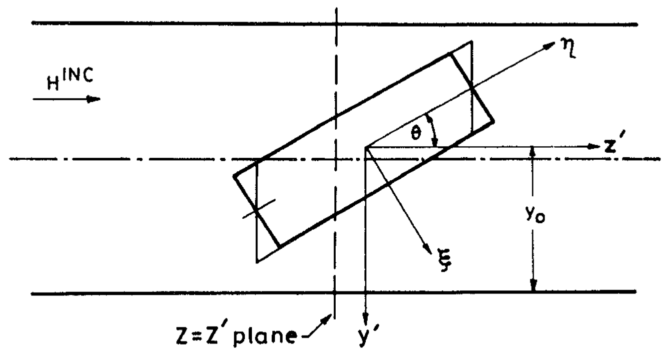

Fig. 2. Modified geometry of the inclined slot.

region 3 is complicated because of the asymmetry of the regions on either side of the line $z = z'$, which increases the dimension of the computation for scattered field evaluation. By modifying the slot geometry as a parallelogram (keeping the area same), as shown in Fig. 2, the integral limits and the integrands can be easily written for the regions on either side of the line of discontinuity $z = z'$.

For wide slots, characterized by length to width ratios of 7 or less, these methods can be equally applicable. However, this computation and experimental verification have not been performed for lack of any practical requirement at this moment. The authors would like to agree that both longitudinal and transverse components of aperture fields have to be accounted for accurate analysis of such wide slots where the same parallelogram approximation is found to be useful for finding out the closed-form expression for scattered field evaluation.

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Comments on the "Criterion of Leakage from Printed Circuit Transmission Lines" [1], [2]

Ricardo Marqués, Francisco Mesa, and Nirod K. Das

Leakage of power in printed transmission lines can be due to the excitation of both volume and surface waves. Depending on the frequency of operation several surface waves can be excited in the background waveguide, contributing to the transversal leakage of power. A crucial point in the analysis is to determine how many of these surface modes contribute to the leakage. In [1] and [2], it is established that only surface modes satisfying the following condition (see (42) of [1]):

$$\mathrm{Re}\,(k_x) < \mathrm{Re}\,(k_\rho) \tag{1}$$

are excited for a given frequency (in the above equation, k_x is the propagation constant of the leaky transmission line mode and k_ρ is the wavenumber associated to the considered surface wave mode). The above condition is called the *phase match constraint* (see also (26) and (48) of [1]), and it is deduced from the fact that leakage of power occurs *when the transmission line mode propagates faster than the substrate mode*. Nevertheless, a careful mode-matching analysis shows that condition (1) is deduced from the above fact only in a perturbation sense and may not be rigorous in general leakage situations. In this letter, we try to discuss the possibility of excitation of surface-wave modes exponentially growing transversally, but with a wave number lesser than the phase constant of the transmission line. These exponentially growing surface modes would satisfy the phase match constraint, although they may not satisfy (1).

Let a leaky mode be propagating in a lossless line, with *complex* propagation constant k_l. The main idea underlying the *phase match* criterion (and an apparent requirement of the mode-matching analysis) is that any background waveguide mode, which forms the leaky field, must have a propagation constant matching the leaky mode propagation constant. However, since the leaky mode propagation constant is complex and the wavenumbers of the different lossless background waveguide modes are either real or purely imaginary quantities, it does not seem possible to *match* the entire *complex* leaky mode propagation constant if only *uniform* waveguide modes are considered. Therefore, the *phase match constraint* (1), if blindly applied to general situations, may lead to possible contradictions.

Actually, the background waveguide modes present in the field expansion of the leaky mode are *nonuniform*. Nonuniform modes are the most *general* solutions to the wave equation inside the waveguide. Nonuniform plane waves in free space are well-known solutions to the Maxwell equations (see, for example, [3] pp. 320–334), and they are similar to the nonuniform waveguide modes mentioned here. The *complex* wavevectors of these modes satisfy

$$\boldsymbol{k}_n \cdot \boldsymbol{k}_n = \gamma_n^2 \tag{2}$$

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where γ_n^2 are the squared wavenumbers of the background waveguide modes (for lossless waveguides, γ_n^2 are real quantities, positive or negative). Similar to nonuniform free space waves, nonuniform waveguide modes propagate along a given direction and attenuate/grow along the orthogonal one. The complex wavevector $\boldsymbol{k_n}$ can be written as the sum of a real part and an imaginary part

$$\boldsymbol{k}_n = \beta_n \hat{\boldsymbol{u}}_n - j\alpha_n \hat{\boldsymbol{v}}_n, \tag{3}$$

where β_n is the phase constant of the nonuniform waveguide mode, and α_n is its attenuation constant (β_n and α_n are real numbers). From (2) and (3), we find that

$$\beta_n^2 - \alpha_n^2 = \gamma_n^2 \tag{4}$$

and

$$\hat{\boldsymbol{u}}_n \cdot \hat{\boldsymbol{v}}_n = 0. \tag{5}$$

The leaky wave in the line will excite nonuniform waveguide modes contributing to the far radiation field. The *phase* as well as *attenuation match conditions* must be satisfied by all the nonuniform modes

$$\mathrm{Re}\,(k_l) = \beta_n \cos\theta_n, \tag{6}$$

$$\mathrm{Im}\,(k_l) = -\alpha_n \sin\theta_n, \tag{7}$$

where θ_n is the angle between the direction of propagation of the transmission line and the leakage direction, $\hat{\boldsymbol{u}}_n$. For *physical* waves, θ_n must be a real number and the basic *phase match constraint* can be written as

$$\mathrm{Re}\,(k_l) < \beta_n. \tag{8}$$

When $\beta_n \simeq \gamma_n$ (i.e. when the n-th waveguide mode is almost uniform), which implies (from (4) and (6)) $\alpha_n \simeq 0$ and $\mathrm{Im}\,(k_l) \simeq 0$, (6) can be approximated as:

$$\mathrm{Re}\,(k_l) \simeq \gamma_n \cos\theta_n, \tag{9}$$

or

$$\mathrm{Re}\,(k_l) < \gamma_n, \tag{10}$$

which is the approximate phase-match condition as given by (42) of [1]. When β_n is different from γ_n (or, when the excited background wave is nonuniform), though in many reported cases the condition (10) is known to apply, it does not *necessarily* follow from (8). The leaky waves with the phase constant, $\mathrm{Re}\,(k_l)$, greater than the wavenumber, γ_n, recently reported in [4] and elsewhere as nonconventional leakage, are such situations.

If the condition (10) does not apply for general cases, another rigorous criterion of excitation of leakage must be searched for. It may be noted that the basic condition (8) is not useful, because unlike the wavenumber, γ_n, the phase constant, β_n, is not an independent physical parameter and is a function of both γ_n and k_l. In fact, as it can be shown, for a given complex propagation constant, k_l, and wavenumber, γ_n, there are always two sets of solutions for β_n, α_n and θ_n satisfying (4), (6), and (7), one of which always satisfies the condition (8), making the criterion (8) indeterministic. Further investigation for a proper criterion of leakage valid in general situations is warranted.

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Corrections to "TE-Mode Scattering from Two Junctions in H-Plane Waveguide"

Hyo Joon Eom

In the above paper,[1] there are serious printing errors that need to be corrected. The corrections are as follows: In (9) and (14), *j* should be replaced by *i*. In (35), 'when $d = a$ and α 0' should be replaced by 'when $b_m = a_n$ and $\alpha = 0$'.

In (31), (32), (44), and (45), ds should be replaced by $d\zeta$. In (40) and (49) $|s = \sqrt{ki^2 - (e\pi/b)^2}$ should be replaced by $|_{\zeta=\sqrt{k_1^2-(l\pi/b)^2}}$. Equation (36) should read

$$B_m = -\pi[|d-a|e^{\imath\zeta|d-a|} - (-1)^m|d+a|e^{\imath\zeta|d+a|}]$$

. Equation (39) should read

$$r_{nm} = \sum_{l=1}^{\infty} 2\cos\,(l\pi)T_{\xi\xi}[1-(-1)^m e^{\imath 2\sqrt{k_1^2-(l\pi/b)^2}a}]$$

. Equation (48) should read

$$z_{nm} = \sum_{l=1}^{\infty} 2\cos\,(l\pi)T_{\eta\eta}[1-(-1)^m e^{\imath 2\sqrt{k_1^2-(l\pi/b)^2}d}]$$

In (56), $e^{-\imath k_{xs}d}$ should be replaced by $e^{-\imath k_{xs}d}$].

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