

Letters

Comments on "Fast and Accurate Analysis of Waveguide Filters by the Coupled-Integral-Equations Technique"

F. Arndt, P. Krauss, and T. Sieverding

In the above paper,¹ the authors analyzed a four-resonator H -plane filter with both the mode-matching technique (MMT) and a coupled-integral-equation technique (CIET). They report {46mtt12-correspd-lt-pt1} that the MMT with 50 odd modes takes 9106 s on an IBM 6000 RS/530 workstation, whereas the CIET takes 22 s for the same number of frequency points (201). This obviously leads to the central claim of the above paper¹ that the CIET be 400 times faster than the MMT.

We applied the MMT utilizing all features described in [1] to the same filter (p. 1615) and took the same numbers of modes (50 odd modes) and frequency points (201) into account. We verified that the total central processing unit (CPU) time (symmetry of the given filter structure utilized) on an IBM 6000 RS/360 was 11 s for the whole set of 201 frequency points.² The reflexion coefficient is plotted in Fig. 1 (dashed line).

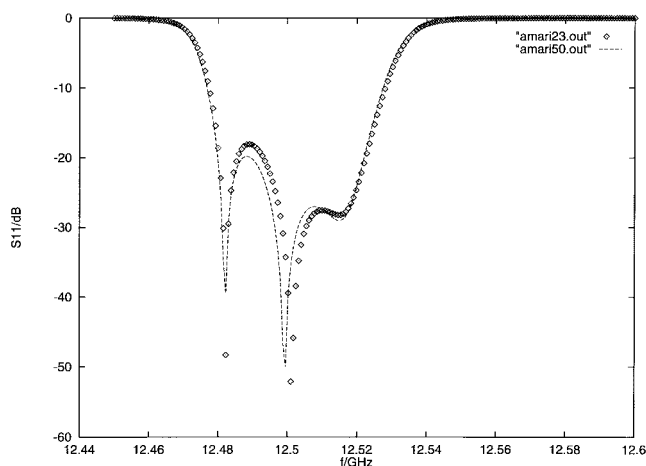


Fig. 1. Mode-matching analysis of the four-resonator H -plane iris coupled filter (data p. 1615) of the above paper,¹ 201 frequency points. Dashed lines 50 odd modes (11-s total CPU time on an IBM 600 RS/360), diamonds 23 odd modes (3.5-s total CPU time on an IBM 600 RS/360).

Moreover, Fig. 1 shows our mode-matching calculations with only 23 modes (diamonds), which lead—in contrast to the result in Fig. 3 of the above paper¹—already to sufficiently converging values (3.5-s total CPU time on an IBM 600 RS/360).

Manuscript received March 16, 1998.

The authors are with the Microwave Department, University of Bremen, D-28334 Bremen, Germany.

Publisher Item Identifier S 0018-9480(98)09055-3.

¹S. Amari, J. Bornemann, and R. Vahldieck, *IEEE Trans. Microwave Theory Tech.*, vol. 45, no. 9, pp. 1611–1618, Sept. 1997.

²We had no IBM 6000 RS/530 available. According to usual tables, the RS/360 and RS/530 show nearly identical performance (Linpack 100 × 100) 22, 20 MFlops, respectively.

REFERENCES

- [1] F. Arndt, R. Beyer, J. M. Reiter, T. Sieverding, and T. Wolf, "Automated design of waveguide components using hybrid mode-matching/numerical EM building-blocks in optimization oriented CAD frameworks—State-of-the-art and recent advances," *IEEE Trans. Microwave Theory Tech.*, vol. 45, pp. 747–760, May 1997.

Authors' Reply

Smain Amari, Jens Bornemann, and Rüdiger Vahldieck

The central processing unit (CPU)-time comparison between the mode-matching technique (MMT) and the coupled-integral-equation technique (CIET) given in the above paper¹ was based on a simple and straightforward implementation of both algorithms without taking advantage of the symmetries in the structure. Our MMT implementation was based on the formalism described in [1], and the CIET code did not take advantage of the sparsity of the matrix. On that basis (ease and simplicity of implementation), the CIET was a factor of 400 faster than the MMT.

Of course, computer programs may be made faster depending on the programming techniques applied. The purpose of the above paper¹ was not to compete with the MMT in view of a faster algorithm as a result of better programming. The intention of the above paper¹ was to present a concept which takes into account field singularities at all discontinuities simultaneously. As demonstrated in the above paper,¹ this technique leads to faster convergence. In the MMT algorithms, the fields are basically approximated by sinusoidal functions, which are well known to converge slowly, since *a priori knowledge of field singularities are not considered*. This typically leads to large matrices and, thus, an inherently slower algorithm. An alternative implementation of the MMT discussed by Shih [2] allows one to reduce the size of the matrices somewhat and, thus, accelerates the MMT algorithm significantly. This is also claimed by Arndt *et al.* and they demonstrate that their MMT algorithm has been made impressively fast.

In an attempt to compare the same thing, we have reformulated the MMT and applied better programming techniques to both our MMT program and the CIET program. This comparison has shown that the CIET is still a factor of 20 faster than the MMT algorithm.

REFERENCES

- [1] J. Uher, J. Bornemann, and U. Rosenberg, *Waveguide Components for Antenna Feed Systems: Theory and CAD*. Norwood, MA: Artech House, 1993.
- [2] T. Itoh, Ed., *Numerical Techniques for Microwave and Millimeter-Wave Passive Structures*. New York: Wiley, 1989.

Manuscript received August 20, 1998.

S. Amari and J. Bornemann are with the Laboratory for Lightwave Electronics, Microwaves and Communications (LLiMiC), Department of Electrical and Computer Engineering, University of Victoria, Victoria, B.C., Canada V8W 3P6.

R. Vahldieck is with the Laboratory for Field Theory and Microwave Electronics, Swiss Federal Institute of Technology, ETH-Zentrum, 8092 Zürich, Switzerland.

Publisher Item Identifier S 0018-9480(98)09054-1.

¹S. Amari, J. Bornemann, R. Vahldieck, *IEEE Trans. Microwave Theory Tech.*, vol. 45, no. 9, pp. 1611–1618, Sept. 1997.