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Study of Planar Transmission Structure and Dependence of Characteristic Impedance for Even and Odd-Modes on Spacing Between Two Metal Strips

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ABSTRACT

In this paper, we present about the study of planar transmission structure and dependence of characteristic impedance for even and odd-modes on spacing between two metal strips. The importance lies in the present study of light weight, small size and lower cost planer transmission structure like MIC's of communications. Also, in the fact that radio astronomers use these frequencies to study electromagnetic radiation originating from stars & others celestial objects.

Keywords : Stripline, Microwave, Microstripline Couplers.

I. INTRODUCTION

In ideal microstripline directional coupler makes use of the basic feature that power flowing in one direction in the strip conductor induces a power flowing in second strip conductor either in same direction or in reverse direction. First case is called forward coupling and second case is called reverse coupling. When a second strip conductor is placed close to the first coupled microstrip structure is formed and the electric and magnetic field lines get distorted. The coupling between the two lines is even and odd. In the even mode coupling power flow is in the same direction and in the odd mode power flow is in the reverse direction after coupling. In the age of modern high technology our country is developing tremendously with the growth of microchips and software. The importance lies in the study of light weight, small size and lower cost planer transmission structure like stripline microstripline specially in the field of communication. It is justified to carry out researches in this field of communication in the range of gigahertz frequency. For the purpose mathematical formulation of the problem is done using CAD and necessary computation & calculation will be carried out by using computers and calculator as well.

II. METHODS AND MATERIAL

The coupling coefficient (C) at mid band frequency has been expressed in equation 1. The feed line characteristic impedance is given by

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$Z_o = [Z_{oe} \times Z_{oo}]^{1/2}$ ------------- 1

Now for the design of a microstripline directional coupler of given coupling coefficient and feed line characteristic impedance we calculate even and odd-modes characteristic impedances using equations

$Z_{oe} = Z_o [(1 + C) / (1 - C)]^{1/2}$ -------------- 2

$Z_{oo} = Z_o [(1 - C) / (1 + C)]^{1/2}$ -------------- 3

Again using these values of characteristic impedances shape ratio for Alumina dielectric substrate ($\epsilon_r = 9.6$) is expressed as

$W/h = 20.37 [4/ Z_{oe} + 1/ Z_{oo}]$ --------------- 4

And approximate value space ratio is given by

$s/h = 377 (4 Z_{oo} + Z_{oe}) / (3 + 5 \sqrt{\epsilon_r}) Z_o^2$ ---------------- 5

Using these equations stripwidth and spacing between two striplines have been calculated for given coupling. Again, these values of shape ratio and space ratio are used to calculate Z_{oo} and Z_{oe} and results obtained are compared for conformity as $Z_{oe} = 86.6\ \Omega$ and $Z_{oo} = 28.8\ \Omega$ for w = 18.8 mils and s = 15 mils. Here 1 mil stand for 10^{-3} inch.

III. RESULTS AND DISCUSSION

Study of dependence of characteristic impedance for even and odd-modes on spacing between two metal strips:

For this study characteristic impedances for even and odd-modes have been computed by putting the values of relative permittivity, substrate height, frequency, and strip thickness and by changing the spacing between two metal strips. These results have been placed in table 1. Keeping spacing on x-axis and characteristic impedances on y-axis graph have been plotted both for even and odd-modes as shown in graph 1.

Table 1: Dependence of characteristic impedance for even and odd-modes on spacing between two metal strips

Spacing (s) mils	Z_{oe} Ω	Z_{oo} Ω	$(\epsilon_{reff})_e$	$(\epsilon_{reff})_o$
10	120.22	42.12	6.78	5.42
20	115.52	49.14	6.72	5.37
50	101.14	60.12	6.65	5.34
100	91.97	70.14	6.62	5.32

h = 100 mils, t = 0.01 mils, f = 2 GHz, $\epsilon_r = 9.6$,

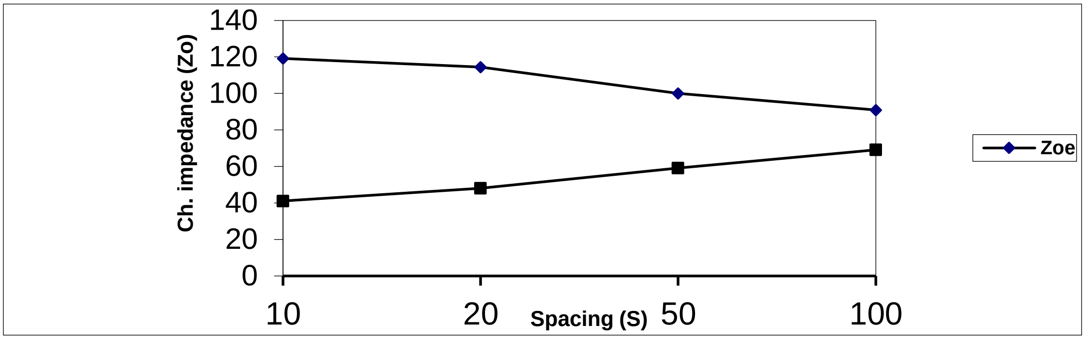
1 mils = 10^{-3} inch = 2.54 µm, w = 30 mils

These results show that with increase of spacing between two metal strips, characteristic impedances for even-mode decreases but for odd-mode increases. Also, for given spacing, the characteristic impedance for odd-mode is smaller than that for even-mode. This concludes that energy flow is larger for wider spacing in case of even-mode and smaller in case of odd-mode.

Graph 1: Dependence of characteristic impedance for even and odd-modes on spacing between two metal strips

h = 100 mils, t = 0.01 mils, f = 2 GHz, $\epsilon_r = 9.6$,

w = 30mils, 1 mils = 10^{-3} inch = 2.54 µm



IV. CONCLUSION

For different values of spacing even and odd-mode results show that with increase of spacing between two metal strips, characteristic impedances for even-mode decreases but for odd-mode increases. Also, for given spacing, the characteristic impedance for odd-mode is smaller than that for even-mode. This concludes that energy flow is larger for wider spacing in case of even-mode and smaller in case of odd-mode.

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