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Design and Analysis of Planar Transmission Structure Using Computer Aided Design Techniques

Rajat Ranjan Pandey[1], Dr. K. B. Singh[2], Dr. Rajendra Prasad[2]
[1] Research Scholar, University Department of Physics, B. R. A. Bihar University, Muzaffarpur, Bihar, India
[2]Department of Physics, L. S. College, Muzaffarpur, Bihar, India

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ABSTRACT

In this paper, we present about the study of analysis and synthesis of single and coupled microstripline structures using computer aided design techniques.. 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 : Self- Inductance, Microwave, Microstripline Couplers.

I. INTRODUCTION

With the development of solid-state devices operating at microwave Giga hertz range of frequency plays very significant and important role to develop different form of transmission structure in the Microwave Integrated Circuit (MIC's) which promises a real revolution leading to both expansion of present markets of microwave and opening of many applications in defense. The proposed project aims at the Analytical Study of synthesis of single and coupled microstripline structures with different characteristic parameters with different substrate which are useful in desining of coupler and filters. 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. The different parameters which characterize the various types of MIC's are the characteristics impedance, phase velocities, wave guide capacitance & inductance. The study of frequency dependence of the capacitance and different parameters with strip geometry is of great significance for the design purpose.

II. MATERIALS AND METHOD

Phase velocity is an important parameter for the calculation of characteristic impedance of the microstripline coupler. The velocity with which wave propagates through the transmission structures is the functions of geometries of the structure, relative permittivity of the dielectric substrate and operating frequency so the phase velocity also determines the characteristic parameters of transmission structure. The phase velocity can be calculated by the formula

$V_p = c / \sqrt{\epsilon_{reff}}$ --------------- 1

In case of coupled microstripline structure there are two modes of propagation even and odd-modes. The equation (1) can be rewritten as

For even mode

$(V_p)_e = c / (\sqrt{\epsilon_{reff}})_e$ --------------- 2

and for odd mode

$(V_p)_o = c / (\sqrt{\epsilon_{reff}})_o$ --------------- 3

The coupling coefficient (C) at mid band frequency has been expressed in equation 4. The feed line characteristic impedance

is given by

$Z_o = [Z_{oe} \times Z_{oo}]^{1/2}$ ------------- 4

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

$Z_{oe} = Z_o [(1 + C) / (1 - C)]^{1/2}$ -------------- 5

$Z_{oo} = Z_o [(1 - C) / (1 + C)]^{1/2}$ -------------- 6

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

$W/h = 20.37 [4/ Z_{oe} + 1/ Z_{oo}]$ --------------- 7

And approximate value space ratio is given by

$s/h = 377 (4 Z_{oo} + Z_{oe}) / (3 + 5 \sqrt{\epsilon_r}) Z_o^2$ ---------------- 8

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

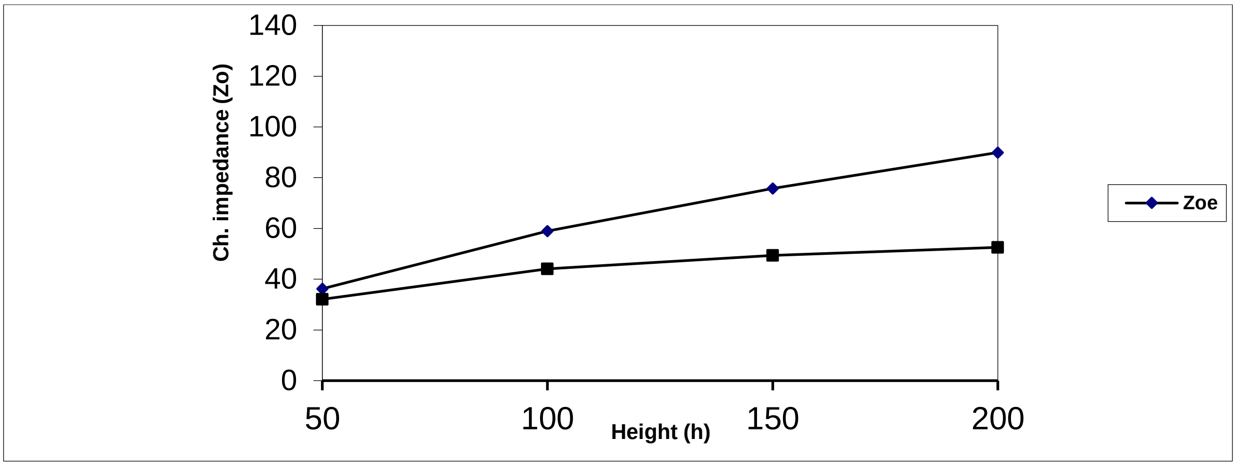
For this study Alumina has been chosen for dielectric substrate. Exhaustive computations have been carried out for different values of substrate height keeping stripwidth, spacing and frequency fixed. Results obtained have been placed in table 1 keeping height on x-axis and even and odd-modes characteristic impedances on y-axis graphs have been plotted as shown in graph 1. Form the result it is clear that even and odd-modes characteristic impedances increases with increase with substrate height but rate of increase for even-mode is larger than that for odd-mode.

Table 1: Dependence of characteristic impedance on height of the dielectric substrate t = 0.01 mils, f = 2 GHz, S = 100 mils, 1 mils = 10^{-3} inch = 2.54 μm, w = 100 mils

Height h	Even-mode	Odd-mode
	Z_{oe} Ω	Z_{oo} Ω
50	36.23	32.08
100	58.97	44.03
150	75.74	49.37
200	89.95	52.55

Graph 1: Dependence of characteristic impedance on height of the dielectric substrate

t = 0.01 mils, f = 2 GHz, S = 100 mils, 1 mils = 10^{-3} inch = 2.54 μm, w = 100 mils



IV. CONCLUSION

The results obtained have been placed in table 1 keeping height on x-axis and even and odd-modes characteristic impedances on y-axis graphs have been plotted as shown in graph 1. Form the result it is clear that even and odd-modes characteristic impedances increases with increase with substrate height but rate of increase for even-mode is larger than that for odd-mode.

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