made. The optimal point, weighted errors from various intervals, and execution time are printed out, and the intermediate results in the optimization procedure if desired.

There is no restriction on the number of design parameters, number of intervals, or discrete point sets.

A recent publication [4] contains the background theory for the optimization algorithm, detailed organization of the program FMLPO, and instructions on how to use it for both unconstrained and constrained optimization problems. This includes a block diagram of the package and flowcharts of its subroutines. The examples demonstrating FMLPO were taken in system modelling and multisection transmission-line filter design. Document NAPS 02274 contains a complete listing and detailed user's manual for the given package fully illustrated with examples [5].

Typically less than a minute of CDC 6400 computer time and a core requirement of about $15K_{10}$ is sufficient to optimize a constrained problem with five parameters and fifty-two sample points.

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The authors wish to thank Dr. C. Charalambous, who is now with the Department of Combinatorics and Optimization, University of Waterloo, Waterloo, Canada, and some of whose recent work is embodied in the package.

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DICOSY (Directional Coupler Synthesis)

PURPOSE: This program performs a synthesis procedure for N-stepped asymmetric TEM-transmission-line directional couplers of any desired mean voltage coupling and coupling tolerance.

LANGUAGE: Fortran IV. Program deck length about 210 cards.

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AVAILABILITY: ASIS/NAPS Document No. NAPS 02231.

DESCRIPTION: Since the program DICOSY is based on an exact synthesis procedure published by Levy [1]–[3], no details of the theory itself will be given in this computer program description.

The input variables are specified as follows.

- N Number of coupling elements.
- CM Mean coupling.
- R Voltage ripple in percent (i.e., coupling varies between $CM\ (1 - R/100)$ and $CM\ (1 + R/100)$; if coupling is wanted to vary between $CM - R$ and $CM + R$ (in decibels), only three cards have to be replaced.
- $SCAT$ Logical variable: IF·TRUE· an analysis of the synthesized coupler is carried out.

The output data are as follows.

- N, CM, R See above.
- BW Bandwidth of coupler.
- $TETA$ Lower bound $(l/\lambda)_c$ of the operating frequency band (l being the overall length of the coupler).
- Z Even-mode impedances Z_{oei} of the N coupling sections normalized to the impedance of the input lines.
- KOP Coupling coefficients $k_i = (Z_{oei}^2 - 1)/(Z_{oei}^2 + 1)$ of the N coupling sections.

If SCAT = ·TRUE·, the real part, the imaginary part, and the modulus of the scattering coefficients S_{14} and S_{12} of the coupler are computed and printed for $0 \leq l/\lambda \leq 4.5$, thus allowing a check of the synthesis procedure.

The program has no limitations in principle and the highest value of N that can be reached by DICOSY only depends upon the number of significant digits the computer processes. For this reason the program is written in double precision.

With 18 significant decimal digits [IBM 7040] N_{max} is about 40, while 25 significant decimal digits [Telefunken TR 440] give $N_{max} \approx 75$. These high values of N allow the construction of directional couplers with high-pass Chebyshev equal-ripple coupling response [4], [5].

The part of the program performing the reduction process of the overall transfer matrix can also be used in connection with the synthesis procedure of multielement symmetrical directional couplers [6].

The running time only depends on the number of elements N. Some typical values for a run on a Telefunken TR 440 computer are as follows:

N	Synthesis (s)	Synthesis and Analysis (s)
10	0.3	2.8
40	2.1	9.7
75	6.3	19.5

On this computer the word-storage requirements for the program are 24 K of the core and 49 K of the drum storage.

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