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COMPUTER OPTIMIZATION OF INHOMOGENEOUS WAVEGUIDE TRANSFORMERS

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The problem of designing broadband multisection, stepped rectangular waveguide impedance transformers, when the input and output guides have different cutoff frequencies but propagate the same mode, is formulated in general terms for direct optimization by digital computer. The formulation is sufficiently flexible to allow non-ideal junction discontinuity effects and mismatched terminations to be taken into account during optimization. Constraints placed on the width, height, or length of any section need be dictated only by consideration for dominant mode propagation and the requirement of small (but not necessarily negligible) junction discontinuities.

The objective of the formulation is a minimax equal-ripple response over a predetermined frequency band satisfying the constraints selected for the particular problem. The optimization technique is a direct search method called Razor Search developed by Bandler and Macdonald, which is designed to handle optimization problems such as this one in which the objective function is characterized by discontinuous partial derivatives. Another direct search method called Ripple Search, developed to locate the extrema of multimodal functions of one variable efficiently, is used to determine the maximum reflection coefficient in the band of interest.

Constrained optimum equal-ripple solutions to examples previously published by Young, Matthaei et al and Riblet are presented. They demonstrate the considerable improvements made possible by this less restrictive formulation with regard to performance, reduction in number of sections and physical size.

A 3-section inhomogeneous transformer designed by Riblet by an approximate synthesis method was optimized keeping the waveguide widths fixed, for convenience, and assuming ideal junctions. An equal-ripple response resulted whose bandwidth is better by 45% for virtually the same overall transformer length. Since both Riblet's and the author's design exceed Riblet's original specification, a 2-section transformer was optimized which was also found to satisfy Riblet's specification. Junction discontinuity effects using data available in Marcuvitz were, for this example, directly incorporated into the optimization process.

This approach should also find application in the design of broadband microwave matching or equalizing networks consisting of noncommensurate components and for which exact synthesis techniques may be unavailable.

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