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Study of The Directivity of Microstripline Directional Coupler and Its Dependance on Stripwidth

Kunjesh Kumar[1], Dr. K. B. Singh[2], Prof. Rajendra Prasad[2]
[1]Research Scholar, University Department of Electronics, 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, I present about the study of the directivity of 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

The study will explore how the parameters can be varied for different specifications (i.e. directivity and coupling factor). The demand for telecommunication services is increasingly shifting from a locally - based telephony to long - distance and wide - based services using mobile telephones & cellular phones. Parallel to this the advent of microwave technology has also revolutionized the concept of telecommunication and data transfer. In the modern world, exchange of information at faster rate is a critical management tool. The advances in microwave technologies have helped in bringing the world closer. The flow of power means the propagation of electromagnetic waves through these structures. There are different modes of propagation of waves such as (i) TEM-mode, (ii) TE-mode, (iii) TM-mode, and (iv) Non-TEM-mode. Which discussing the propagation of wave through Stripline or microstriplines TEM-mode is considered in the lower giga hertz range of frequency in the present work [1-4].

II. MATERIALS AND METHOD

It is the measure of discrimination of a directional coupler between forward and backward waves and is defined as the ratio of the voltage coupled to the desired port and of the voltage coupled to the undesired port, i.e.

$D = V_4/V_3$

$$D(dB) = -20 \text{ Log } V_4/V_3 \quad \text{--------------- } 1$$

For an ideal forward directional coupler directivity is infinity, i.e. voltage at port 3 should be ideally zero. The signal is coupled only to port 4, ports (2) and (4) being perfectly matched. [3-5] With microstrip the differing field pattern associated with the odd and even modes, give rise to different phase velocities. This results in some coupling to the unwanted port as well. The greater difference in the phase velocities of the even and odd modes makes the coupling tighter. This parallel microstrip directional coupler may not give a wide band width performance for tight coupling. Further the directivity depends on microstrip geometry and substrate property ϵ_r . An approximate but simpler mathematical expression for the directivity of the coupled microstrip coupler is given as

$D = [4|\xi| / \Delta\pi(1- |\xi^2|)]^{-2}$

$$D = [\lambda\pi(1- |\xi^2|) / 4|\xi|]^2 \quad \text{--------------- } 2$$

Where,

$$\Delta = [\lambda_{go} / \lambda_{ge}] -1 \quad \text{--------------- } 3$$

λ_{ge} and λ_{go} are the guide wavelengths of the coupled lines for even and odd modes respectively and expressed by equation and

$$\xi = [\rho_e / 1- \rho_e^2] - [\rho_o / 1+ \rho_o^2] \quad \text{---------------- } 4$$

Where,

ρ_e = Reflection coefficient for even mode.

$$= Z_{oe} - Z_o / Z_{oe} + Z_{oo} \quad \text{--------------- } 5$$

and ρ_o = Reflection coefficient for odd mode.

$$= Z_{oo} - Z_o / Z_{oe} + Z_{oo} \quad \text{--------------- } 6$$

III. RESULTS AND DISCUSSION

The coupling coefficient and directivity can be calculated manually using calculators by measuring the values of characteristic impedance for even and odd-modes and guide wavelengths and the results obtained are placed in tabular form as shown in table 1 for further study. For the study of dependence of directivity on metal stripwidth and spacing for a given coupling coefficient and at given frequency [5-9]. Manual calculations have been carried out and graph has been plotted with stripwidth on x-axis and directivity on y-axis as shown in graph 1. Result shows that as stripwidth increases directivity decreases showing the amount of power coupled to the neighbouring stripline in forward direction. Also, directivity decreases with increase of spacing between two striplines.

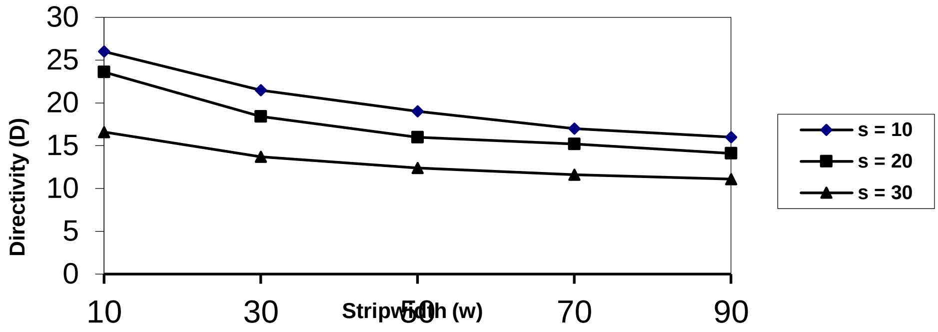
Table 1: Dependence of Directivity on stripwidth

h = 100 mils, f = 2 GHz, t = 0.01 mils, ϵ_r = 9.6

w	S = 10 mils		S = 20 mils		S = 50 mils	
	C (dB)	D	C	D	C	D
10	6.1	26.1	7.1	23.9	11.6	16.7
30	6.3	21.6	8.2	18.5	11.7	13.8
50	6.9	19.1	8.4	16.1	11.8	12.5
70	7.3	17.1	8.6	15.3	12.2	11.7
90	8.1	16.1	9.3	14.2	12.6	11.2

Graph 1: Dependence of Directivity on stripwidth

h = 100 mils, f = 2 GHz, t = 0.01 mils, Єr = 9.6



IV. CONCLUSION

Different methods have been developed for the study of characteristics, and design techniques for computing coupling factor and directivity of the coupled lines of given parameters. To study of directivity of the microstripline coupler mathematical formulation of the problem is accomplished using CAD to obtain specified parameters. Manual calculations have been carried out and graph has been plotted with stripwidth on x-axis and directivity on y-axis as shown in graph 1. Result shows that as stripwidth increases directivity decreases showing the amount of power coupled to the neighbouring stripline in forward direction. Also, directivity decreases with increase of spacing between two striplines.

V. REFERENCES

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

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

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

[4]. Gupta K.C. et al, "Microstrip and Slotlines", Artech house, pp-66-71, 1979.

[5]. Gupta K.C. and Singh Amarjeet, "Microwave Integrated Circuits", 1974.

[6]. H. Howe, "Stripline circuit design of coupled Parallel lines", Artech House, pp. 112-137, 1974.

[7]. M.K.Krage, "Characteristics of coupled microstrip transmission line by coupled mode formulation of inhomogeneous lines", IEEE vol. MTT-18, No.-4, April 70.

[8]. Banmal Rawat& G.R. Babu, "Determination of coupled microstripline parameter using Green's function Technique. Int. J. Electronics, 1985 vol. 58, No.1, pp.133-139.

[9]. G. Policky, "Parallel coupled lines as microstrip", Texas Instrument Inc. Rept. 03-61-67.

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

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

[12]. M.V. Schneider "Dielectric loss in integrated Microwave circuits. Bell system", Technical Journal, vol.48, page 2325-2332, (1969).

[13]. A. Shelby, D. R. Smith, S. Schultz, "Experimental verification of a negative index of refraction," Science, 292, pp. 77–79, 2001.

[14]. R. Marques, F. Mesa, J. Martel, and F. Median, Comparative analysis of edge and broadside coupled split ring resonators for metamaterial design-Theory and experiment, IEEE Trans. Antennas Propag.51, pp 2572–2581.2003,

[15]. D.R. Smith, J.B. Pendry, and M.C.K. Wiltshire, Metamaterials and negative refractive index, Science, 305, pp.788–792. 2004,

[16]. S. A. Ramakrishna, "Physics of negative refractive index materials," Rep. Prog. Phys. 68, pp. 449–521, 2005.

[17]. P.M.T. Ikonen, S.I. Maslovski, C.R. Simovski, and S.A. Tretyakov, on artificial magnetodielectric loading for improving the impedance bandwidth properties of microstrip antennas, IEEE Trans. Antennas Propag. 54, pp.1654–1662. 2006

[18]. Yoonjae Lee and Yang Hao, "Characterization of microstrip patch antennas on metamaterial Substrates loaded with complementary split-ring Resonators" Wiley Periodicals, Inc. Microwave Opt Technol. Lett. 50, pp.2131–2135, 2008.

[19]. Hou, D.-B.; et, al., "Elimination of scan blindness with compact defected ground structures in microstrip phased array", IET Microwaves, Antennas and Propagation, 3: 269–275, doi:10.1049/iet-map:20080037, 2009.

[20]. Guha, D.; Biswas, S.; Antar, Y. "Defected Ground Structure for Microstrip Antennas", in Microstrip and Printed Antennas: New Trends, Techniques, and Applications, John Wiley & Sons: UK, doi:10.1002/9780470973370, 2011.

[21]. Pozar, David M., Microwave Engineering Addison–Wesley Publishing Company. ISBN 978-81-265-4190-4, 2017.

[22]. Lee, Kai Fong; Luk, Kwai Man," Microstrip Patch Antennas". World Scientific. pp. 8–12. ISBN 978-9813208612, 2017.

[23]. Pandey, Anil, "Practical Microstrip and Printed Antenna Design", Bostan: Artech House. p. 443. ISBN 9781630816681, 2019.

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