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Dependence of reflection and transmission Coefficient of Micro-strip line in directional coupler

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Abstract -*Any good micro-strip line directional coupler utilize the fundamental principle which states that power flowing in one direction in the main micro strip line induces flow in the second line in the opposite direction. The coupling characteristics of line & the direction of reflection of waves depend upon width of micro-strip line, spacing between them and the frequency of operation. In the directional coupler, some power gets reflected back. In this paper, we will show the effect of dependence of reflection and transmission coefficient on strip width of micro-strip line in a directional coupler. The result is plotted on IE3D software.*

Key Words: *micro-strip line, directional coupler, reflection coefficient and transmission coefficient*

1. INTRODUCTION

Micro strip directional couplers have been employed in microwave systems to measure transmitted and reflected power accurately. They possess several advantages like manufacturability, repeatability as well as low cost. It has been a topic of extensive research to design micro strip line directional couplers with widespread application.

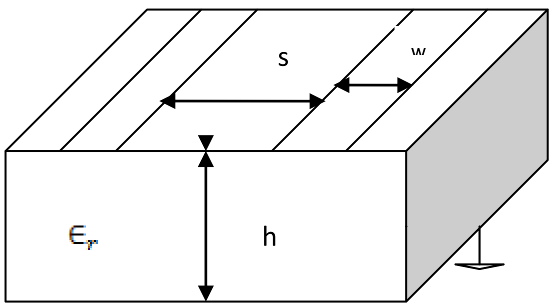


Fig 1: Two-line microstrip directional coupler

The complication in directional coupler lies in controlling the input such that we get two output signals. On the other hand, when input is applied to opposite ports of any internally terminated coupler, we get an output signal. We find output signals unequal in amplitude. Larger signals are produced at the main-line output port. The smaller signal is found at the coupled port. From design, we find that main-line insertion loss depends on the signal level at the coupled port. Isolation between the coupled port and main-line output is high. Basic characteristics of a directional coupler are:

i. coupling coefficient
ii. coupling flatness
iii. main-line loss
iv. directivity

High performance features of these units allow the following signal processing functions to be taken care of. They include measurement of incident and reflected power so as to find VSWR along with signal sampling, signal injection, signal generator/oscillator leveling, and power flow monitoring. 3. There is high isolation between the coupled port and the output of the main-line. A schematic representation of the coupler is as follows; the arrows show signal flow: Key characteristics of a directional coupler include coupling coefficient, coupling flatness, main-line loss and directivity, defined on the next page. Mini-Circuits' full line of directional couplers, spanning 5 kHz to 2 GHz, provide excellent performance. They feature:

1. Flat coupling over a broad bandwidth
2. Low main-line loss, as low as 0.1 dB
3. Directivity as high as 55 dB and
4. A wide range of coupling values, from 6 dB to 30 dB directional coupler applications

The high performance characteristics of these units enable the following signal processing functions to be accomplished: measure incident and reflected power to determine VSWR, signal sampling, signal injection, signal generation as well as oscillation leveling and power flow monitoring.

2. THE REFLECTION AND TRANSMISSION COEFFICIENT

The transmission line at any point is given by:

$$V = ae^{-Px} + be^{Px} \quad (1)$$

$$I = \frac{1}{z}(ae^{-Px} + be^{Px}) \quad (2)$$

Where ae^{-Px} represent the incident wave and be^{Px} represent the reflected wave. Consider y distance measured from the terminated load impedanceZ_r. Then equation (1) and (2) can be rewritten as

$$V = ae^{Py} + be^{-Py} \quad (3)$$

$$I = \frac{1}{z}(ae^{Py} + be^{-Py}) \quad (4)$$

When$y = 0$, that implies at the receiving end, we have:

$$V = V_R \quad (5)$$

$$I = I_R \quad (6)$$

Where:

$$V_R = A + B \quad (7)$$

$$I_R = (A - B)/Z_0 \quad (8)$$

Therefore, we get values of:

$$A = \frac{(V_R + Z_0 I_R)}{2} \quad (9)$$

And

$$B = \frac{(V_R - Z_0 I_R)}{2} \quad (10)$$

Reflection coefficient denoted by Γ is given mathematically as:

$$\Gamma = \frac{V_r}{V_i} \quad (11)$$

$$\Gamma = \frac{be^{-Py}}{ae^{Py}} \quad (12)$$

$$\Gamma = \frac{be^{-2Py}}{a} \quad (13)$$

At Z_r termination, y=0, so we get:

$$\Gamma = \frac{b}{a} \quad (14)$$

$$\Gamma = \frac{Z_r - Z_0}{Z_r + Z_0} \quad (15)$$

So, we can calculate Γ if Z_r(load impedance) and Z_0(characteristic impedance) are known.

3. DEPENDENCE OF REFLECTION COEFFICIENT AND TRANSMISSION COEFFICIENT ON STRIP-WIDTH

As per definitions of the reflection and transmission coefficients the characteristic impedance for even and odd-modes of propagations and their geometric mean play an important role for the study of these coefficients. It is proved that these are the functions of strip geometries, substrate permittivity and operating frequencies. We have focused our study on dependence of reflection and transmission coefficients on the strip-width and spacing between two metal strips. The results of chapter 4 have been also used here. On the basis of computed results various manual calculations have been carried out for different strip-width keeping spacing between two strips fixed. The results have been placed in table 1 and graphs have been plotted keeping strip-width on x-axis and reflection and transmission coefficients on y-axis as displayed in graph 1. As the results shows that as metal strip-width increases, reflection coefficient both in even-mode and odd-modes decreases where as transmission coefficient increases with increase of metal strip-width. This means concentration of flux is greater in case of wider strip than that for thinner strips and flow of power through the strip in the forward direction both for even and odd-modes is larger than in the backward direction. As a result the ability for transmission is always greater than the ability of reflection for all metal strip-width. The result is also applicable for both in case of even and odd-modes for wider strips.

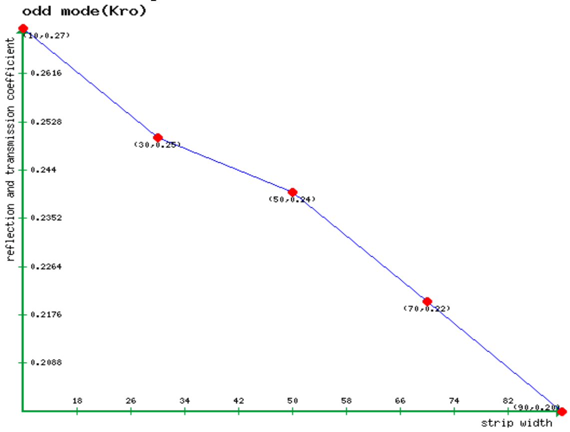
4. RESULT

Table No. 1-Dependence of reflection and transmission coefficient on strip width

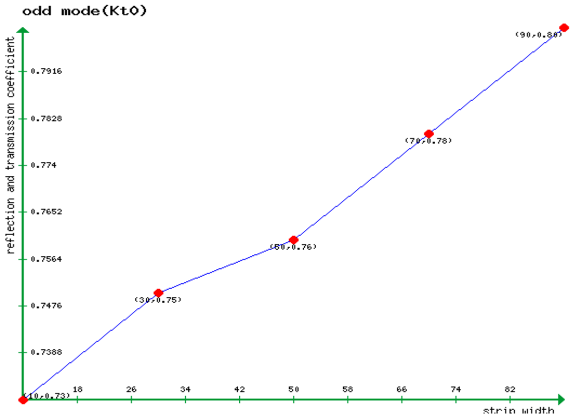
f = 2GHz, t = 0.05 mils, s = 10 mils, Єr = 9.6

w	Even-mode		Odd-mode	
	Kre	Kte	Kro	Kto
10	0.26	0.74	0.27	0.73
30	0.23	0.77	0.25	0.75
50	0.22	0.78	0.24	0.76
70	0.21	0.79	0.22	0.78
90	0.20	0.80	0.20	0.80

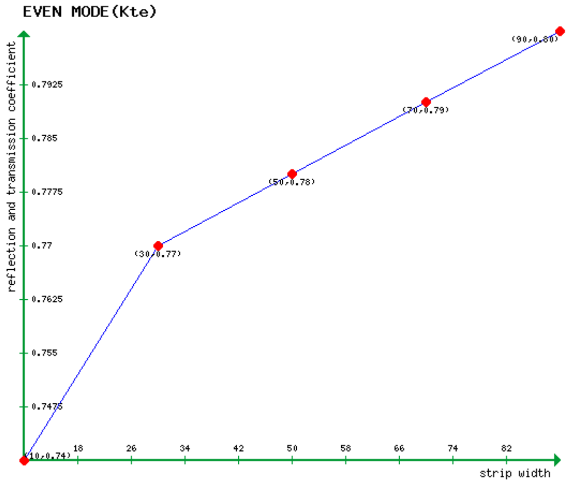
Graph No. 1-Dependence of reflection and transmission coefficient on strip width for Kro.



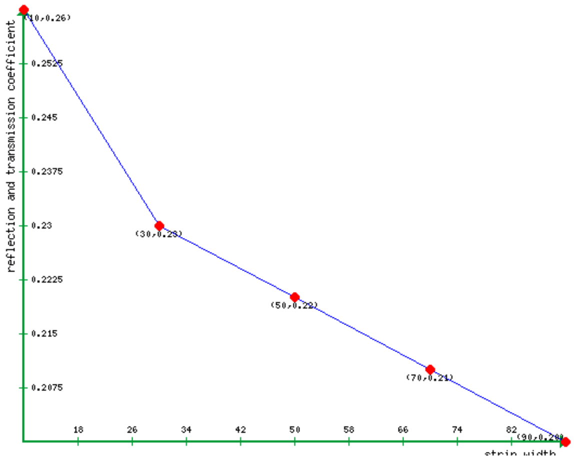
Graph No. 2-Dependence of reflection and transmission coefficient on strip width for Kto.



Graph No. 3-Dependence of reflection and transmission coefficient on strip width for Kte.



Graph No. 4
Dependence of reflection and transmission coefficient on strip width for Kre.



5. DISCUSSION AND CONCLUSION

As above discussion we concluded that the characteristic parameters such as characteristic impedance, phase velocity and guide wave length are the functions of geometries of the structures and the relative permittivity of the substrate used. From here we get to know that energy flux linked with the coupled structures is more for wider stripwidth. And this could be for wider spacing in case of even-mode compared to odd-mode. We have studied the reflections and transmission coefficients for micro-strip line coupler. The variation of coefficients with respect to strip-width, and relative permittivity has been found out with help of IE3D. We find that the reflection coefficient for narrow metal strips is greater than that in wider strip-width. It is also valid for narrower spacing. We find that energy flux is greater in the reflected part for wider strip and spacing. The transmission coefficient is good for wider strip and spacing both for even and odd-modes. Thus, more and more power are transmitted in wider metal strip and spacing. We can utilize this design for different microwave components like micro-strip isolator, circulator as well as directional coupler. The power flow can be taken care of by suitable approach of the design structure, and substrate material and frequency. Future research scope of microwave components and their characteristics will find wide application.

REFERENCES

[1] Sah, H.L, R.R, Kumar & K.B.Singh, "A new horizon of communication using fibre technology", NSOE-03, April-2003, Meerut (India).

[2] B. Bhat and S. K. Koul."Strip line like transmission lines for MIC's", Wiley Eastern Limited, (1990).

[3] H.A. Wheeler, Transmission line properties of parallel strip separated by dielectric sheet. IEEE, Tr. MTT-13, page 172-185 (1965).

[4] S. B. Cohn, "Slot line on dielectric substrate", IEEE Trans MTT-17, 1969, pp 168-178.

[5] I. J. Bahl & P. Bhartia,"Microwave engineering and applications", John Wiley & Sons, N.Y.1994.

[6] K.C Gupta, Ramesh Garg, Inder Bahl & Prakash Bhatia, "Microstrip lines and Slotlines", Second edition,.Artech House, Boston, London.

BIOGRAPHIES

Sonjuhi Mrinalee has done her B.Tech from RTU Kota in E&C. Currently she is doing ME in E&C from BIT Mesra. She has worked as Assistant professor for two years in JEC Kukas. Her area of interest is MIC, Decoders, Signal Processing etc.

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