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Study of Design Synthesis and Fabrication of a Microstripline Coupler

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ABSTRACT

In this paper, I present about the study of design synthesis and fabrication of a microstripline coupler. 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

A natural coupling exists when two microstriplines are placed parallel to each other in close proximity. 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. FORMULATION OF MICROSTRIPLINE COUPLER

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

III. DESIGN SYNTHESIS OF MICROSTRIPLINE COUPLER

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

is given by

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

IV. STUDY OF DEPENDENCE OF GUIDE WAVELENGTH FOR EVEN AND ODD-MODES ON STRIPWIDTH AND SPACING

For this purpose, exhaustive computational works have been performed. Manual calculation of the guide wavelength has been also carried out. For different values of stripwidth even and odd-mode guide wavelength have been calculated keeping spacing, frequency and relative permittivity fixed. The results obtained have been placed in tables 1. Graphs have been plotted keeping stripwidth on x-axis and guide wavelength on y-axis as shown in graphs 1. The results show that as stripwidth increases guide wavelength for even-mode decreases but for odd-mode increases. For different values of spacing even and odd-mode guide wavelength have been calculated keeping stripwidth, frequency and relative permittivity fixed. The results obtained have been placed in tables 1. Graphs have been plotted keeping spacing on x-axis and guide wavelength on y-axis as shown in graphs 1. But effect of spacing on guide wavelengths is very little.

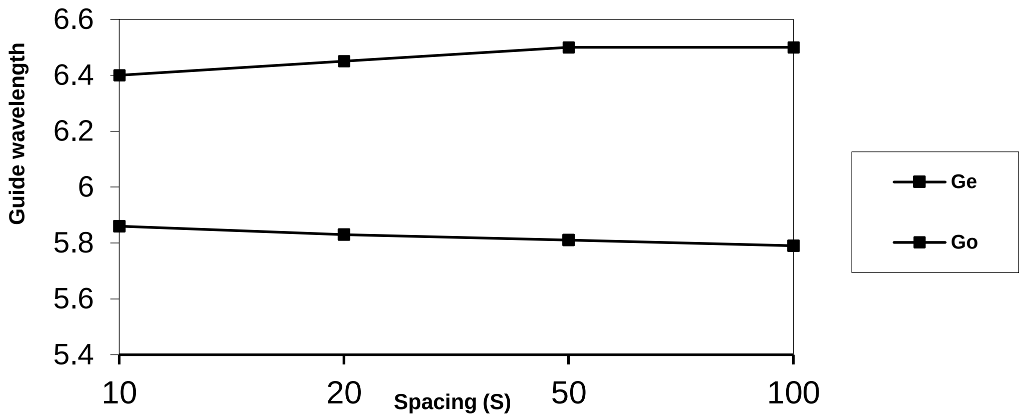
Table 1: Dependence of guide wavelength for even and odd-modes on spacing

f = 2 GHz, t = 0.01 mils, ϵ_r = 9.6

Spacing S mils	Even mode				Odd-mode			
	$(\epsilon_{reff})_e$	$\sqrt{(\epsilon_{reff})_e}$	V_{pe} x 10^8 m/sec	λ_{ge} x 10^{-2} m	$(\epsilon_{reff})_o$	$\sqrt{(\epsilon_{reff})_o}$	V_{po} x 10^8 m/sec	λ_{go} x 10^{-2} m
10	6.59	2.57	1.173	5.87	5.45	2.34	1.29	6.51
20	6.61	2.58	1.168	5.84	5.42	2.33	1.28	6.47
50	6.67	2.59	1.163	5.82	5.36	2.32	1.31	6.51
100	6.71	2.61	1.159	5.79	5.33	2.31	1.31	6.51

Graph 1: Dependence of guide wavelength for even and odd-modes on spacing

f = 2 GHz, t = 0.01 mils, ϵ_r = 9.6



V. CONCLUSION

For different values of spacing even and odd-mode guide wavelength have been calculated keeping stripwidth, frequency and relative permittivity fixed. The results obtained have been placed in tables 1. Graphs have been plotted keeping spacing on x-axis and guide wavelength on y-axis as shown in graphs 1. But effect of spacing on guide wavelengths is very little.

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