Letters

A Microstrip and Stripline Crossover Structure

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Abstract—**A microstrip or stripline four-port structure which allows two signal paths to physically cross over while maintaining high isolation is described in this letter.**

Introduction

The development of microstrip and stripline theory has resulted in transmission-line circuits of increased complexity. As circuit packaging densities increase, transmission-line layout and routing problems become important. Situations may arise where signal channels must geometrically cross each other. A four-port network which allows two signal paths to cross over while maintaining high isolation and which is constructed without use of hybrid technology is described in this letter.

Theoretical Development

It is well known that the signals at the two output ports of a branch-arm hybrid are in phase quadrature and have magnitudes equal to $\sqrt{2}/2$ of the incident signal. If two branch-arm hybrids are cascaded as in Fig. 1(a), it can be shown by applying standard hybrid analysis techniques that the signal emerges only at the diagonal port of the composite structure, theoretically, with no insertion loss. Very little power emerges from the remaining two ports and consequently, high isolation between two crossing signal channels can be achieved. The usable bandwidth for 0-dB crossover is determined by the product of the swept frequency characteristics for the two hybrids and can be increased using multisection structures. Two cascaded single-section hybrids are reducible to the four-port structure shown in Fig. 1(b).

Experimental Design and Results

A two-section microstrip crossover structure with a center frequency of 6.0 GHz was constructed on a thin plastic substrate (h = 10 mil, ε_r = 2.3, 1.0-mil copper metallization). Junction parasitics were accounted for using the equations presented by Leighton and Milnes [1]. The swept-frequency characteristics of the crossover structure are shown in Fig. 2. The input-port return loss was greater than 18 dB at the center frequency (Fig. 2a) while the insertion losses at the isolated ports 2 and 3 were each greater than 20 dB [Fig. 2(b) and (c)]. The insertion loss at the diagonal port was less than 1.0 dB [Fig. 2(d)], a reasonable value for the substrate and metallization employed.

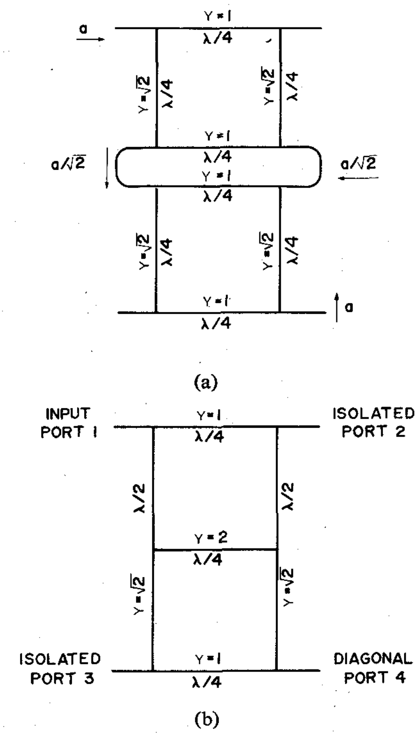

Fig. 1. Microstrip and stripline crossover structure. (a) Two cascaded branch-arm hybrids. (b) Crossover structure.

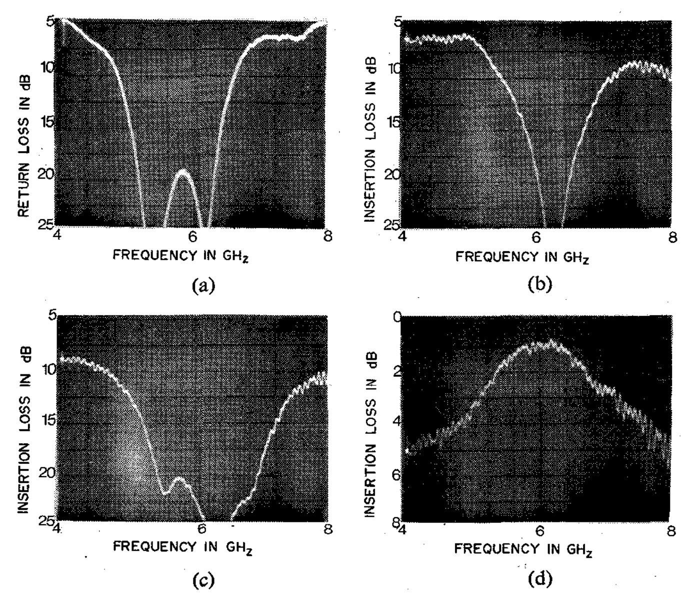

Fig. 2. Swept frequency characteristics of the microstrip crossover structure. (a) Input port return loss. (b) Isolated port 2 insertion loss. (c) Isolated port 3 insertion loss. (d) Diagonal port insertion loss.

References

[1] W. H. Leighton, Jr., and A. G. Milnes, "Junction reactance and dimensional tolerance effects on X-band 3 dB directional couplers," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-19, pp. 818–824, Oct. 1971.

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