakawa, K. Ohwada, and T. Sugita, "Uniplanar MMIC's and their applications," *IEEE Trans. Microwave Theory Tech.*, vol. 36, pp. 1896-1901, Dec. 1988.
- [3] D. Cahana, "A new coplanar waveguide/slotline double-balanced mixer," in *IEEE MTT-S Int. Microwave Symp. Dig.*, 1989, pp. 967-968.
- [4] T. Itoh and R. Mittra, "Dispersion characteristics of slotlines," *Electron. Lett.*, vol. 7, pp. 364-365, 1971.
- [5] J. B. Knorr and K. D. Kuchler, "Analysis of coupled slots and coplanar strips on dielectric substrate," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-23, pp. 541-548, July 1975.