Correction to "On the Question of Computation of the Dyadic Green's Function at the Source Region in Waveguides and Cavities"

Y. RAHMAT-SAMII

In the above paper,[1] the following typographical errors should be corrected.

On page 763, the expression following (13) needs a change of sign and should read as

$$\Gamma_{nm}^2 = -k^2 + \left(\frac{n\pi}{a}\right)^2 + \left(\frac{m\pi}{b}\right)^2.$$

On the same page, the last term in (17) should be

$$\frac{n\pi}{a}\cos\frac{n\pi x}{a}\sin\frac{n\pi x'}{a}\cos\frac{m\pi y}{b}\cos\frac{m\pi y'}{b}\hat{z}\hat{y}.$$

On page 764, the right-hand side of both (26) and (28) should be multiplied by a minus sign.

Acknowledgment

The author wishes to thank Prof. D. G. Dudley from the University of Arizona for bringing these changes to his attention.

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[1] Y. Rahmat-Samii, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-23, pp. 762–765, Sept. 1975.

Computer Program Descriptions

Transmission From a Rectangular Waveguide into Half Space Through a Rectangular Aperture

PURPOSE: The program calculates the admittance seen by the waveguide, the tangential electric field in the aperture, and the radiation gain patterns for a rectangular waveguide feeding a rectangular aperture in a perfectly conducting plane of infinite extent.

LANGUAGE: Fortran IV.

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AVAILABILITY: ASIS-NAPS Document No. 03178. Also available from the authors as a report [1]. Card decks are available from the authors at a cost of $15.00.

DESCRIPTION: The problem being considered is illustrated in Fig. 1. It consists of a rectangular waveguide of arbitrary dimensions exciting half space through a rectangular aperture of arbitrary dimensions within the waveguide cross section. The half space is bounded by a perfectly conducting plane of infinite extent.

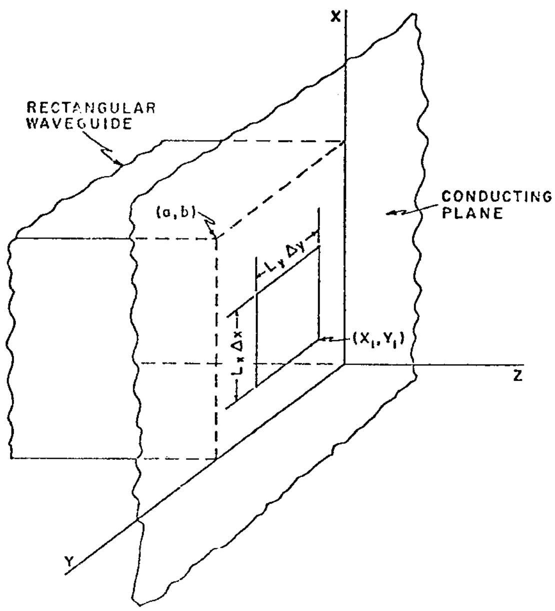

Fig. 1. A rectangular waveguide radiating through a rectangular aperture into half space bounded by an electric conductor.

The method of solution is that of the generalized network formulation [2]. This consists of dividing the problem into two regions by covering the aperture with an electric conductor and placing the magnetic current $\boldsymbol{M} = \boldsymbol{n} \times \boldsymbol{E}$ on the waveguide side of this conductor and $-\boldsymbol{M}$ on the half-space side of this conductor. By having $+\boldsymbol{M}$ on one side and $-\boldsymbol{M}$ on the other side

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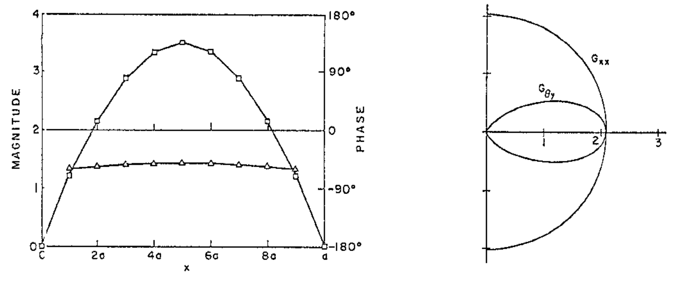

(a) Magnetic current (b) Gain patterns

Fig 2 Equivalent magnetic current M_x and radiation gain patterns for a rectangular waveguide of dimensions λ by $\lambda/2$ radiating through a centered rectangular slot of dimensions λ by $\lambda/10$. Squares denote magnitude and triangles denote phase.

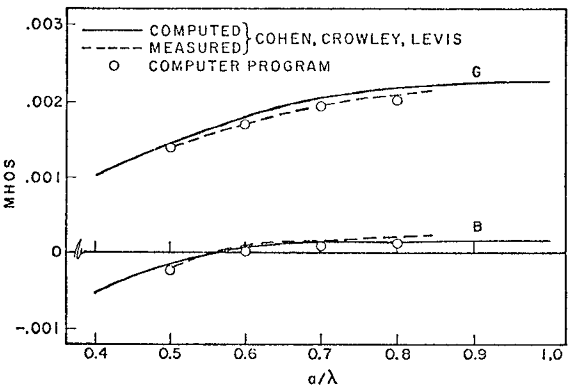

Fig. 3. The equivalent aperture admittance seen by the dominant mode for an open-ended square waveguide of width a radiating into half space Our computed results are compared to those calculated and measured by Cohen, Crowley, and Levis [5].

the boundary condition that tangential $\boldsymbol{E}$ be continuous across the aperture is always satisfied. Enforcement of the remaining boundary condition that tangential $\boldsymbol{H}$ be continuous across the aperture leads to an integral equation for the unknown $\boldsymbol{M}$. The method of moments [3] is applied to this integral equation to obtain generalized admittance matrices for each region. These generalized admittance matrices are then combined in parallel with current sources dependent on tangential $\boldsymbol{H}$ from incident field to determine the solution. The expansion and testing functions used in the solution are triangles in the direction of $\boldsymbol{M}$ and pulses in the direction transverse to $\boldsymbol{M}$.

The admittance matrix for the half-space region is identical to that for the problem of electromagnetic transmission through a rectangular aperture in a conducting plane [4]. The admittance matrix for the waveguide region is of the form of a summation over all modes. The excitation may be taken to be any mode, but normally it is taken to be the dominant mode.

The main program computes the complex coefficients V_i which determine the magnetic current $\boldsymbol{M}$ according to

$$\boldsymbol{M} = \sum_i V_i \boldsymbol{M}_i \qquad (1)$$

where $\boldsymbol{M}_i$ are the above described expansion functions, the amplitudes Γ_i of the reflected waveguide modes, the equivalent aperture admittance according to

$$Y = \frac{1 - \Gamma_0}{1 + \Gamma_0} Y_0 \qquad (2)$$

the complex power flowing through the aperture, and four radiation gain patterns. The four gain patterns are those of two orthogonal components of $\boldsymbol{E}$ in the two principal planes.

The equivalent magnetic current in the aperture and the radiation gain patterns for a slot λ by $\lambda/10$ are shown in Fig. 2. The slot is centered in the cross section of a rectangular waveguide of dimensions λ by $\lambda/2$ excited in the dominant TE_{10} mode. The gain patterns are the two principal plane patterns, G_{xx} denoting an x-polarized field in the $x = 0$ plane, and $G_{\theta y}$ denoting a θ-polarized field in the $y = 0$ plane. Note that the $\boldsymbol{M}_x$, or, equivalently, the $\boldsymbol{E}_y$ in the slot, is nearly the same as the dominant mode field, which is a commonly made assumption.

Fig. 3 shows a comparison of some computed values of the equivalent aperture admittance seen by a waveguide to some measured values and to some computed values from another solution [5]. The waveguide cross section is square and opens into half space through a square aperture of the same size. Other examples of computation of magnetic current, radiation gain patterns, and waveguide admittances for various cases are given in the original report [1].

References

[1] J R. Mautz and R F Harrington, "Transmission from a rectangular waveguide into half space through a rectangular aperture," Report TR-76-5, Department of Electrical and Computer Engineering, Syracuse University, May 1976

[2] R F Harrington and J R. Mautz, "A generalized network formulation for aperture problems, *IEEE Trans Antennas Propagat.*, vol AP-24, pp 870-873, Nov 1976

[3] R F Harrington, *Field Computation by Moment Methods*. New York Macmillan, 1968

[4] R F. Harrington and J. R Mautz, "Electromagnetic transmission through an aperture in a conducting plane," *AEÜ*, vol 31, pp 81-87, Feb. 1977

[5] M Cohen, T Crowley, and K Levis, "The aperture admittance of a rectangular waveguide radiating into half space," Antenna Lab Rept. ac 21114 S R. no 22, Ohio State University, 1953