FIN LINE DESIGN MADE EASY

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ABSTRACT

Fin line is an attractive transmission medium at millimeter wavelengths for its ease of fabrication and its compatibility with semiconductor devices. Its wide bandwidth, low dispersion and moderate attenuation (when compared with microstrip in that frequency range) would make it a favorite candidate for many designers, were it not for the cumbersome design procedures available to date.

Treatment of the fin line as a ridged waveguide of identical dimensions yields only poor accuracy, 15% at best for the effective permittivity and characteristic impedance.

Meier's [1] expressions for these parameters are certainly adequate for most applications, particularly at frequencies well above cutoff of the fundamental TE_{01}-mode, but unfortunately, the determination of the effective dielectric constant of the line requires a sample measurement, which is expensive and time consuming.

On the other hand, the exact solution of Maxwell's equations in fin line, as presented by Hofmann [2], tends to dissuade many designers by its involved mathematics, even though it is the ultimate approach.

The objective of the present paper is to present an easier but nevertheless accurate method to theoretically predict the guided wavelength in a fin line which may then be used to determine the effective dielectric constant in Meier's [1] formulae. Practically speaking, Meier's sample measurement is replaced by a theoretical evaluation.

To this end, the transverse resonance condition in a fin line resonator is solved using either a graphical method (very cheap but quite accurate) or a programmable pocket calculator perusing a standard routine for the calculation of the root of a function. The equation for the transverse resonance condition contains an expression for the discontinuity susceptance of the fins and the substrate. It is this susceptance that will be presented in mathematically closed form, following the style of Marcuvitz' [3] Waveguide Handbook. This approach is familiar to all microwave circuit designers and combines the advantages of easy mathematical formalism and the accuracy of the exact solution from which it has been derived.

The exact solution is based on Cohn's [4] treatment of the unshielded slot line. Taking into account the transverse impedance of the fin line enclosure acting as a rectangular short-circuited waveguide below cutoff, the susceptance of the combined substrate-fin discontinuity is derived from Cohn's expressions which have already been conceived for fast convergence on a computer.

In conclusion, the fin line designer will benefit from the present approach because he will

a. save time by following an already well known design procedure,
b. apply the results of an exact solution without having to solve the boundary value problem himself, and
c. take advantage of the available wealth of fin line design information by adapting the above results to Meier's formulae.

REFERENCES

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