International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
doi : https://doi.org/10.32628/IJSRST

Study of Heat Losses in Isolated Microstripline Structure

Dharmendra Sharma[1], Dr. K. B. Singh[2], Prof. Rajendra Prasad[2]
[1]Research Scholar, Department of Physics, B. R. A. Bihar University, Muzaffarpur, Bihar, India
[2]P. G. Department of Physics, L. S. College, Muzaffarpur, Bihar, India

ARTICLEINFO

Article History:
Accepted: 05 Jan 2023
Published: 30 Jan 2023

Publication Issue
Volume 10, Issue 1
January-February-2023

Page Number
650-653

ABSTRACT

In this paper, we discussed the analytical study of the heat losses in isolated microstripline structure due to wave propagation in the Gigahertz of frequency. For the study of heat loss due to presence of metal strip and dielectric material rise of temperature has been calculated. For the purpose we have calculated first conductor loss (αc) & Dielectric loss (αd).

Keywords: MICs, Directional Couplers, Ch. Impedance

I. INTRODUCTION

Several authors have developed various methods for the study of characteristics of single & coupled microstriplines [1]. Using a brief account of some methods we deal this paper with the analytical study of the characteristic impedance of microstripline couplers and their variation with geometry and frequency using Alumina substrates for the design synthesis of the microstripline coupler which is the aim of the present work. All the parallel line couplers, whether mode of propagation is true TEM or not, have the even and odd-mode property which always results in even- mode characteristic impedance (Z_{oe}) and odd-mode characteristic impedance (Z_{oo}). For the study of the characteristic impedance of the microstripline coupler we develop the mathematical formula for even and odd-mode and then we will calculate the results. With the help of these results design synthesis technique is used to obtain the geometrical parameters of a coupler of given parameters. The mathematical formulation is based on the conformal transformation technique developed by H.A. Wheeler and Calculation is based on the computer programming developed by S. K. Kaul using closed form formula of Schwarzmann. This technique is too much popular now-a-days and provides an easy approach for the analysis and synthesis of single and coupled microstriplines and other structures useful in MIC's. These results were found in reasonable agreement amongst themselves. Banmali, Rawat and Babu using methods of images calculated the characteristic parameters and founded them in close agreement with each other. The results obtained by image method were intermediate between Wheeler's two results for wide and narrow strips [2-5].

II. FORMULATION OF THE PROBLEM OF A MICROSTRIPLINE COUPLER

The study of microstripline coupler involves the analysis of even- and odd- modes of propagation. In the even-mode, energy traveling down, one microstrip line is coupled into a parallel line and travels in the same direction, where as in the odd-mode energy travels in the reverse direction after coupling. The derivation of the equation for the modes begins with the consideration of a basic single microstrip conductor shown in Fig (1). The characteristic impedance can be calculated with the help of elementary transmission line equation expressed as $Z_o = 1/V_P C_P$, Where, V_P= phase velocity of the wave traveling along the microstrip line. C_P = capacitance per unit length of the line. The capacitance of the line is the result of the combination of different components indicated in fig (1). These are:

C_{PP} = parallel plate capacitance between lower surface of the microstrip and the ground plane and is given by

$C_{PP} = [\varepsilon_{reff}/c.\eta]. (w/h)$ --------------- 1

C_{PPU} = capacitance between the upper surface of the microstrip and the ground plane which is expressed as

$C_{PPU} = (2/3) [\varepsilon_{reff}/c.\eta]. (w/h)$ -------------- 2

C_F = the fringing capacitance at the edges of the microstrip and is expressed

$C_F = [\varepsilon_{reff}/ c.\eta]. (2.7/Log4h/t)$ --------------- 3

Where, w =microstrip width, ε_{reff} = the effective dielectric constant of the medium, h=height of the substrate, Z_o=free space impedance = 377 Ω ,c=the velocity of light in free space = 3.0 X 10^8 m/sec, t = microstrip thickness.Thus the total capacitance (C_P) of the isolated microstrip structure is expressed as

$=C_{PP} + C_{PPU} + C_F$ or

$C_P=(\varepsilon_{reff} / c.\eta) (w/h) + (2/3) (\varepsilon_{reff} / c.\eta) (w/h) (\varepsilon_{reff} / c.\eta)(2.7/Log4h/t)$------ 4

This is the expression of the capacitance of the microstrip structure in terms of its geometric parameters. The phase velocity V_P can be calculated by the formula

$V_P = c / \varepsilon_{reff}$ -------- 5

For wide strip, ε_{reff} , ε_r , and For narrow strip, ε_{reff} , $(\varepsilon_r + 1) / 2$

Where, ε_r = relative dielectric constant.From equations (1, (2) and (3), we get

$Z_o = (\varepsilon/\varepsilon_{reff}). [1/[(w/h) + (2w/3h) + (2.7/Log4h/t)]]$ -------- 6

The calculations made on the basis of this expression give the characteristics impedance, the propagation constant and other transmission parameters of a single microstrip structure [5-7].

III.STUDY OF HEAT LOSS IN ISOLATED MICROSTRIPLINE

For the study of heat loss due to presence of metal strip and dielectric material rise of temperature has been calculated. For the purpose we have calculated first conductor loss (α_c) & Dielectric loss (α_d). Exhaustive computational work has been carried out. Further for the study of variation of thermal loss with geometry, permittivity and operating frequency following process has been adopted [7-12].

(i) Variation in rise in temperature with stripwidth;
(ii) Variation of rise in temperature with relative permittivity;
(iii) Variation of rise in temperature with frequency.

IV. DISCUSSIONS AND CONCLUSIONS

From above study it has been found that heat loss due to propagation of wave through isolated microstripline depends on the presence of metal strip and dielectric material. It is also found that this effect is the function of frequency also. The increase of stripwidth decreases the thermal effects and rise in temperature. Further this effect is larger for dielectric material of higher permittivity. Discussion of the result exhibit that change of strip geometry causes the distortion of field and flow of power through the stripline gets affected. In case of narrower strip, thermal effect is larger. Thus, it can be concluded that to get higher thermal effects narrower strip and substrate material of higher relative permittivity should be taken. Thermal effects due to waves of giga hertz frequency can be supposed to be another mode of heat transfer and production. It is also found that with increase of stripwidth effective width and effective permittivity increase for both even and odd-modes of propagation. They also show increase with increase of frequency. This variation has the impact on variation in flux line and flow of power causing variation in heat losses.

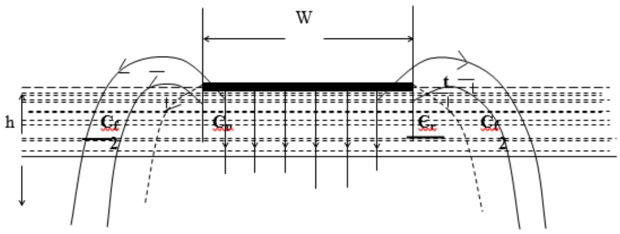


Fig 1. Electric field configuration in a microstrip (Isolated)

Table No. 1: Variation of rise in temperature with stripwidth of isolated microstripline taking relative permittivity as a parameter

h = 100 mils, w = 100 mils, f = 3 GHz

w (mils)	Ɛr = 3.75			Ɛr = 6			Ɛr = 10		
	αd x 10-2 dB/m	αc dB/m	ΔT °C	αd x 10-2 dB/m	αc dB/m	ΔT °C	αd x 10-2 dB/m	αc dB/m	ΔT °C
10	2.24	2.28	30.67	2.72	2.73	36.72	4.06	3.12	42.03
50	2.66	0.74	10.08	3.08	0.85	11.58	4.28	1.13	15.41
100	2.71	0.47	6.47	3.18	0.56	7.71	4.37	0.76	10.46
150	2.76	0.38	5.27	3.28	0.46	6.37	4.46	0.51	7.10
200	2.80	0.33	4.57	3.76	0.40	5.60	4.55	0.48	6.73

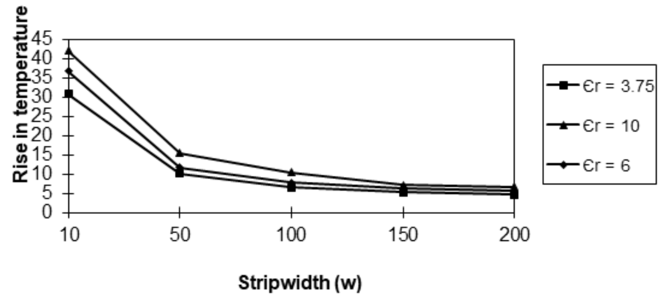
Table No. 2: Variation of rise in temperature with frequency of isolated microstripline

t = 0.01 mils, w = 100 mils, h = 100 mils, Ɛr = 10

Frequency GHz	αd dB/m	αc dB/m	ΔT °C
3	0.022	0.785	10.65
6	0.023	0.775	9.85
12	0.026	0.670	9.01
18	0.027	0.640	8.74

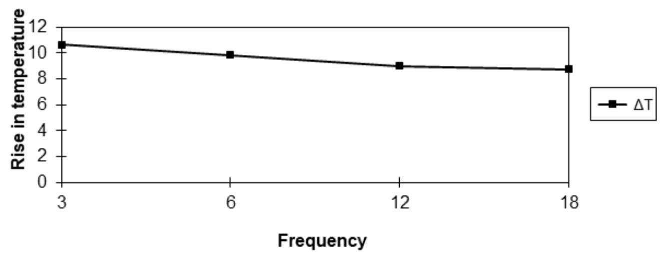
Graph No.1: Variation of rise in temperature with stripwidth of isolated microstripline taking relative permittivity as a parameter

h = 100 mils, w = 100 mils, f = 3 GHz



Graph No. 2: Variation of rise in temperature with frequency of isolated microstripline

w = 100 mils, Ɛr = 10, h = 100 mils, t = 0.01 mils



V. REFERENCES

[1]. Bhat & Bharti "CAD of microstrip circuits & antennas", 4th ISRAMT, New Delhi & Agra (India), 1995.

[2]. Sah, H.L, K. B. Singh "A new horizon of Communication using fibre technology", NSOE-03, April-2003, Meerut (India).

[3]. S. Liayo "Microwave device and circuits" PHI, N. Delhi, 1995.

[4]. K. C. Gupta "Microwave"; Wiley Publication, (1976).

[5]. 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

[6]. 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.

[7]. Welcome to antennas 101" by Louis E. Frenzel, "Electronic Design" 2008.

[8]. 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.

[9]. 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.

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

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

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

Cite This Article :

Dharmendra Sharma, Dr. K. B. Singh, Prof. Rajendra Prasad, " Study of Heat Losses in Isolated Microstripline Structure", International Journal of Scientific Research in Science and Technology(IJSRST), Print ISSN : 2395-6011, Online ISSN : 2395-602X, Volume 10, Issue 1, pp.650-653, January-February-2023.
Journal URL : https://ijsrst.com/IJSRST52310355