Computer Program Description

Slot-Line Parameters

PURPOSE: The program calculates guide wavelength and characteristic impedance of a slot line as a function of physical dimensions, substrate permittivity, and frequency.

LANGUAGE: Fortran IV (ASA-standard).

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DESCRIPTION: Several ways have been proposed to calculate the major parameters of a slot line (Fig. 1). This program is based on a variational method given by Pregla and Pintzos [1]. By this approach a transcendental equation for the effective dielectric constant $\epsilon_{r\,\mathrm{eff}}$ is obtained, which is stationary with respect to the electric field $\vec{E}$ in the slot. Using the static electric field for infinite substrate thickness as an approximation for $\vec{E}$, the equation takes the form

$$\int_0^\infty \mathrm{int}(w,h,f,\epsilon_r,\epsilon_{r\,\mathrm{eff}},x)\,dx=0 \tag{1}$$

where w is the slot width, h the substrate height, ϵ_r the dielectric constant (see Fig. 1), and f the frequency. The integration variable x has the dimension of a reciprocal length. The definition of the characteristic impedance Z given by Cohn [2] yields the equation

$$Z=\frac{\pi^3 w^2}{4\int_0^\infty \mathrm{int}_z(w,h,f,\epsilon_r,\epsilon_{r\,\mathrm{eff}},x)\,dx}. \tag{2}$$

The integrands int and int_z are transcendental functions [1].

The computer program consists of the main program and four FUNCTION-subprograms. The input variables are

EPSR	dielectric constant ϵ_r of the substrate material,
H	substrate height h, in centimeters,
WANF, *DW*, *WEND*	first value, difference between successive values (>0), and last value of slot width w, in centimeters,
FANF, *DF*, *FEND*	first value, difference between successive values (>0), and last value of frequency f, in gigahertz.

Equation (1) is solved for $\epsilon_{r\,\mathrm{eff}}$ using the *Regula falsi* method with initial values $\epsilon_{r\,\mathrm{eff}}=2.0$ and $0.8\cdot\epsilon_r$. The iteration process

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Further information concerning this program can be obtained from the author.

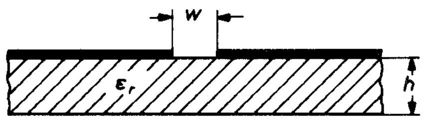

Fig. 1. Cross section of slot line.

stops if the difference between two successively computed approximations for $\epsilon_{r\,\mathrm{eff}}$ is less than 10^{-4}. The subprogram INT calculates the function values int(...). Numerical integration is performed by the subprogram GINTEG, which applies an eight-point Gaussian quadrature formula [3]. An upper integration limit of 400 cm^{-1} has proven to be sufficiently high. With $\epsilon_{r\,\mathrm{eff}}$ known the slot wavelength λ_g and the relative wavelength ratio λ_g/λ_0 (λ_0 is the free-space wavelength) are easily obtained from the definition $\epsilon_{r\,\mathrm{eff}}=(\lambda_0/\lambda_g)^2$.

The characteristic impedance Z is computed according to (2). Again GINTEG is used for integration. The subprogram ZINT calculates the values of the integrand $\mathrm{int}_z(\ldots)$. The last subprogram, JZERO, called by INT and ZINT, computes the Bessel function of first kind and order utilizing polynomial approximations [3]. Finally, the following parameters are printed.

W	actual value of slot width w, in centimeters,
F	actual value of frequency f, in gigahertz,
LAMG	slot wavelength λ_g, in centimeters,
LAMG/LAMO	relative wavelength ratio λ_g/λ_0,
EPSREFF	effective dielectric constant $\epsilon_{r\,\mathrm{eff}}$,
Z	characteristic impedance Z, in ohms.

The so-determined values of λ_g/λ_0 are in very good agreement with those computed by Cohn. As already mentioned in [1], the corresponding results for the characteristic impedance may show a difference of a few percent. For one set of parameters w, h, ϵ_r, and f the computation time required is usually 5–7 s on a Telefunken TR 440 computer.

References

[1] R. Pregla and S. G. Pintzos, "Determination of the propagation constants in coupled microslots by a variational method," in *Proc. 5th Colloquium on Microwave Communication*, (Akadémiai Kiadó, Budapest, Hungary), vol. IV, 1974, pp. 491–500.

[2] S. B. Cohn, "Slot Line on a Dielectric Substrate," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-17, pp. 768–778, Oct. 1969.

[3] M. Abramowitz and I. A. Stegun (Eds.), *Handbook of Mathematical Functions.* Washington, DC: Nat. Bur. Stand., 1964.