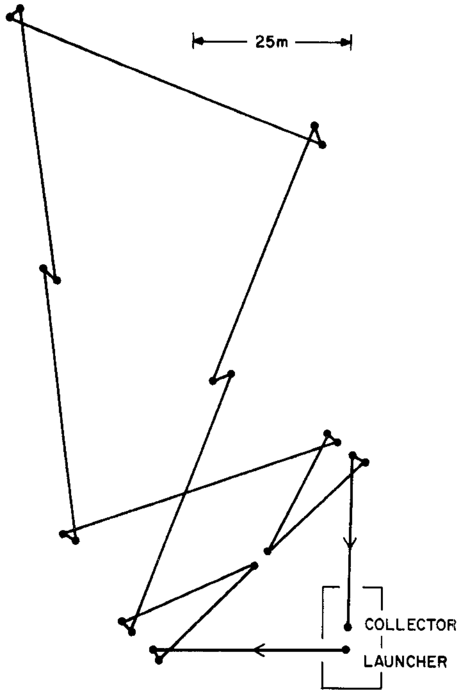

Fig. 1. Outline of the experimental path setup at Crawford Hill, Holmdel, N. J. This path incorporates 10 focusers. The dots along the broken line indicate mirror locations.

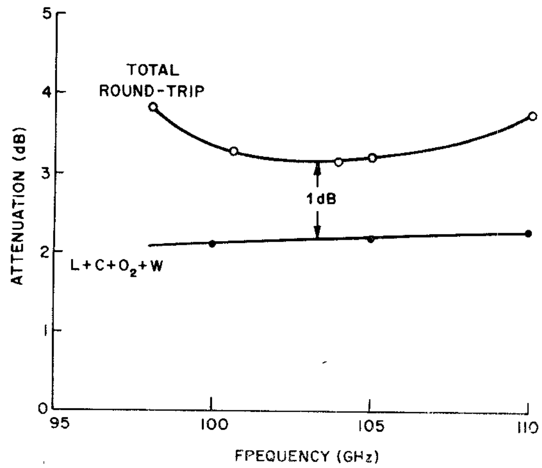

Fig. 2. The top curve gives the measured total round-trip attenuation in decibels as a function of frequency. The lower curve is the sum of the attenuation measured when the launcher and collector face each other (1.8 dB at 104 GHz), the Mylar window loss (0.2 dB), and the attenuation by the atmospheric oxygen (0.23 dB at 104 GHz).

mirror edges and the fact that smaller portions of the cylindrical mirrors are used at the higher frequency (degradations resulting from the lack of uniformity in mirror curvature are lessened if the beam size is reduced). When going from 52 to 104 GHz the only changes that need to be made are substitution of new feeds and optimization of the curvature of the cylindrical mirrors. The same launching and collecting dishes, made of spun aluminum, are used at both frequencies.

The variation of the measured round-trip loss as a function of frequency is shown in Fig. 2. This figure shows that the loss does not exceed 1.6 dB over a 10-percent bandwidth centered at 104 GHz. This loss is significantly higher than the theoretical ohmic loss ($\sim$0.1 dB). Yet it is negligibly small compared with losses resulting from heavy rains. To determine the losses due to the mirror surfaces being wet, a mirror was thoroughly sprayed with water. The attenuation increases by 0.1 dB. Recovery occurs 30 s after the termination of the spraying under average wind conditions.

The variations in transmission due to wind are of the order of 0.2 dB for 8–16-km/h winds and 0.5 dB for 24–32-km/h winds. Gusts of 55-km/h winds can produce 2-dB variations.

Slow daily variations, not exceeding 3 dB, are observed at 52 and 104 GHz; they are attributed to thermal changes resulting in deformations of the supporting structures (made of steel pipes).

In conclusion, we have shown that commercial (1-m by 1-m) glass mirrors can be used for guiding and directing 104-GHz beams with little losses.

Acknowledgment

The author wishes to thank J. A. Arnaud for help and advice in conducting this experiment.

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Fast Parameters Calculation of the Dielectric-Supported Air-Strip Transmission Line

EUGENIO COSTAMAGNA

The method presented by Smith in [1] for the evaluation of the fringing capacitances in microstrip and suspended substrate structures is very useful in analysis and optimization problems and permits fast and accurate calculations.

We have applied the method to the structures, with electric or magnetic side walls, shown in Fig. 1, which differ from those considered in [1] because at the bottom a magnetic wall instead of an electric one is assumed.

The fast calculation of these structures is of great interest and includes as a particular case ($g_1=0$) the analysis of the dielectric-supported air-strip transmission line in Fig. 2.

In his paper [1] Smith expresses the capacitance of the line as a slowly converging series. Convergence is obtained by subtracting from it, term by term, a second series representing the capacitance (Smith's C_T) in a convenient structure, in which the charge distribution (Smith's $\rho(x)$) is similar and can be readily found together with the capacitance from conformal mappings.

In our case, a convenient series expression for the capacitance and a trial function for the charge distribution are obtained from the structure with homogeneous dielectric in Fig. 3. The capacitance and the charge distribution for this geometry can be found from Smith's conformal mappings applied to the new geometry in Fig. 4.

This is because Green's functions for the geometry in Fig. 3 and the geometry in Fig. 4 (which differs from that introduced by Smith for the geometrical dimensions only), calculated on the center conductor, are identical, as will be shown in the following paragraph.

In the case of electric side walls, with homogeneous dielectric, it is sufficient to compare Green's functions for a half section in Fig. 3 [2] and for a half section in Fig. 4 [3]. For the first half section, with the notation introduced in [2], we have:

$$G_0 = \frac{2}{\pi\epsilon_0} \sum_{1,3,5\cdots}^{\infty} \frac{\sinh\frac{m\pi}{2a}g_2 \cosh\frac{m\pi}{2a}g_2 \sin\frac{m\pi}{2a}x \sin\frac{m\pi}{2a}\xi}{\frac{m}{2}\cosh\frac{m\pi}{2a}2g_2}$$

and for the second half section:

$$G_0 = \frac{2}{\pi\epsilon_0} \sum_{1,3,5\cdots}^{\infty} \frac{\sinh\frac{m\pi}{2a}2g_2 \sinh\frac{m\pi}{2a}2g_2 \sin\frac{m\pi}{2a}x \sin\frac{m\pi}{2a}\xi}{\frac{m}{2}\sinh\frac{m\pi}{2a}4g_2}.$$

The two expressions, as seen by inspection, coincide, and a variational

Manuscript received July 28, 1972; revised October 13, 1972.
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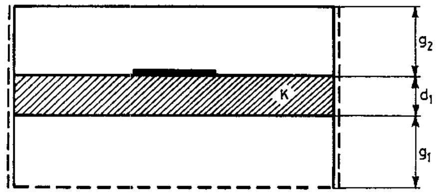

Fig. 1. Cross section of strip transmission line with magnetic wall at the bottom side.

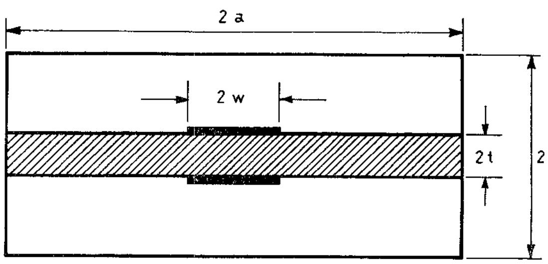

Fig. 2. Dielectric-supported air-strip transmission line.

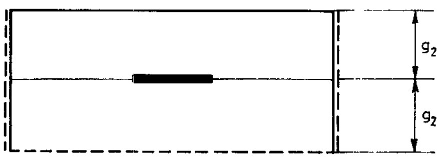

Fig. 3. Geometry for the homogeneous problem.

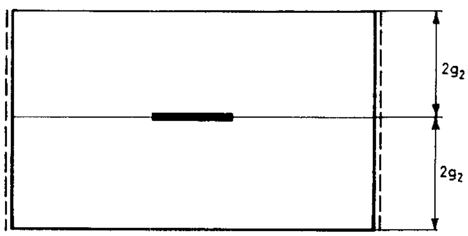

Fig. 4. Modified geometry for the homogeneous problem.

TABLE I

NUMERICAL RESULTS

2a	2b	2w	2t	THIS METHOD		GISH AND GRAHAM'S METHOD	
				Zo	vr	Zo	vr
2	2	1.6	1	22.64	.2481	22.71	.2475
2	2	.4	1	58.94	.2475	59.02	.2475
2	2	.4	.2	103 0	.2717	102.8	.2713
.9	6	.15	.2	7260	.2607	7268	.2606

calculation will give the same results for the two geometries. Hence the capacitance and the charge distribution in Fig. 3 can be easily obtained operating with Smith's conformal mapping process on the new dimensions in Fig. 4.

Finally, the published Fortran program [1] can be applied to the new structures simply by introduction of a suitable Green's function in the series expression. For example, in the case of electric side walls, Smith's ψ_m in [1, eq. (12)] should be written:

$$\psi_m = \frac{(1+K\coth mg_1 \coth md_1)\rho_m}{m\{\coth mg_2(1+K\coth mg_1\coth md_1)+K(K\coth mg_1+\coth md_1)\}}.$$

There is good agreement between the numerical results obtained with this method and the diagrams shown in [2]. This is exemplified by Table I where the values of the characteristic impedance Z_0, and the relative phase velocity v_r, for some geometrical configurations considered in [2, figs. 7, 8, 12, 13] and with the same relative dielectric constant of the substrate, are shown together with the values obtained with the present method. For the sake of greater precision the former values have been obtained by means of a computer program, according to [2], rather than by reading the diagrams. The geometrical dimensions are reported in Fig. 2, using the same notation as in [2].

In conclusion, the present method gives accurate results and the process of optimization of the charge distribution is avoided as in [1].

The saving in computer time obtained is of the order of 80 to 90 percent, which is very important in the analysis and optimization processes of complex geometrical structures.

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Conditions for Approximating the Limit-TEM Mode by a Quasi-TEM Mode in a Ferrite-Filled Coaxial Line

MELVIN M. WEINER

***Abstract*—Sufficient conditions for the quasi-TEM mode in a ferrite-filled coaxial line are reviewed.**

Using a Taylor series expansion of the Bessel functions in the determinantal equation for the limit-TEM mode in a ferrite-filled coaxial line, Wolff [1] has shown that the conditions

$$|s_1|(r_a - r_i) \ll 1 \qquad |s_2|(r_a - r_i) \ll 1 \tag{1}$$

are more general sufficient conditions than the conditions

$$|s_1|r_a \ll 1 \qquad |s_2|r_a \ll 1 \qquad |s_1| \ll r_i \qquad |s_2|r_i \ll 1 \tag{2}$$

which were originally proposed by Weiner [2] for approximating the limit-TEM mode by a quasi-TEM mode. The propagation constant for the quasi-TEM mode in coaxial geometry was shown by Teragawa *et al.* [2, ref. [2]–[5]] to be identical to the Suhl and Walker equation in parallel-plane geometry.

Unfortunately, Wolff attributes conditions (1) to Brodwin and Miller [3]. However, Brodwin and Miller [3] do not state conditions (1), but instead state on page 497: "The results of the numerical analysis show that the Suhl and Walker equation is a close approximation to the propagation constant [of the limit-TEM mode] for the lossless case. The approximation is especially valid for magnetic fields much larger than the resonant field, and for close spacing between inner and outer conductors."

The first sentence of their statement is generally not true and was the subject of correspondence by Weiner [2], [4] and Lewis [5].

As a test of the latter part of the second sentence, Weiner [2] explicitly proposed conditions (1) but rejected them as not being sufficient for reasons recently shown by Wolff [1] to be incorrect. Although Brodwin and Miller [2] believed that conditions (2) were not necessary, they neither proposed nor argued in support of conditions (1). Instead they argued that the Suhl and Walker equation was approximately valid even if conditions (1) were not satisfied [2, entries 1 and 3 in Table I].

In conclusion, conditions (1) should not be attributed to Brodwin and Miller. On the other hand, Wolff's validation of conditions (1), first mentioned by Weiner, is greatly appreciated.

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Manuscript received August 7, 1972.

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