MEASUREMENTS OF DISPERSION CHARACTERISTICS AND FIELD DISTRIBUTIONS IN INVERTED STRIP DIELECTRIC WAVEGUIDE IN MILLIMETER WAVELENGTH

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ABSTRACT

Numerically analyzed propagation constant and field distributions of inverted strip dielectric waveguides are reviewed. Measurements of these characteristics in the 50 - 75 GHz range are presented. A directional coupler is realized and tested about 70 GHz. The dimensions of this component are different from those proposed by ITOH (1). Our structure is essentially single mode and has low loss in transmission. There is a good agreement between theoretical and experimental results.

Introduction

Inverted strip dielectric waveguides are attractive transmission lines for integrated circuits in millimeter wave frequencies. At present, analytical calculations of theses structures are approximate. The purpose of this paper is to determine experimentally the dispersion characteristics and the field distributions in theses waveguides in the 50 to 75 GHz range. This is of great importance in verifying the validity of the analysis based on the effective dielectric constant concept.

Transmission lines

The inverted strip dielectric waveguide presented in this paper has the configuration shown in figure 1. The dielectric strip is a teflon strip ($\varepsilon' = 2.1$) and the guiding layer is in quartz ($\varepsilon' = 3.8$). We applied Knox and Toulios' analysis (2) to calculate the dispersion diagram and the field distribution from 20 to 100 GHz. As simple examples, the figure 2, 3 and 4 indicate the computed curves for two cases of different strip width and thickness.

A CW signal is supplied to the mode launcher through a standard metal waveguide. This transition is schematized in figure 5. The input - output insertion loss and the VSWR distribution of the system from 68 to 72 GHz are equally indicated in figure 5.

The measurement of the guided wavelength and of the field distribution of waves is made by using a section of miniature 50 Ω coaxial cable. This probe moves on the inverted strip dielectric waveguide. The latter is short circuited through a mode launcher.

As simple example, the figure 6 show the probe voltage by runing the probe on the strip. The guided wavelength of this structure is easily deduced. Theses values are indicated in figure 2.

Then we studied the influence of sharp direction change of the strip with insertion loss and VSWR for different cases. We observed that this influence is negligeable for small angles θ ($\theta \leqslant 5°$). The experimental results are plotted in figure 7.

Distributed directionnal coupler

From the dispersion diagram indicated in figure 2 we can define a distributed directionnal coupler using a single mode transmission line. The theoretical and measured coupling ratio are plotted in figure 8.

Conclusion

Dispersion characteristics and field distributions in inverted strip dielectric waveguide have been measured in 4 mm wavelength. There is good agreement between experimental and calculated results. The validity of the analysis is confirmed.

References

(1) R. RUDOKAS and T. ITOH - "Passive millimeter wave I C components made of inverted strip dielectric waveguides" - IEEE Trans on MTT, Dec. 1976.

(2) R.M. KNOX and P.P. TOULIOS - "Integrated circuits for the millimeter through optical frequency range" Proc. Symp. Submillimeter wave, Vol. XX, Apr. 1970, pp. 497-515.

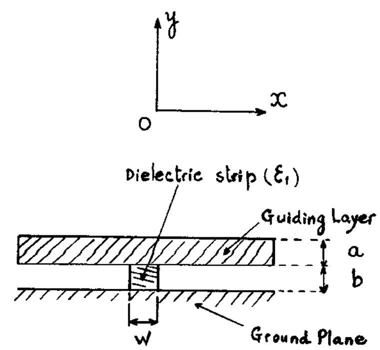
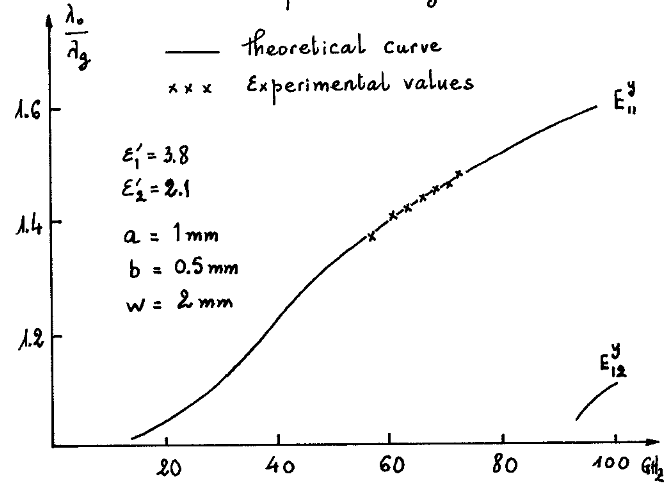


Fig. 1. Cross section of inverted strip dielectric waveguide

FIG. 2. Dispersion Diagram



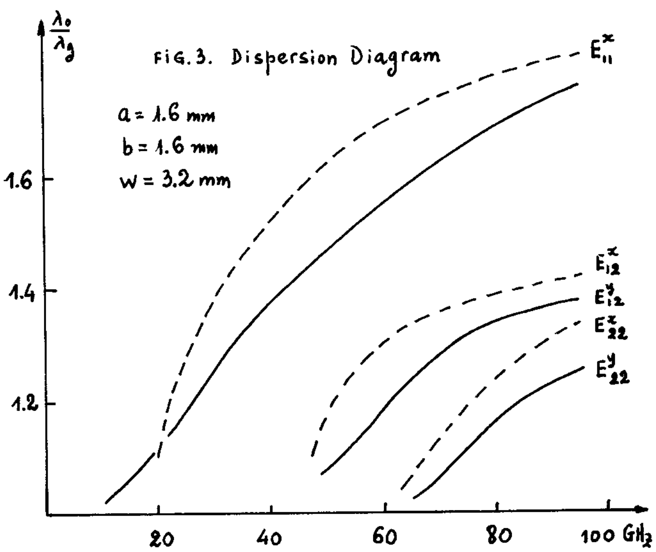


FIG. 3. Dispersion Diagram

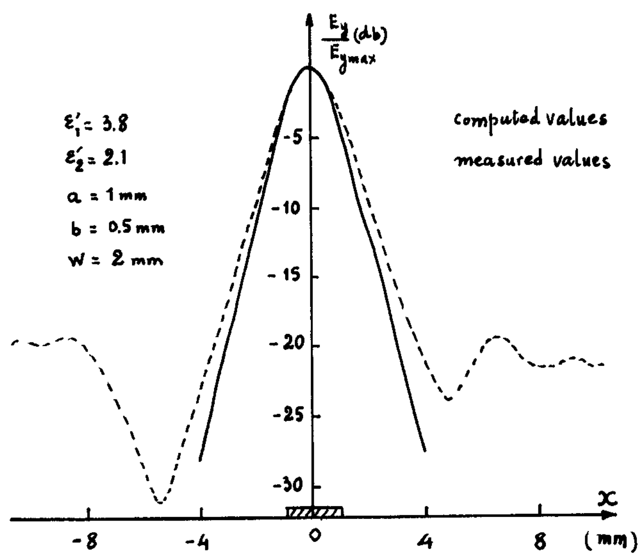
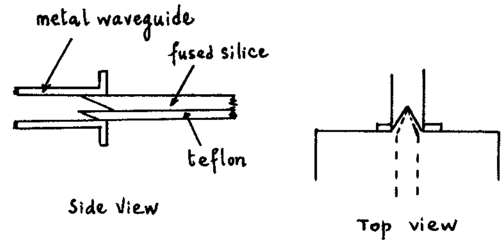


FIG. 4. Normalized field distribution along Ox.



Configuration of transition

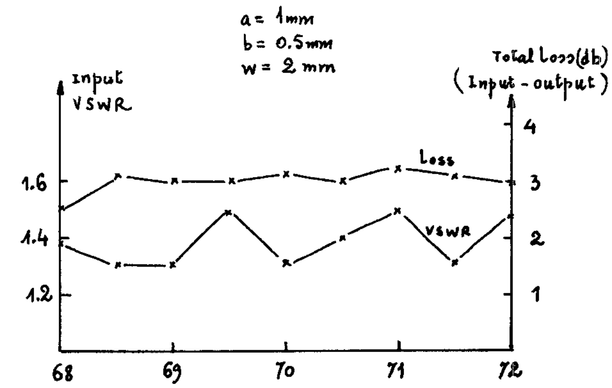


FIG. 5. Transmission and reflection characteristics of transitions.

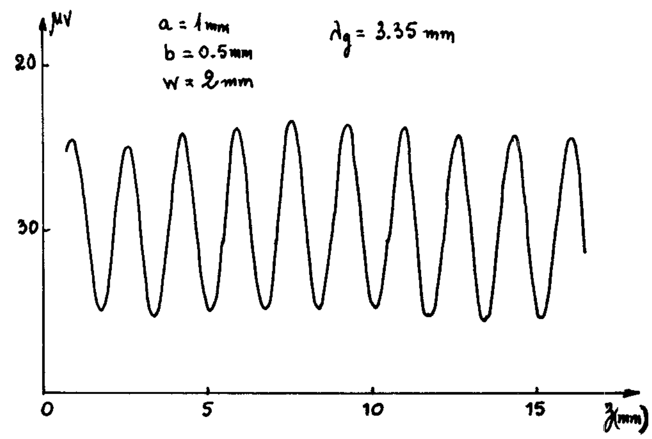


FIG. 6. Standing wave pattern at 63 GHz

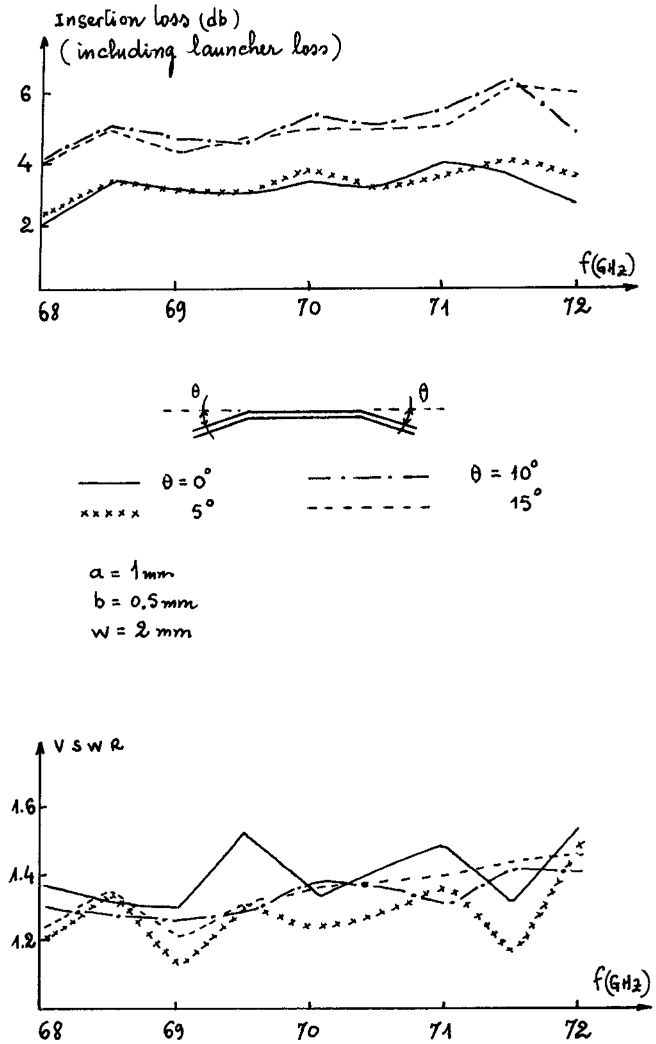


Fig. 7. Effect of θ on insertion loss and VSWR

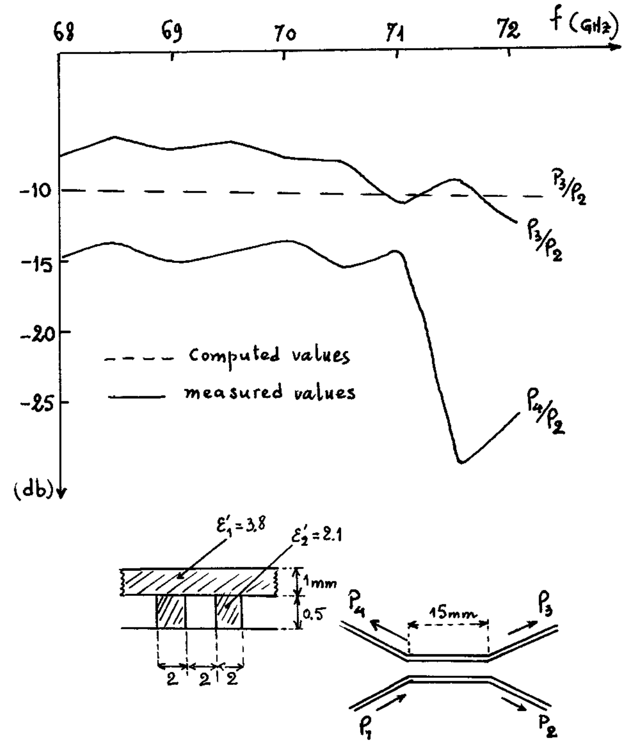


Fig. 8. 10 db Coupling ratio directional coupler