Scattering at a Junction of Two Waveguides with Different Surface Impedances

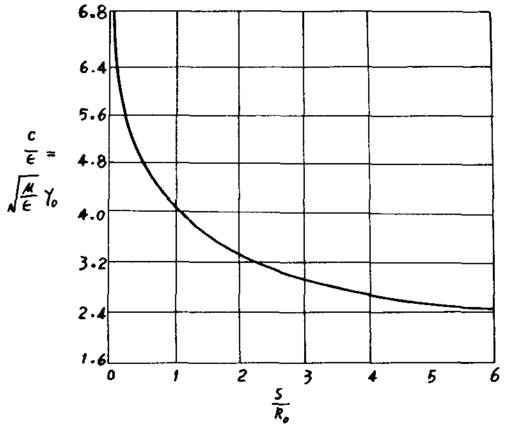

Fig. 3.

We finally have (8) and the following equation:

$$\frac{s}{R_0} = \frac{\pi}{2K'\left\{\sqrt{1-\frac{E'}{K'}}\,\sqrt{1+k^2}\,\frac{K'}{E'} - z(v,k')\right\}} \tag{9}$$

to solve for k and v simultaneously to substitute the former into (6) to find C. Conversely, given k, we can calculate C from (6) and the ratio of slit width $2s$ to the diameter $2R_0$ by (8) and (9) of Fig. 1. The curve in Fig. 3 is constructed from [1].

This new transmission line of Fig. 1 is of reduced height, which is equal to the diameter of its upper circular conductor, and intuitively this new line will have lower loss than the conventional two-wire line because its large plane conductor will offer low ohmic, as well as radiation, loss. In addition, it can be used to detect and to measure the width of the slit of a flat conducting plate, because when $2R_0$ is known, the width $2s$ of the slit can be calculated from the measured value of C, from the curve of Fig. 3 or from (6).

References

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[2] P. F. Byrd and M. D. Friedman, *Handbook of Elliptic Integrals for Engineers and Scientists*. Berlin Heidelberg, New York: Springer-Verlag 1971, 119.03.

[3] K. J. Binns and P. J. Lawrenson, *Analysis and Computation of Electric and Magnetic Field Problems*. Oxford: Pergamon Press, 1963, p. 315.

Letters

Correction to "Optical Fiber Delay-Line Signal Processing"

Due to a clerical error, the above paper[1] by K. P. Jackson, S. A. Newton, B. Maslehi, M. Tur, C. C. Cutler, J. W. Goodman and H. J. Shaw appeared in the March 1985 issue (pp. 193–210) without being identified as an *Invited Paper*.

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[1] K. P. Jackson *et al.*, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-33, pp. 193–210, Mar. 1985.

Comments on "Scattering at a Junction of Two Waveguides with Different Surface Impedances"

V. DANIELE, I. MONTROSSET, AND R. ZICH

In the above paper,[1] a criterion has been given in order to establish if the scattering problem of the junction between two waveguides with different surface impedances can be solved in closed form. In this comment, a different approach, based on a spectral formulation, shows that the possibility to obtain analytical expressions of the scattering coefficients depends on the form of the relevant Wiener–Hopf equation.

The above paper[1] presents some results on the problem of the scattering at the junction of two waveguides having different surface impedances. From a theoretical point of view, the most important concerns the possibility to obtain analytical expressions of the scattering coefficients when certain conditions on the geometries of the waveguides are satisfied. The procedure used in [1] has some limitations; more general results can be obtained by following a different approach based on the Wiener–Hopf formulation of the problem. Let us consider [1, fig. 1] and indicate with a and a' the waveguides at the left and the right side, respectively, of the junction. A spectral formulation of the problem leads to a Wiener–Hopf equation having the form

$$G(\alpha)F_+(\alpha) = F_-(\alpha) + F_0(\alpha) \tag{1}$$

where $G(\alpha)$ and $F_0(\alpha)$ are known, and the unknowns $F_+(\alpha)$ and $F_-(\alpha)$ are the Fourier transforms of suitable components of the electromagnetic fields in the guide a' and a, respectively. In all

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[1] C. Dragone, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-32, pp. 1319–1328, Oct. 1984.

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the geometries considered in [1]–[5], eq. (1) has a scalar form and, according to the theory of the modal representations of electromagnetic fields in closed waveguides, $G(\alpha)$ must be a meromorphic function having zeros at the modal propagation constants $\pm j\gamma_n'$ of the guide a' and poles at the modal propagation constants $\pm j\gamma_n$ of the guide a. With these conditions, a Weierstrass factorization of $G(\alpha)$ leads straightforwardly to expressions of scattering coefficients having the forms given in [1, eqs. (50) and (51)]. A different situation occurs when (1) has a matrix form. In this case, a considerable effort has been made in the past by one of the authors to obtain a closed-form solution [3]. Even if some progress has been accomplished, a general solution of a matrix Wiener–Hopf equation is not available. From the previous considerations it follows that 1) a general criterion on the validity of the scattering coefficients given in [1] has to be based on the scalarization of the Wiener–Hopf formulation of the problem at hand, and 2) more general approximate solutions have to be worked out by using, on the W–H formulation, the powerful methods developed in the literature (see, for example, [6]). Those solutions, with respect to the perturbational one proposed in [1], have a deeper mathematical justification.

Reply[2] *by C. Dragone*[3]

A junction between two waveguides can, under certain general conditions derived in [1], be represented by a scalar Wiener–Hopf equation. Then, as shown in [2], the junction can be treated rigorously by either one of two well-known methods.

The authors of the above comments criticize the mode-matching technique used in [1] and claim that a rigorous treatment of a junction can only be given by the Wiener–Hopf technique, as shown by their work in [5]. They also claim that all geometries considered in [1] are described by a scalar Wiener–Hopf equation. Furthermore, they question the utility of the perturbation solution of [1].

The above two techniques are well known, and their validity is well established [7]. They are based on two different representations of a junction. One representation involves the Fourier transform of the field along the axis, and leads in general to two integral equations. The other, leads to an infinite set of equations, as in [1]. The two representations are entirely equivalent. Under certain conditions, one representation can be reduced to a scalar integral equation of the Wiener–Hopf type. Under the *same* conditions, the infinite set of equations will assume a simple form, which can also be solved straightforwardly as shown in [1]. The two representations are well known [7], they are equally important, and either one can be obtained from the other by suitable transformations. In [1], the former representation was used in order to derive some of the results and, in particular, to obtain the perturbation solution. Perturbation solutions are important, particularly when better solutions are not available. They are widely used in the treatment of small imperfections or discontinuities in waveguides and in numerous other applications. Of course, since the perturbation solution in [1] is derived from an infinite series, it only applies if the series converges [8].

The results of [1] imply that the problem can be reduced, under certain conditions, to a scalar Wiener–Hopf equation. This is obvious, in view of the form of the solution given in Section V, and it can also be verified without difficulty using the method of [6]. However, the geometries of [1] are *not* in general described by a scalar Wiener–Hopf equation. In fact, the *perturbation analysis* of Section IV shows that the solution given in Section V is only possible under certain conditions: If the coefficients $M_{n,i}$ are separable and, furthermore, either $(X-X')(Y-Y')=0$ or $X-X'=Y-Y'$. The former condition is not satisfied by the horn of [9]. Then, a solution in the form of [1, eq. (50)] is not possible.

[2] Manuscript received March 29, 1985.

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[1] C. Dragone, "Scattering at a junction of two waveguides with different surface impedances," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-32, pp. 1319–1328, Oct. 1984.

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[9] C. Dragone, "A rectangular horn of four corrugated plates," *IEEE Trans. Antennas Propagat.*, vol. AP-33, pp. 160–164, Feb. 1985.

Correction to "A Novel Quasi-Optical Frequency Multiplier Design for Millimeter and Submillimeter Wavelengths"

JOHN W. ARCHER, SENIOR MEMBER, IEEE

In the above paper,[1] there is a typographical error in an equation on p. 424, first column. This should read:

"... Above cutoff the power transmission (T) is given, for normal incidence, by [16]

$$T^2 = 4/\left(4\left(C-\frac{B_s}{Y_2}S\right)^2+\left(\frac{Y_1}{Y_2}S+2\frac{B_s}{Y_1}C+\frac{Y_2}{Y_1}S-\frac{B_S^2}{Y_1Y_2}S\right)^2\right)$$

where...".

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[1] J. W. Archer, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-32, pp. 421–427, Apr. 1984.

Correction to "Design of Nonradiative Dielectric Waveguide Filters"

TSUKASA YONEYAMA, SENIOR MEMBER, IEEE, FUTOSHI KUROKI, AND SHIGEO NISHIDA, SENIOR MEMBER, IEEE

In the above paper,[1] Figs. 1 and 7 should be interchanged.

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[1] T. Yoneyama, F. Kuroki, and S. Nishida, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-32, pp. 1659–1662, Dec. 1984.