METHOD OF LINES ANALYSIS OF COUPLED MICROSTRIP TRANSMISSION LINE WITH A NOTCH

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ABSTRACT: The purpose of this paper is to investigate the characteristics of a two symmetric conductor microstrip line with a notch in the millimeter wave frequency range. Previous quasi-static based data was reported and an extension of some of these data to higher frequencies is considered here. The numerical technique, Method of Lines (MoL), is used to compute the effective dielectric constants and the phase velocities of the even and odd modes at higher frequencies up to 100GHz. The results show that the quasi-static based characteristics are not necessarily valid at higher frequencies.

I. FORMULATION OF THE PROBLEM

Quasi-static method of moment based techniques to overcome the distortion due to the difference between the propagation phase velocities of the dominant modes are reported in [1]. The idea of those techniques is to control the dielectric constant of the notch, the height and width of the notch, dielectric substrate, and overlay materials. In this work, the method of lines (MoL) is used to compute the effective dielectric constants of the even and odd modes as functions of frequency. The details of the method of lines are not given here as they are described in [2]. The transmission line being investigated in this work consists of two symmetric thin perfectly conducting strips with a rectangular notch between them as shown in Fig. 1. In this work, changing the dimensions of the notch along with its dielectric constant are considered to control the propagation constants of the dominant modes at higher frequencies.

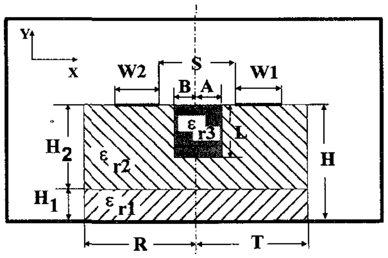

Fig. 1, Geometrical model of the two conductor microstrip transmission line with a notch.

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II. NUMERICAL RESULTS

The effective dielectric constants of the even and odd modes are plotted in Fig. 2 versus the dielectric constant of the notch ε_{r3}. The MoL based results obtained here are compared with those reported in [1]. Good agreement is observed in Fig.2. For the odd mode case, the total number of magnetic lines is 136 and the number of magnetic lines on the strip is 16 with 0.066mm as discretization distance. For the even mode case, the total number of magnetic lines is 133 and the number of magnetic lines on the strip is 15 with 0.068mm as discretization distance. The dimensions of Fig. 1 are W1=W2=H=1mm, S=2, A=B=.99mm, T=R=6mm, L=0.48mm, and $\varepsilon_{r1} = \varepsilon_{r2} = 2.2$ [1]. The results shown in Fig. 2 indicates that as $\varepsilon_{r3} = 9.5$, the effective dielectric constants of the even and odd modes are equal. Upon fixing the dielectric constant of the notch equal to 9.5, the normalized phase velocities of the even and odd mode are computed and plotted as functions of frequency up to 100GHz as shown in Fig. 3. In Fig. 4, the relative dielectric constant of the notch is chosen to be $\varepsilon_{r3} = 15$ while the height of the notch is varied from L/H=0.04 to L/H=0.78. The effective dielectric constants of the even and odd modes are plotted versus the notch height (L/H) and shown in Fig. 4. The results show that as L/H=0.117 or L/H=0.7, the effective dielectric constants of the even and odd modes become equal. No such equality can be obtained if the notch is filled with air. Upon choosing L/H=0.7, the effective dielectric constants of the even and odd modes are plotted versus the frequency and shown in Fig. 5. The results in Figs. 3 and 5 show that the normalized phase velocities of the even and odd modes are deviating from each other at higher frequencies although they started with equal values.

CONCLUSIONS

The numerical results provided more details about the effect of the notch parameters on the propagation phase velocities of the dominant modes at higher frequencies. The controlling parameters of the notch that are obtained at DC frequency can not be used at higher frequencies if low distortion microstrip transmission line is needed [3].

REFERENCES

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ACKNOWLEDGEMENT

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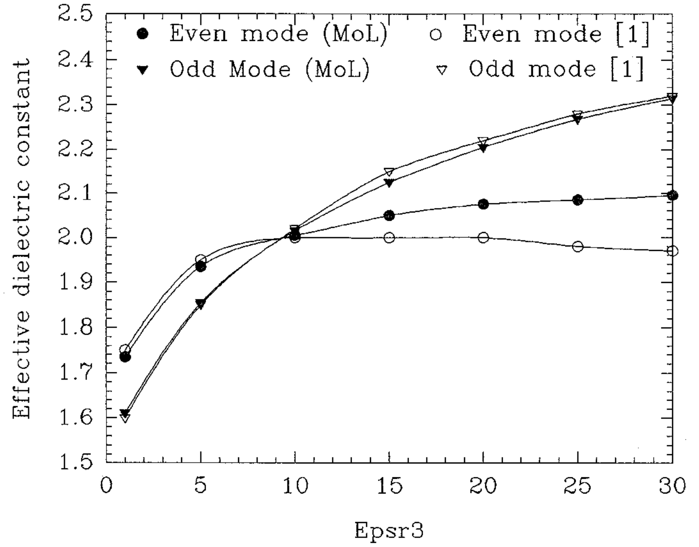

Fig. 2, Effective dielectric constant versus ϵ_{r3} with W1=W2=H=1mm, S=2mm, A=B=.99mm, T=R=6mm, L=0.48mm, $\epsilon_{r1}=\epsilon_{r2}=2.2$, and f=1GHz.

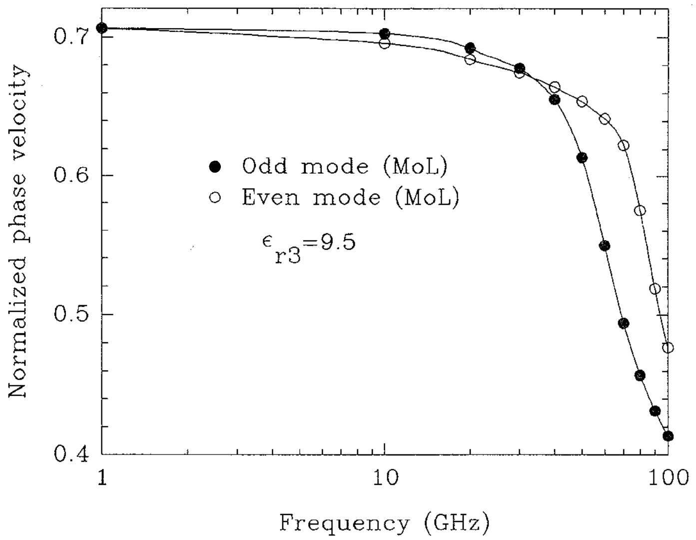

Fig. 3, Normalized phase velocity versus frequency for the same dimensions as in Fig. 2.

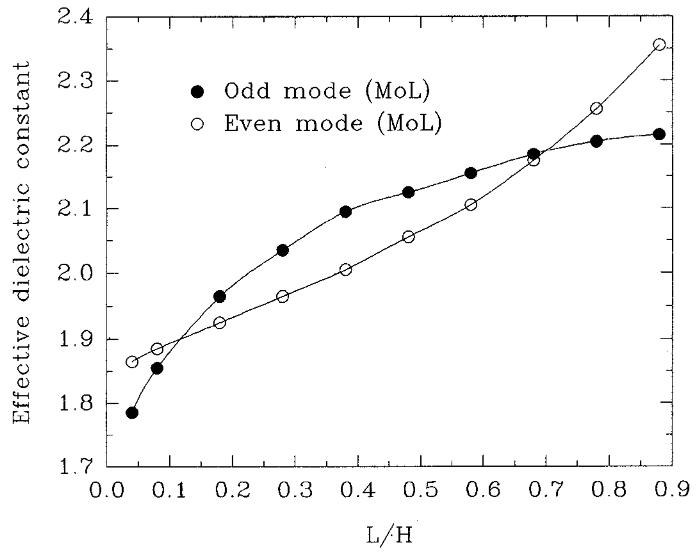

Fig. 4, Effective dielectric constant versus notch height, with ϵ_{r3}=15.0, W1=W2=H=1mm, S=2mm, A=B=0.99mm, T=R=6mm, $\epsilon_{r1}=\epsilon_{r2}$=2.2, and f=1GHz.

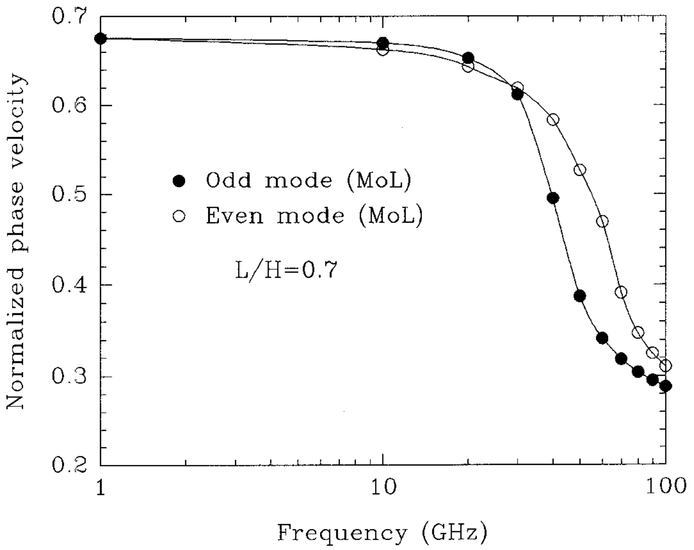

Fig. 5, Normalized phase velocity versus frequency, with ϵ_{r3}=15.0, W1=W2=H=1mm, S=2mm, A=B=0.99mm, T=R=6mm, $\epsilon_{r1}=\epsilon_{r2}$=2.2, L/H=0.7