configuration consisting of a transitional section only, the computer execution time is 36 s, with $N=6$ and $NF=6$. In one trial, computer printout results showed the broad-band matching of 141 (out of $6!=720$) permuted transitional sections to be superior to the tapered multilayer section which was used as a starting design. A modest improvement (4 percent) in the energy transmitted through the window was indicated when compared with the starting design. Only a modest improvement could be expected, because the tapered multilayer section used at the start had been established as an optimum design by another optimization method [1].

REFERENCE

[1] D. L. Huffman, "On the design of broadband electromagnetic windows," Ph.D. dissertation, Ohio State Univ., Columbus, 1970.

Electrostatic Microstrip Analysis Programs—MICRO and INFSTR

PURPOSE: Each program determines the electrostatic capacitance of microstrip transmission lines. MICRO also returns characteristic impedance and relative phase velocity, INFSTR the charge density distribution.

LANGUAGE: Fortran IV, level G. MICRO source deck is 177 cards. INFSTR source deck is 179 cards.

AUTHORS: P. Silvester and P. Benedek, Department of Electrical Engineering, McGill University, Montreal 110, Quebec, Canada.

AVAILABILITY: The programs are available as ASIS–NAPS Document No. NAPS-01952. Copies of a source deck package containing both routines may be purchased through the first author at 15 dollars (U.S.), within three years of publication.

Manuscript received May 5, 1972; revised September 7, 1972.
For program listing, order NAPS-01952 from ASIS National Auxiliary Publications Service, c/o CCM Information Corporation, 909 Third Avenue, New York, N. Y. 10022; remitting $2.00 per microfiche or $5.00 per photocopy.

DESCRIPTION: MICRO [1] calculates the wave-propagation properties of microstrip transmission lines. The integral equation governing the electrostatics of microstrip configurations is solved using the substrip method. MICRO includes a main program and I/O statements. The required input is the number of subdivisions, the width-to-substrate height ratio, and the substrate relative dielectric constant. When N subdivisions are specified, the program automatically recomputes with $N/2$ subdivisions, and a quadratic Aitken extrapolation is used to return results equivalent to about $2N$ subdivisions. The output includes the capacitance and characteristic impedance, with and without dielectric, as well as the relative phase velocity. For further details see [1].

INFSTR calculates the electrostatic capacitance for microstrip transmission lines. The governing integral equation for the electrostatics of the microstrip is solved using a projective method [2]. The charge density distribution is expanded on a function space well suited to account for the edge singularities. INFSTR is in subroutine form and the required input parameters are: width-to-substrate height ratio, relative dielectric constant of the substrate, and the desired number of expansion functions. It is suggested that for maximum efficiency two expansion functions be utilized. This subroutine returns, in addition to the microstrip electrostatic capacitance per unit length, the vector of coefficients for the charge density expansion set. Therefore, a function describing the charge density distribution on the microstrip becomes available. There is usually no significant improvement in specifying more than two expansion functions. In its present form the program is usable for width-to-height ratios less than 3.0. This limitation can be removed by using higher order quadrature formulas. INFSTR calls subroutine SIMQ, part of the IBM Scientific Subroutine Package. If desired, any other general simultaneous equation solver may be substituted, by altering one Fortran statement.

Both programs have been repeated by run on IBM 360 machines, and MICRO has also been used on IBM 7094. In view of the standard Fortran employed, however, they should be completely portable. Comparative results and computation times for the two programes are given in [2].

REFERENCES

[1] P. Silvester, "TEM wave properties of microstrip transmission lines," *Proc. Inst. Elec. Eng.*, vol. 115, no. 1, pp. 43–48, Jan. 1968.
[2] P. Silvester and P. Benedek, "Electrostatics of the microstrip—Revisited," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-20, pp. 756–758, Nov. 1972.