Letters

Comments on "Transmission From a Rectangular Waveguide into Half Space Through a Rectangular Aperture"

FRED E. GARDIOL

The authors of the above computer program description[1] failed to acknowledge several publications dedicated to the same subject. An open-ended waveguide terminated by a flat infinite metal flange and radiating into an open half space of homogeneous, isotropic, and possibly lossy medium was considered in [1]. The electromagnetic field distribution, the equivalent admittance of the aperture, and the reflection coefficient were presented. In another publication [2], the same approach was applied to radiation through a partial rectangular aperture; it was then also extended to radiation into a slab. The study of a rectangular cavity made from a section of open-ended rectangular waveguide was also treated and further developed in a third publication [3]. Computer programs have been available for all these problems on a complimentary basis and were widely distributed.

It may be noted that our main interest in these studies was connected with the measurement of material properties, rather than the possible use of open waveguides as radiating elements. This may explain why they were not duly referenced.

References

[1] M. C. Decréton and F. E. Gardiol, "Simple nondestructive method for the measurement of complex permittivity," *IEEE Trans. Instr. Meas.*, vol. IM-23, pp. 434–438, Dec. 1974.

[2] M. C. Decréton and M. S. Ramachandraiah, "Nondestructive measurement of complex permittivity for dielectric slabs," *IEEE Microwave Theory Tech.*, vol. MTT-23, pp. 1077–1080, Dec. 1975.

[3] M. S. Ramachandraiah and M. C. Decréton, "A resonant cavity approach for the nondestructive determination of complex permittivity at microwave frequencies," *IEEE Trans. Instr. Meas.*, vol. IM-24, pp. 287–291, Dec. 1975.

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[1]J. R. Mautz and R. F. Harrington, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-26, pp. 44–45, Jan. 1978.

Comments on "Aperture Coupling Between Microstrip and Resonant Cavities"

MAHESH KUMAR AND M. G. SHARMA

In the above paper,[1] the authors have considered the case of coupling between two identical microstrips in Section II-B. The equivalent model of parallel plate waveguide with magnetic side walls (Fig. 3) has been used for the determination of normalized reactance of a small aperture. The notations and relations of [1] have been used directly for analyzing this equivalent model. It may be noted, however, that the case considered in [1] is of transmission through a transverse plane while the case considered by the authors of the above paper is transmission through broad wall of the guide Fig. 2(b). Therefore, the end result obtained in Section II-B is not convincing.

The relationship between the normalized reactance x and T for the particular case of Fig. 2(b) of the above paper as given by Levy [2] is

$$T=\frac{-jx}{2(1+jx)}.$$

Ignoring the imaginary part in the denominator compared to unity for small apertures the relationship between x and T becomes

$$x=2jT.$$

Thus it is concluded that the result obtained for x in the above paper needs modification.

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[1]D. S. James, G. R. Painchaud, and W. J. R. Hoefer, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-25, pp. 392–398, May 1977.

References

[1] C. G. Montgomery, R. H. Dicke, and E. M. Purcell, *Principles of Microwave Circuits*. New York and Dover: 1965, Ch. 6, pp. 176–179.

[2] R. Levy, "Analysis and synthesis of waveguide multiaperture directional couplers", *IEEE Trans. Microwave Theory Tech.*, vol. MTT-16, pp. 995–1006, Dec. 1968.

Reply[2] by Wolfgang J. R. Hoefer[3], Guy R. Painchaud[4], and David S. James[5]

The comments by Kumar and Sharma give us the opportunity to elaborate in more detail the expression for aperture coupling between two identical microstrips through the common ground plane [1].

In fact, the coupling formula given by Levy [2] and cited by Kumar and Sharma describes the magnetic aperture coupling between two waveguides which are matched at all four ports, (see Fig. 1). In this arrangement, the coefficient of transmission from port 1 to port 2 is indeed

$$T=\frac{jx'}{2}$$

while the formula cited by Kumar and Sharma describes the transmission from port 1 to port 3.

In our paper [1] however, the coupling situation is different since ports 3 and 4 are open-circuited at $3\lambda_g/4$ beyond the aperture, which is equivalent to short-circuiting them at $\lambda_g/2$ beyond the aperture (see Fig. 2). A careful comparison of both

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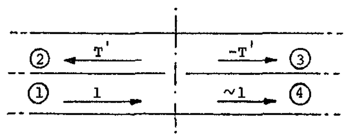

Fig. 1. Aperture coupling described by Levy [2] and cited by Kumar and Sharma. All four ports are matched.

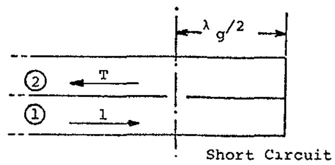

Fig. 2. Aperture coupling described in our paper [1]. Both waveguides are short circuited at $\lambda_g/2$ beyond the coupling hole.

figures shows that the coefficient of transmission form port 1 to port 2 is four times larger in Fig. 2 than in Fig. 1. Consequently, the coupling inductance between ports 1 and 2 in Fig. 2 is only one forth of that in Fig. 1. Thus

$$x=\frac{x'}{4}=\frac{T}{2j}$$

which is (13) in our paper [1]. This situation is equivalent to the coupling through an identical small aperture in a common transverse plane.

The following argument shows that this must be so. In the absence of the coupling hole, the total magnetic field at the bottom wall at $\lambda_g/2$ from the short circuit is the same as at the transverse plane. The electric field is zero at both locations, thus the coupling is purely magnetic in both cases. If the exciting fields as well as all line and aperture dimensions are the same in both cases, the coupling inductances must also be the same.

This statement is supported by such classical authors as Wilson, Schramm, and Kinzer [3]. Their expression for the coefficient of magnetic coupling between a rectangular waveguide and a cavity is identical for an aperture in the end-wall of the guide and the same aperture in the broad wall of the guide at $\lambda_g/2$ from a short circuit.

Thus we believe that the result obtained for x in our paper [1] needs no modification.

References

[1] D. S. James, G. R. Painchaud, and W. J. R. Hoefer, "Aperture coupling between microstrip and resonant cavities," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-25, pp. 392–398, May 1977.

[2] R. Levy, "Analysis and synthesis of waveguide multiaperture directional couplers", *IEEE Trans. Microwave Theory Tech.*, vol. MTT-16, pp. 995–1006, Dec. 1968.

[3] I. G. Wilson, C. W. Schramm, and J. P. Kinzer, "High Q resonant cavities for microwave testing," *Bell Syst. Tech. J.*, vol. 25, pp. 408–433, July 1946.

Correction to "A Directional Coupler with Very Flat Coupling"

GORDON P. RIBLET

In the above paper[1], (17) of Section VI should read

$$\frac{\sin\theta}{Y_1}-(1+Y_2/Y_1)\left(Y_1\sin\theta-Y_2\frac{\cos^2\theta}{\sin\theta}\right)=-\left(\frac{Y+1}{Y-1}\right)^{1/2}. \tag{17}$$

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[1] G. P. Riblet, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-26, pp. 70–74, Feb. 1978.