Ariel

13 Rapid #: -1957620 **IP: 130.184.236.32**

Status	Rapid Code	Branch Name	Start Date
Pending	MUU	Main Library	8/13/2008 9:06:36 AM

CALL #:	**TK3 .A57**
LOCATION:	**MUU :: Main Library :: cniii**
TYPE:	Article CC:CCL
JOURNAL TITLE:	AEU. Archiv fur Elektronik und Ubertragungstechnik
USER JOURNAL TITLE:	AEU-International Journal of Electronics and Communications
MUU CATALOG TITLE:	AEU; ARCHIV F{232}UR ELEKTRONIK UND {232}UBERTRAGUNGSTECHNIK :
ARTICLE TITLE:	The method of lines for the analysis of asymmetric coupled microstrip lines on multilayers with an inhomogeneous overlay
ARTICLE AUTHOR:	El-Shenawee, M.
VOLUME:	51
ISSUE:	6
MONTH:	
YEAR:	1997
PAGES:	309-11
ISSN:	0001-1096
OCLC #:	
CROSS REFERENCE ID:	367833
VERIFIED:	

BORROWER:	**AFU :: Main Library**
PATRON:	**Woten, Douglas**
PATRON ID:	
PATRON ADDRESS:	
PATRON PHONE:	
PATRON FAX:	
PATRON E-MAIL:	
PATRON DEPT:	
PATRON STATUS:	
PATRON NOTES:	EI:Compendex

-1957620
4 pp.
8/13/08

RAPIDILL

System Date/Time: 8/13/2008 2:37:11 PM MST

AEÜ Int. J. Electron. Commun.
51 (1997) No. 6

Letters

The Method of Lines for the Analysis of Asymmetric Coupled Microstrip Lines on Multilayers with an Inhomogeneous Overlay

Magda El-Shenawee

Abstract **The semi-analytical method of lines (MoL) technique is used in this work to analyze a configuration that consists of two asymmetric coupled microstrip lines on dielectric multilayers with a finite width overlay. The effective dielectric constants of the dominant modes (c and π-modes) are obtained as functions of the frequency up to 40 GHz. The numerical results show that the position of the inserted finite width overlay has a significant effect on the phase velocities of the dominant c and π-modes. Equal phase velocities of the dominant modes can be achieved at specific positions of the overlay. This phenomena is needed to reduce pulse distortion caused by the difference in phase velocities of the propagating dominant modes.**

Keywords **Method of lines, asymmetric coupled microstrip lines, multilayers with an inhomogeneous overlay.**

1. Introduction

Recently, multiconductors on inhomogeneous multilayers are used in advanced microelectronic packaging. Compactly etched microstrip transmission lines on multilayered printed circuit boards are usually used for VLSI interconnects. Significant problems are raised due to the close proximity and the dispersive nature of these multiconductors. Pulse distortion on the signal line and crosstalk in the neighboring lines are considered the most important problems that should be taken into account to design low distortion multiconductor microstrip transmission lines. Therefore an accurate full wave analysis for multiple microstrip lines on multilayers, which could be inhomogeneous, is needed. For this purpose, the versatile numerical technique method of lines (MoL) [1] is used to obtain the position of a finite width overlay that makes the dominant c and π-modes propagate at the same velocity. The configuration to be investigated is shown in Fig. 1. To the author's knowledge, there has been no published data for an asymmetric coupled microstrip lines with an overlay of finite width [2].

2. Numerical Results

A computer program, based on MoL, has been developed to calculate the effective dielectric constants of the dominant modes for the configuration shown in Fig. 1. The accuracy of the computer code is checked by comparing its results with published results using the SDA technique [3]. The dimensions of the asymmetric microstrip lines are $W_1 = 0.6$ mm, $W_2 = 1.2$ mm, $S = 0.3$ mm, $H_1 + H_2 = 20$ mm, $H_3 + H_4 = 0.635$ mm, $\epsilon_{r1} = \epsilon_{r2} = 1.0$, and $\epsilon_{r3} = \epsilon_{r4} = 9.8$. In Fig. 2, the effective dielectric constants of the c and π-modes are plotted versus frequency. The total number of magnetic lines is $N = 51$, the discretization distance is $h = 0.114$ mm, the number of electric lines on the left and right strips are $M_1 = 5$ and $M_2 = 10$, respectively, and the number of electric lines in the separation between the two strips is $M_s = 3$. To simulate the open struc-

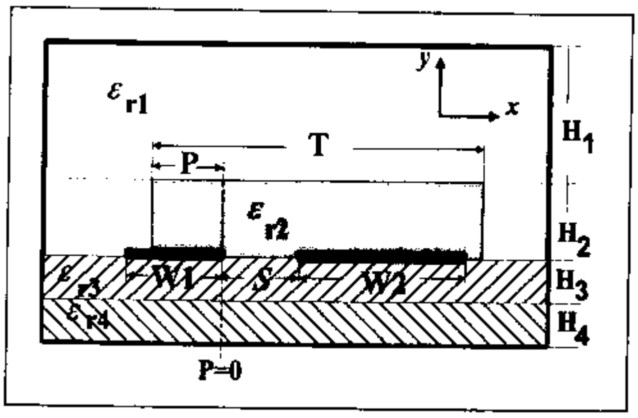

Fig. 1. A two asymmetric coupled microstrip lines with a finite width overlay.

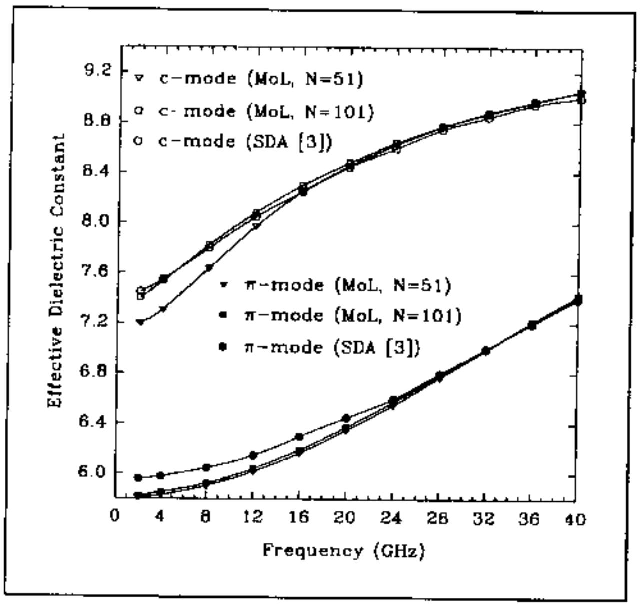

Fig. 2. Effective dielectric constant versus frequency, $W_1 = 0.6$ mm, $W_2 = 1.2$ mm, $S = 0.3$ mm, $H_1 + H_2 = 20$ mm, $H_3 + H_4 = 0.635$ mm, $\epsilon_{r1} = \epsilon_{r2} = 1.0$, and $\epsilon_{r3} = \epsilon_{r4} = 9.8$.

Received October 1, 1996; revised May 21, 1997.

Dr. M. O. El-Shenawee, Pacific States University, College of Electrical Engineering and Computer Science, Los Angeles, CA 90006, USA.

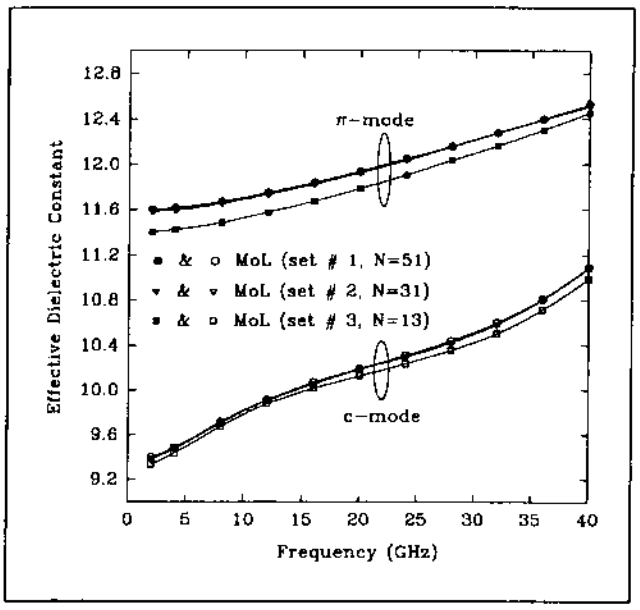

Fig. 3. Effective dielectric constant versus frequency, $W_1 = 0.6$ mm, $W_2 = 1.2$ mm, $S = 0.3$ mm, $H_1 = 20$ mm, $H_2 = 0.635$ mm, $H_3 + H_4 = 0.635$ mm, $\epsilon_{r1} = 1.0$, $\epsilon_{r2} = 16$ (full layer), and $\epsilon_{r3} = \epsilon_{r4} = 9.8$.

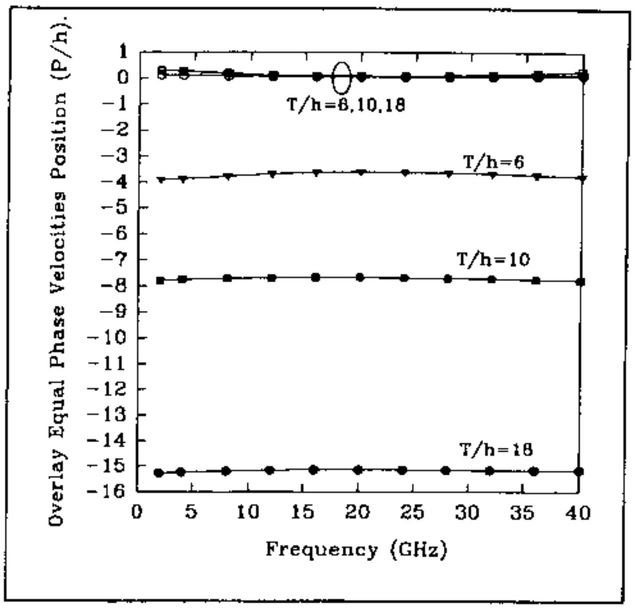

Fig. 4. Overlay equal phase velocities position (P/h) versus frequency, $W_1 = 0.6$ mm, $W_2 = 1.2$ mm, $S = 0.3$ mm, $H_1 = 20$ mm, $H_2 = 0.635$ mm, $H_3 + H_4 = 0.635$ mm, $\epsilon_{r1} = 1.0$, $\epsilon_{r2} = 16$, and $\epsilon_{r3} = \epsilon_{r4} = 9.8$.

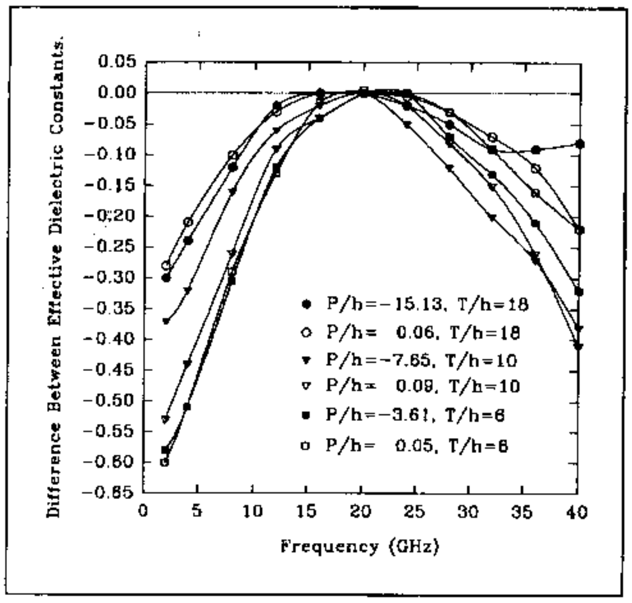

Fig. 5. Difference between effective dielectric constants versus frequency, $W_1 = 0.6$ mm, $W_2 = 1.2$ mm, $S = 0.3$ mm, $H_1 = 20$ mm, $H_2 = 0.635$ mm, $H_3 + H_4 = 0.635$ mm, $\epsilon_{r1} = 1.0$, $\epsilon_{r2} = 16$, and $\epsilon_{r3} = \epsilon_{r4} = 9.8$.

ture that was analyzed in [3], the total number of magnetic lines is increased to be $N = 101$ with the same discretization distance $h = 0.114$ mm. The data in Fig. 2 show good agreement between the MoL results and those published in [3] especially as $N = 101$ for the c-mode. Notice that the effective dielectric constant of the c-mode is larger than the effective dielectric constant of the π-mode in Fig. 2. A full dielectric layer of constant $\epsilon_r = 16$ and height $H_2 = 0.635$ mm is inserted above the two asymmetric microstrip lines (with $H_1 = 20$ mm and the same other dimensions as used before). The effective dielectric constants of the dominant c and π-modes are plotted versus frequency and the results are shown in Fig. 3. To show the convergence of the MoL, three different sets of N, M_1, M_2, and M_s are used in Fig. 3. In the first set (squares), $N = 13$, $h = 0.48$ mm, $M_1 = 1$, $M_2 = 2$, and $M_s = 1$. In the second set (triangles), $N = 31$, $h = 0.27$ mm, $M_1 = 3$, $M_2 = 6$, and $M_s = 2$. In the third set (circles), $N = 51$, $h = 0.114$ mm, $M_1 = 5$, $M_2 = 10$, and $M_s = 3$. Notice the convergence of the solutions for both modes as the number of lines is increased (third set). In Fig. 3, the effective dielectric constant of the c-mode (hollow) is smaller than the effective dielectric constant of the π-mode (solid). Thus inserting a dielectric layer of $\epsilon_{r2} = 16$ above the asymmetric microstrip lines causes the effective dielectric constant of the c-mode to be smaller than that of the π-mode. These results suggested the idea that there must be a certain geometrical dimensions of the inserted layer that will make the phase velocity of the c-mode equal to the phase velocity of the π-mode. Therefore, an overlay of finite width T, dielectric constant $\epsilon_{r2} = 16$, and height $H_2 = 0.635$ mm is introduced in the configuration as shown in Fig. 1. The question is how to choose the position of this overlay (dimension P in Fig. 1) to obtain equal phase velocities for the c and π-modes. To answer this question, the distance P is varied with keeping the height of the overlay constant ($H_2 = 0.635$ mm) for three different overlay widths $T = 6h$, $10h$, and $18h$ ($h = 0.114$ mm). The exact positions of the dielectric overlay, intended to provide equal phase velocities of the dominant modes, are plotted as functions of frequency and shown in Fig. 4. The results

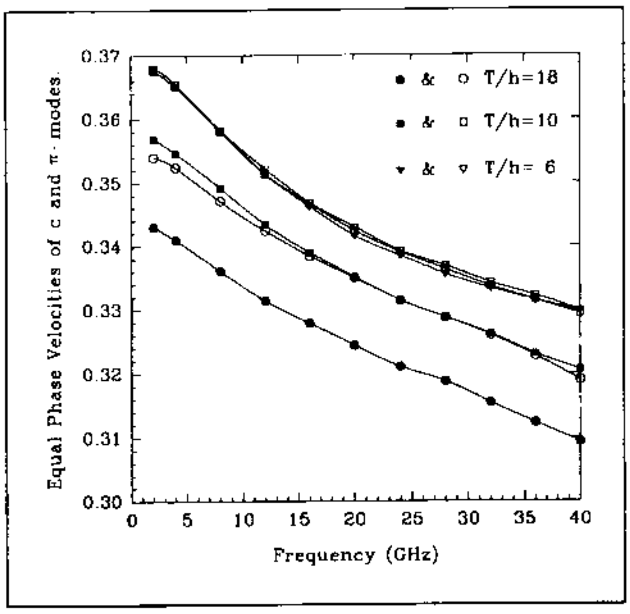

Fig. 6. Equal phase velocities of c and π-modes versus frequency, $W_1 = 0.6$ mm, $W_2 = 1.2$ mm, $S = 0.3$ mm, $H_1 = 20$ mm, $H_2 = 0.635$ mm, $H_3 + H_4 = 0.635$ mm, $\epsilon_{r1} = 1.0$, $\epsilon_{r2} = 16$, and $\epsilon_{r3} = \epsilon_{r4} = 9.8$.

show that the equal phase velocity positions change with frequency. Notice that if an overlay of width $T = 6h$, $10h$, or $18h$ is located at $P/h \approx 0$, the dominant c and π-modes will propagate at the same phase velocity. That particular position is exactly at the beginning of the separation (S) between the two strips, see Fig. 1. This position is considered an optimal one since the dominant modes will propagate at the same phase velocity regardless of the width of the overlay. Moreover, as the finite width is decreased ($T/h = 6$), the distance between the two locations of the equal phase velocities becomes smaller at all frequencies from 2–40 GHz. For example, at $f = 20$ GHz, the two positions are $P/h = -3.61$ and 0.05 for $T/h = 6$ compared with $P/h = -15.13$ and 0.06 for $T/h = 18$. Therefore, using an overlay of smaller width will provide a smaller distance between the two locations and consequently a smaller difference between the phase velocities. Then the position of the overlay is chosen exactly at $P/h = -15.13, 0.06$ for $T/h = 18$, $P/h = -7.65, 0.09$ for $T/h = 10$, and $P/h = -3.61, 0.05$ for $T/h = 6$. These particular positions are chosen such that the difference between the effective dielectric constants is equal to zero at $f = 20$ GHz. In Fig. 5, the difference between the effective dielectric constants (of the c-mode minus that of the π-mode) is plotted versus frequency for each of these chosen positions. The results show that the difference between the effective dielectric constants changes with the frequency and that change is more dramatic for smaller overlay width ($T/h = 6$). The equal phase velocity of the c and π-modes are plotted versus frequency in Fig. 6, where hollow symbols are used for P/h close to zero and solid symbols are used for negative values of P/h (overlay is located to the left of $P = 0$). Notice that the equal phase velocity position of the overlay changes with the frequency (as shown before in Fig. 4), therefore the position of the overlay can not be specified in Fig. 6. The results show that for smaller overlay width ($T/h = 6$), the equal phase velocities becomes very close (triangles) regardless of the overlay location.

3. Conclusions

The results show that the position of a finite width overlay can be chosen appropriately to make the dominant modes propagate at the same phase velocity. These equal phase velocity positions depend on both the frequency and the width of the overlay. Larger finite width overlay can be located at specific positions to obtain equal phase velocities that is less sensitive to frequency change. While equal phase velocities achieved by using smaller finite width overlay are more sensitive to frequency. On the other hand, choosing smaller finite width overlays provide smaller distance between the two equal phase velocity positions and, consequently, a smaller difference between the phase velocities.

Acknowledgement

The author is endebted to the reviewers for their precious comments.

References

[1] Pregla, R.; Pascher, W.: Numerical techniques for microwave and millimeter wave passive structures. – Itoh, T. (ed.). New York: Wiley, 1989, ch. 6.

[2] El-Shenawee, M.: Effect of inhomogeneous dielectric layers on dispersion of microstrip lines using MoL. Proc. IEEE Antennas a. Propag. Symp., Baltimore, 1996. 2206–2209.

[3] Tripathi, V. K.; Lee, H.: Spectral-domain computation of characteristic impedance and multiport parameters of multiple coupled microstrip lines. IEEE Trans. Microw. Theory a. Techn. MTT-37 (1989), 215–221.

A Class of Generalized Chebyshev Low-Pass Prototype Filter Design

Zlatoljub D. Milosavljević and Miodrag V. Gmitrović

Abstract **A design method is presented for a class of low-pass prototype filters having an equi-ripple characteristic in the passband and stopband, maximal selectivity and three real transmission zeros at the most of any multiple. A procedure for real transmission zeros determination and recurrence relations for magnitude function calculating are given.**

Keywords **Filters, generalized Chebyshev filters.**

Received November 11, 1996; revised July 8, 1997.

Dipl.-Ing. Z. Milosavljević, Prof. Dr.-Ing. M. Gmitrović, Faculty of Electronic Engineering, Department of Telecommunications, Beogradska 14, 18000 Niš, Yugoslavia, E-mail: zlatko@europa.elfak.ni.ac.yu.