

Analysis of Rectangular Waveguide With Corrugated Broad Wall

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Abstract – Analysis of rectangular waveguide with corrugated broad wall is performed based on Galerkin method in conjunction with Floquet's theorem. Dispersion, power, energy, modal field distribution of the structure are calculated.

Keywords - Galerkin method, Floquet's theorem, dispersion.

I. INTRODUCTION

The corrugated waveguide is a classic example of a slow-wave structure that has been used in many microwave oscillator and amplifier experiments [1]. With the increasing interest in metamaterials corrugated waveguides find their application in composite right-left-handed transmission lines design [2]. Among the attractive features of such structures are the scalability to smaller dimensions and shorter wavelengths, minimal radiation losses and disability to suffer from any extraneous effects.

In this paper the waveguide broad wall has dielectric-filled transverse corrugations as shown in Fig. 1. Analysis of the structure is performed by means of Galerkin method and reducing the system of integral equations for wave eigenfunctions to a matrix equation. In the literature equivalent-circuit model of the structure is analyzed instead.

II. THEORY

The geometry of an infinite rectangular waveguide with dielectric-filled broad wall transverse corrugations is shown in Fig. 1. The waveguide is air filled. The corrugation length l doesn't equal to a , but $l \leq a$. The corrugations are filled with material having ϵ_2, μ_2 , and have width L_1 , depth t and period L_2 . The waveguide height b is from the corrugation interface to the other wall of the waveguide.

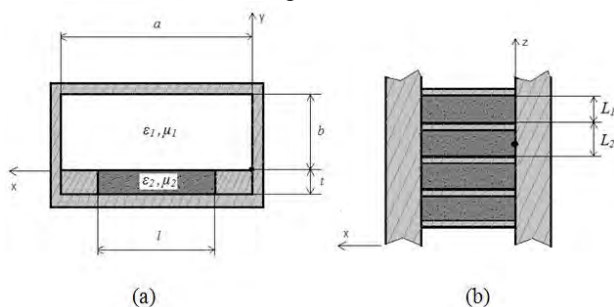


Fig.1 Rectangular waveguide with dielectric-filled corrugations. (a) Transverse section. (b) Longitudinal section

Dividing the structure into 2 regions (region 1 is $y > 0$, region 2 is $-t < y < 0$) from the Maxwell's equations electrical and magnetic fields in each region can be found: fields in

region 1 – must satisfy the periodicity requirements imposed by Floquet's theorem, fields in region 2 – by viewing the shorted corrugation as a rectangular waveguide.

Boundary conditions at $y = 0, -L_1/2 \leq z \leq L_1/2$ are the continuity of electrical and magnetic fields' tangential components. Also, the tangential components of electrical field are vanishing at the metal interface or $y = 0, L_1/2 \leq |z| \leq L_2/2$.

We have to solve a set of Fourier-transformable basis functions with unknown coefficients by using the Galerkin method, which generates a system of linear equations by means of suitably defined inner product that uses the same set of functions for basis as well as testing.

III. NUMERICAL RESULTS

Dispersion relation is shown in Fig. 2 for the parameters of the structure $\epsilon_2 = 10.2, \mu_2 = 1, a = 17 \text{ mm}, b = 4.46 \text{ mm}, l = 15 \text{ mm}, t = 3.7 \text{ mm}, L_1 = 1.27 \text{ mm}, L_2 = 1.905 \text{ mm}$ [2] and a system of linear equations of fourth order.

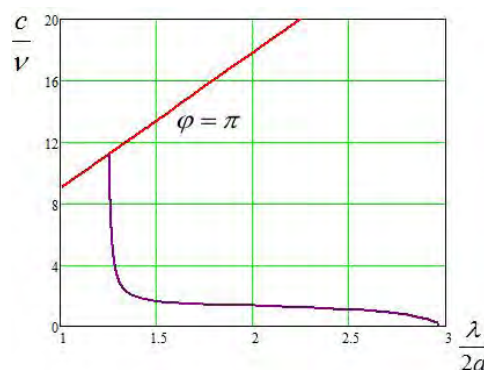


Fig.2 Dispersion relation

Other characteristics of the structure such as group velocity, power and energy were calculated.

IV. CONCLUSION

Analysis of the corrugated waveguide was done in order to obtain structure's eigen waves characteristics. All results are in agreement with other literature.

REFERENCES

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