Letters

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

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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 paper[1] 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).

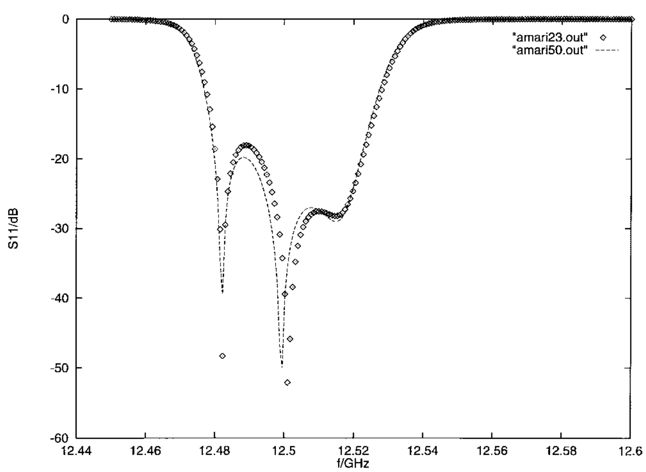

Fig. 1. Mode-matching analysis of the four-resonator H-plane iris coupled filter (data p. 1615) of the above paper,[1] 201 frequency points. Dashed lines 50 odd modes (11-s total CPU time on an IBM 600 RS/360), diamonds 23 odd modes (3.5-s total CPU time on an IBM 600 RS/360).

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 paper[1]—already to sufficiently converging values (3.5-s total CPU time on an IBM 600 RS/360).

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

[2] We 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

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The central processing unit (CPU)-time comparison between the mode-matching technique (MMT) and the coupled-integral-equation technique (CIET) given in the above paper[1] 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 paper[1] was not to compete with the MMT in view of a faster algorithm as a result of better programming. The intention of the above paper[1] 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.

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