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Theoretical Study of MMIC as CPW Line for Conductance and Capacitance

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Abstract— ***This a coplanar waveguide (CPW) line structure is presented, the equivalent circuits of the CPW's is drawn. Basically four parameters are in this structure. It is only conductance and capacitances are analysed and during analysis TEM modes is considered. This typical geometries of CPW is analysed for MM-Wave frequencies with constant inductance and resistance. During the analysis it is found that attenuation is improved up to 15%.***

Keywords— ***Coplanar waveguide, conductance, capacitance***

I. Introduction

This In modern microwave integrated circuits (MIC's) more and more the coplanar waveguide (CPW) is used as transmission-line[1]. The miniaturization of CPW structure, constitutes an essential part of any microwave integrated circuit design tool. The fig. 1 showed the coplanar waveguide geometry and the parameters of the geometries. The analyses [2]-[4] indicate here that modelling approach taken into account metallization thickness and different properties of the conductors. The description offers advantages because the parameters derived separately and fit into common analysis environment. In microstrip several researchers [5]-[7] have published corresponding work but descriptions employed expensive and hence they purpose a limited potential regarding practical applications and extracting the elements R, L, C and G from the corresponding structure [3], it finds the variation of C and G with frequency remains negligible whereas resistance R and inductance L exhibit considerable frequency dependence[8]. The behaviour can be explained by the change in CPW structure parameters with current-density distribution.

II. Structure of Coplanar wave guide

The Coplanar waveguide cross section ($\mu = \mu 0$, $\epsilon = \epsilon r \epsilon 0$) except for substrate, δ denotes the conductivity of the metallization. Coplanar waveguide line resistance R and conductance G are as a function of frequency f [14]. Coplanar waveguide structure with w = 40µm, s = 5µm, t = 1.5 µm, wg = 200µm , Єr= 12.3. parameters shown figure1. The equivalent of this structure is shown in figure2.

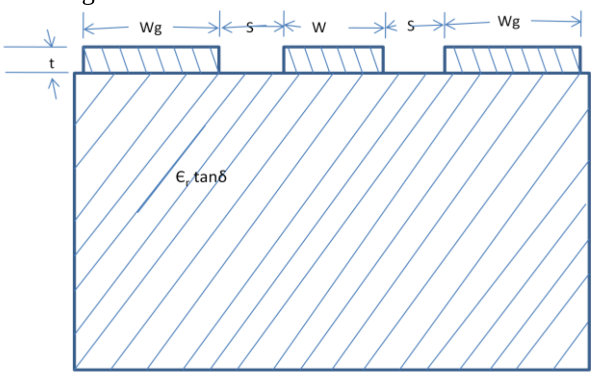

Figure: Cross sectional structure of coplanar waveguide

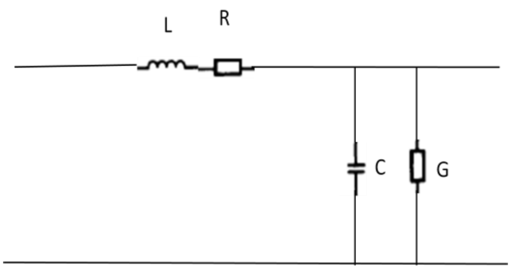

Figure2: Equivalent circuits of coplanar waveguide

III. CALCULATION OF THE CAPACITANCE AND CONDUCTANCE

If one neglects the influence of the backside metallization and assumes the ground metallizations to extend to infinity the problem. Only one quarter of the cross section is considered, which corresponds to a capacitance C. For Є=1 thickness t' is equal to half the metallization thickness t defined in Figure1. For Є > 1 the magnetic wall is placed at the substrate surface with good approximation. At t' = t for the upper half and for lower plane t' = 0. The capacitance (C) may be derived with arbitrary values of t' by means of a Schwartz-Christoffel conformal mapping procedure. First, the complex z plane is transformed into the z1 plane, in the z1 plane, coplanar geometry of zero thickness. Thus its capacitance can be determined easily [11]. The nonlinear system of equations has to be solved. Owyang and Wu [12] applied a perturbation method to obtain a first-order approach for small but finite values of t', and its mathematical derivation contained an inconsistency to leads erroneous results.

structures of interest, since t' exceed the limitations given by the first-order, additional considerations are mandatory. for instance, the limit of large values of t'. When increasing thickness t', the capacitance increment is simply that of a parallel-plate geometry, and holds

∂C/ ∂t' = Є0 / s. For good accuracy t' = s/2 , and the resulting formula for the capacitance C,(t') = Є . F(t') with F(t') being the function given in [13], [14]. Here K(k) and K'(k) denote complete elliptic integrals of the first kind, for the coefficients ki and Pci refers [13], [14], for the total line capacitance C and the conductance G:

$$C = 2\,Є0\,(F\ up + Єr\ .\ F\ low) \quad 1$$

$$G = 2\omega\,Є0\,Єr\,\tan\delta\,F\ low \quad 2$$

$$F\ up = F(t' = t) \quad 3$$

$$F(t')\frac{K(k1)}{K'(k1)} + Pc0 * \left(\frac{t'}{s} * \left(Pc1 - \ln\frac{2t'}{s}\right) + \left(\frac{t'}{s}\right)^2 * \left(1 - \frac{3}{2}Pc2 + Pc2 * \ln\frac{2t'}{s}\right)\right) \quad 4$$

$$F\ low = \frac{K(k1)}{K'(k1)} \quad 5$$

Where

$$Pc0 = \frac{b}{2a}\frac{1}{(K'(k1))^2} \quad 6$$

$$Pc1 = 1 + \ln\left(\frac{8\pi a}{a+b}\right) + \frac{a}{a+b}\ln\frac{b}{a} \quad 7$$

$$Pc2 = Pc1 - 2\frac{a}{b} * (K'(k0))^2 \quad 8$$

And

$$a = \frac{w}{2}\ \text{and}\ b = \frac{w}{2} + s \quad 9$$

$$tH = \frac{t}{2}$$

IV. RESULT AND DISCUSSION

The analysis of the capacitance is shown in the figure3, the variation of the capacitance with increasing the width of the centre width at different slots. It is clear that the relation between capacitance and centre width is non linear and when slot width is increasing the capacitance is going to reduce. Here capacitance is in nano farad while centre width is in meter.

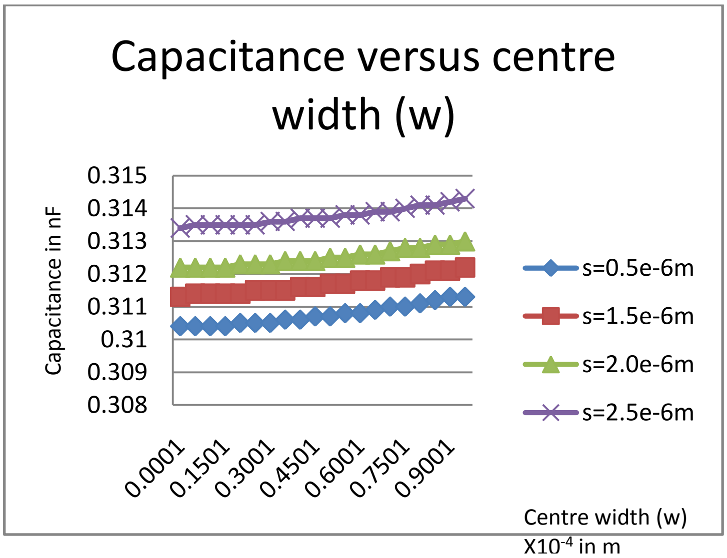

Figure3: Capacitance versus centre width of the coplanar waveguide with different slot width

The analysis of the conductance is shown in the figure4, the variation of the conductance with increasing the width of the centre width at different slots. It is clear that the relation between conductance and centre width is approximately linear but not at all and when slot width is increasing the conductance is going to reduce. Here conductance is in mho/m while centre width is in meter.

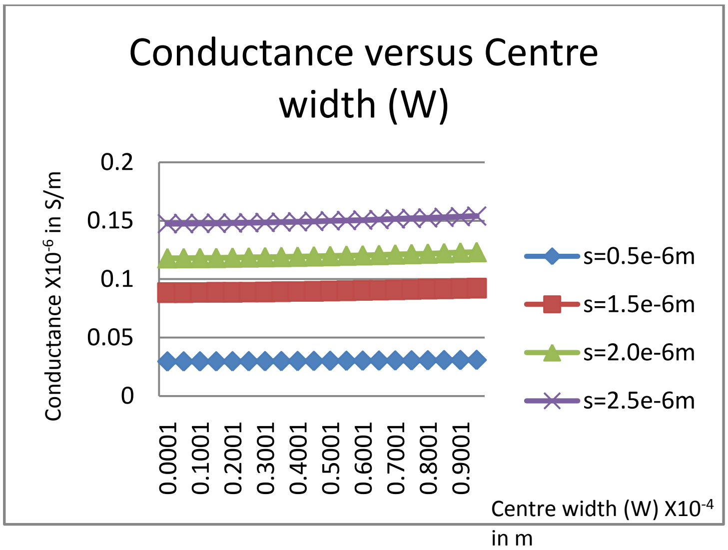

Figure4: Conductance versus frequency of the coplanar waveguide

The analysis of the conductance is shown in the figure5, the variation of the conductance with increasing frequency at constant slot width and centre width. It is clear that the relation between Conductance and frequency is non linear in logarithmic scale and when frequency is increasing up to 8Ghz then conductance is nearly linear but after that conductance increases very fast with non linear in nature.

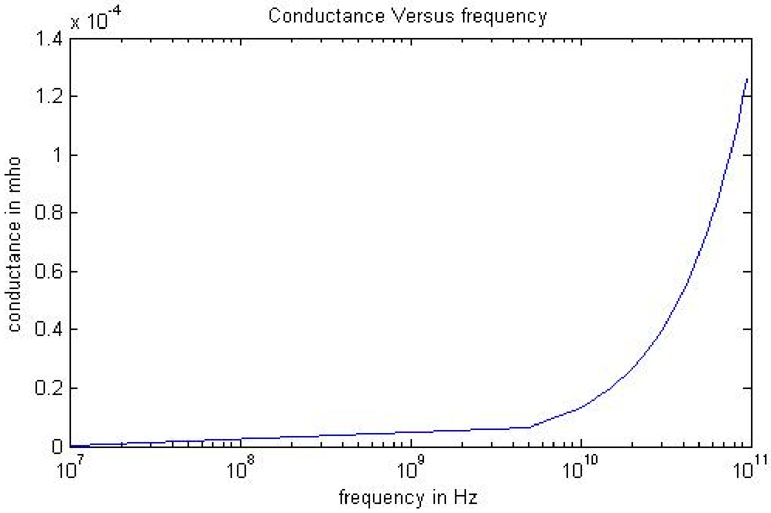

Figure5: Conductance versus frequency for coplanar waveguide

V. CONCLUSION

derived formulas on one hand, and those obtained by a rigorous spectral-domain hybrid mode analysis on the other hand, have shown an excellent accuracy of better than one percent for most of the practical ranges of physical dimensions Both finite thickness of the metallizations and their nonideal conductivity have to be accounted for. The field characteristics of the CPW are two-dimensional on principle. Thus approximations for strip resistance R and inductance L adopted from one-dimensional considerations fail to predict important effects. As a further consequence, the external inductance becomes frequency dependent to a substantial amount.

The formulas given in this paper provide a very efficient formulation

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