Calculation of reflection factor H_{0i} - waves of a round waveguide from a dielectric window with a compensating groove

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Abstract: *The method of calculation of irregular wave guides with partial dielectric filling is offered. Results of the decision of a task about selection of the reflector compensating reflection H_{01} of a wave of a round wave guide from a dielectric window are resulted.*

Keywords: hollow irregular waveguide, dielectric window, mathematical model operation

Introduction

Dielectric inserts of the special form are used in many elements of waveguide the MICROWAVE TECHNIQUE. So development of effective methods of calculation of irregular wave guides with partial dielectric filling is actual.

In [1, 2] for the decision of regional tasks in a case it is longitudinal irregular wave guides with vacuum filling the effective procedure of the decision successfully combining a method of transformation of coordinates, the subsequent data of a task to system the ODE is offered on the basis of a method of straight lines, partial conditions of radiation on entrance and target sections and a method of block matrix prorate.

In the present work described in [1, 2] the technique is advanced for a case of a longitudinal - irregular wave guide with dielectric inserts. By way of illustration opportunities of a method the task about selection of a reflector of a round wave guide as the resonant flute compensating reflection of a symmetric H-wave from a thin dielectric window is solved.

Main Part

Dielectric windows in vacuum MICROWAVES devices (for example, in generators of Cherenkov) are used for isolation of vacuum from the air environment. Very important, to make this window such, that the wave passed the MICROWAVE through it without attenuation.

Fig. 1 illustrates a dielectric window with a compensating reflector.

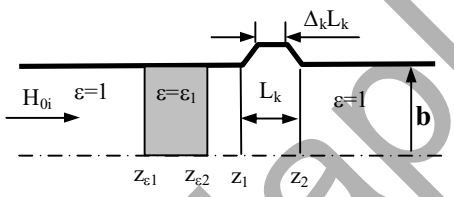
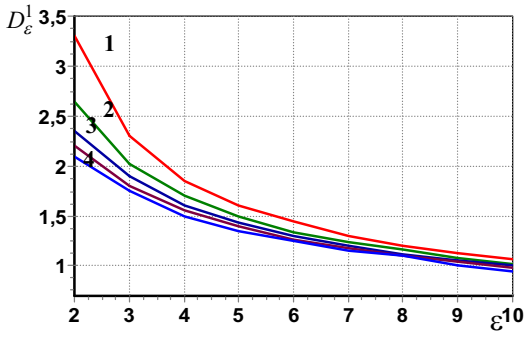


Figure 1. Geometry of a dielectric window with a compensating groove

On an input falls symmetric H - a wave. It is in part reflected from a dielectric insert, in part absorbed (if ε1 - complex), in part passes. The compensating reflector is executed as a groove with parameters h_k - depth, Δ_k - parameter of a steepness, L_k - width [1]. With the help of the developed program the factor of reflection $K = 1 - P_s(L)/P_1^+(0)$ of a dielectric window paid off with a reflector (P_1^+ and P_s capacities falling and taking place waves). Below geometrical sizes are resulted in terms of $\lambda/2\pi$.

Calculations have shown, that at real thickness



curves: 1- b = 4, 2 – b = 5, 3 – b = 6, 4 – b = 7

Figure 2. Dependence of change of resonant width of a window on dielectric permeability for various radius of a wave guide

$D_\varepsilon = z_{\varepsilon 2} - z_{\varepsilon 1} \cong 0{,}5 \div 1$ the factor of reflection from it K_ε reaches significant size, however dependence has periodic character. At the certain values D_ε size of reflection

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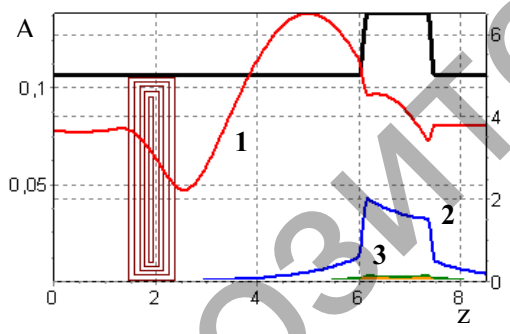
K_ε it becomes insignificant small. As show test calculations by our technique, the period corresponds to half of length of a wave in of dielectric $\Lambda_\varepsilon^{H_{0i}} = 2\pi / \sqrt{W^2\varepsilon - (\mu_{0i}/b)^2}$ that will completely be coordinated to the theory of long lines.

According to the given theory the dielectric window thickness in a floor of length of a wave represents the resonant half-wave transformer and as investigation it possesses property of full passage of a wave (without its reflection).

On fig. 2 the dependence of thickness of the dielectric D_ε^1, relevant is submitted to the first minimum K_ε is designed. Apparently, at values $\varepsilon < 3$ thickness of a dielectric D_ε^1 will achieve the high values which are unacceptable at practical realization.

Realization of a thin transparent dielectric window in this case can be carried out with the help of a reflector as a compensating groove. At the certain sizes, position of a groove for any thickness a dielectric the resonant effect resulting in sharp reduction of factor of reflection is possible. In this case between a dielectric and a groove some half-waves, i.e. system a dielectric-groove are established is equivalent to the half-wave transformer.

Fig. 3 illustrates allocation of amplitudes of partial waves between the dielectric window and a reflector at the minimal reflection for a case of one half-wave.

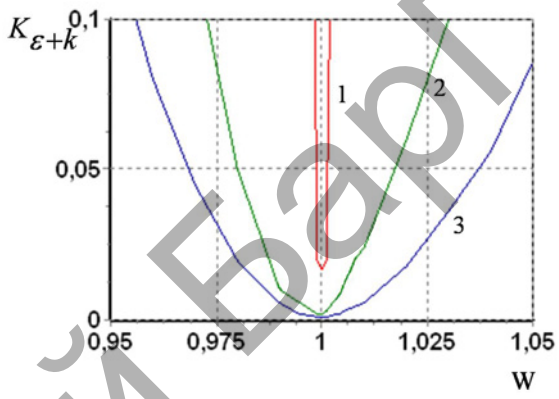


1, 2, 3 – amplitudes H_{0i}-waves $|A_i|$, i=1,2,3

Figure 3. Distribution of amplitudes of raised waves at the minimal reflection

By optimization of parameters a dielectric and groove have been received the results showing, that the compensating reflector allows to reduce reflection in hundreds times due to what it is possible to choose necessary thickness of a dielectric. At increase b till 8-10 for preservation of the minimal reflection of a wave it is required to increase depth of a groove h_k. At big b the distance between a groove and a dielectric practically does not change.

Research of dependence of factor of reflection of a dielectric insert with a groove from frequency at the fixed thickness of a dielectric window has shown that the strip of frequencies extends with increase in radius of a wave guide (Fig. 4).



curves: 1 – b = 4, 2 – b = 5, 3 – b = 6

Figure 4. Dependence of factor of reflection on frequency

Conclusion

The effective method is developed, allowing to expect electrodynamics symmetric H waves in an irregular wave guide with dielectric filling.

Parameters of a reflector as a groove located near to a dielectric window of any thickness at which the resonant effect resulting in sharp reduction of factor of reflection of a working H_{01}-wave is realized are found.

Dependence of a reflectivity of the dielectric window with a groove from frequency is received.

References

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