Letters

Comments on "CAD Models for Asymmetrical, Elliptical, Cylindrical, and Elliptical Cone Coplanar Strip Lines"

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In the above paper,[1] Du *et al.* present analytical closed-form expressions for the quasi-TEM parameters for asymmetrical coplanar strip lines with a finite boundary substrate by using the conformal mapping technique. The authors of the above paper have pointed out that the expressions of k_d and Q in [1, eqs. (10) and (12)] are wrong. Actually, the expression of k_d in [1, eq. (10)] is faulty, and it should be given as (12) of the above paper. This fault is only in the writing of the expression and, therefore, there is not any fault on the graphics illustrated in [1, Figs. 3 and 4].

However, the expressions of Q in [1, eq. (12)] is exactly true. In the above paper, the geometrical parameters w_1, w_2, and s for the cylindrical coplanar strip lines (CCPS's) are described on the planar structure, and they are identical to the angles θ_1, θ_2, and ψ subtended by the arc strip lines and by the gap between the two strips, respectively. On the contrary, in [1], the strip widths w_1 and w_2, and the gap s between the two strips are described on the cylindrical structure, not on the planar one. Therefore, the geometrical parameters w_1, w_2, and s in [1] are given as follows:

$$w_1 = b(\theta_1 - \phi) \quad w_2 = b(\theta_2 - \phi) \quad s = 2b\phi.$$

Essentially, in theoretical formulation of [1], it is pointed out that the widths w_1 and w_2 and the gap s are the angular extents.

In summary, the expression of k_d in [1, eq. (10)] should be expressed as

$$k_d = \sqrt{\frac{[\sinh(Qs) - \sinh(Q(s+2w_1))]\,[\sinh(Qs) - \sinh(Q(s+2w_2))]}{[\sinh(Qs) + \sinh(Q(s+2w_1))]\,[\sinh(Qs) + \sinh(Q(s+2w_2))]}}$$

as stated in the above paper, but the expression of Q in [1, eq. (12)] should be given without any variation as

$$Q = \frac{\pi}{4bh}.$$

References

[1] C. Karpuz, A. Görür, and M. Alkan, "Quasistatic analysis of cylindrical coplanar strip lines," *Microwave Opt. Technol. Lett.*, vol. 17, no. 2, pp. 148–151, Feb. 1998.

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Authors' Reply—Some Problems About Asymmetrical Coplanar Strip Lines

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Let us first reply to the commonts of the above paper.[1] We would like to state that the equations we corrected in the above paper should be (10) and (12) instead of (11) and (12) in [1]. Also Q should be $\pi/(4bh)$, as the comments to the above paper have pointed out. However, the above faults in the above paper will not affect any other parts of it.

What we want to clarify is another problem related to the analysis of coplanar strip lines (CPSs).

In [1], the authors used the mapping function

$$z_2 = \sinh\left(\frac{\pi z_1}{2h}\right) \tag{1}$$

to transform the dielectric region of the asymmetrical coplanar strip lines (ACPSs) with a finite substrate on the z_1-plane shown in Fig. 1(a) into the lower half region of an ACPS with an infinite substrate on the z_2-plane shown in Fig. 1(b) [1, eq. (6)]. The mapping function (1) was taken by [2] and [3] earlier. We would like to point out the mapping function (1) is suitable for the symmetrical coplanar waveguide (CPW) analyzed in [2], but not suitable for the symmetrical CPS analyzed in [1] and [3]. When Hanna's method [2] is applied to the CPS [3], it is pointed out by Ghione *et al.* [4] that it seems to lead to incorrect results, in particular, the conclusion that the impedance of the line increases when the substrate thickness decreases is unacceptable, and leads to absurd consequences in the limit $h \to 0$. In [4], Ghione *et al.* did not give the reason causing such incorrect results. From [1, Figs. 3(a) and 4] we can also find that the effective dielectric constant is larger when the substrate thickness is smaller. Obviously, the conclusion is incorrect. It can be proven that the incorrect conclusion is caused by applying the mapping function (1) to the CPS.

If (1) is used to analyze the ACPS (and symmetrical CPS), when $z_1 = x_1 + jy_1$, the following result can be obtained:

$$\begin{aligned} z_2 &= \sinh\left(\frac{\pi z_1}{2h}\right) \\ &= \cos\left(\frac{\pi y_1}{2h}\right) \cdot \frac{\exp\left(\frac{\pi}{2h}x_1\right) - \exp\left(-\frac{\pi}{2h}x_1\right)}{2} \\ &\quad + j\sin\left(\frac{\pi y_1}{2h}\right) \cdot \frac{\exp\left(\frac{\pi}{2h}x_1\right) + \exp\left(-\frac{\pi}{2h}x_1\right)}{2} \\ &= \cos\left(\frac{\pi y_1}{2h}\right) \cdot \sinh\left(\frac{\pi x_1}{2h}\right) + j\sin\left(\frac{\pi y_1}{2h}\right) \cdot \cosh\left(\frac{\pi x_1}{2h}\right). \end{aligned} \tag{2}$$

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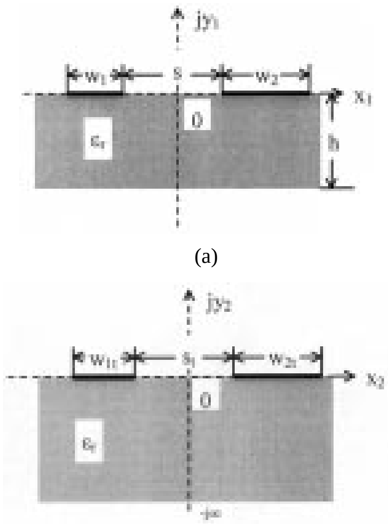

(a)

(b)

Fig. 1. ACPS with one-layer substrate. (a) z_i-plane. (b) z_2-plane.

When $z_1 = x_1 - jh$, $z_2 = -j\cosh(\pi x_1/2h)$. Therefore when $x_1 \to \pm\infty$, we can get $z_2 \to -j\infty$. It means that (1) cannot give a single value transformation. Thus, we can conclude that the mapping function (1) cannot be used as a conformal mapping function for the ACPS and symmetrical CPS. However, for the symmetrical CPW, since only one-half of the structure is taken to analyze [2], there is no such question.

The proper mapping function for the ACPS (and symmetrical CPS) should be

$$z_2 = \tanh\left(\frac{\pi z_1}{2h}\right). \tag{3}$$

In [5] we took (3) instead of (1) just because of the above reason. In addition, the mapping function (3) was also implied in [6] and [7].

In conclusion, the mapping function (1) is incorrect for the ACPS (and symmetrical CPS), and the proper one should be (3). Therefore, the references including [1] about the ACPS (and symmetrical CPS) if which took (1) as the mapping function are incorrect and they should be corrected by (3).

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