Erratum

Comments on "Reconstruction of the S-Matrix for a 3-Port Using Measurements at Only Two Ports"

James C. Rautio

The author of the above letter[1] is to be complemented on finding a closed form solution to the set of bilinear transforms which transform correct S-parameters of a three-port device into the imperfectly terminated two-port S-parameters usually measured [1]. However, readers of his paper might also benefit from work previously published in this area.

Specifically, in [1], an iterative algorithm solving the same set of equations is presented. In addition, the algorithm is extended to N-ports, with the equations for four-port measurement given in the paper. However, more than four ports, while theoretically possible, does become cumbersome when approached in this way.

However, [1] also presents a closed-form approach that does not face the limitation of the bilinear transform approach. Rather, the set of measured two-port data are converted to Gamma-R parameters (introduced in that paper), which are similar to S-parameters normalized to the impedance of the imperfect terminations used on each port. The complete N-port Gamma-R matrix is assembled from the measured two-port Gamma-R parameters, and then it is converted to 50-Ohm normalized S-parameters. This algorithm is closed form and is easily extend to any number of ports in practice.

In addition, no work on multiport microwave measurements can be complete unless it at least also mentions the extensive pioneering work of Tippet and Special [2].

Author's Reply by Marat Davidovitz

I would like to thank J. C. Rautio for pointing out the additional references. They are undoubtedly of great interest to anyone concerned with measurements of multiport components.

However, it should be noted that the technique presented in the letter under discussion is distinct from those outlined in the comments, as well as that of another recently found article [3]. Specifically, the latter require measurements on all possible two-port permutations, and all device-ports must be outfitted with transitions to the network analyzer. In some situations these requirements may lead to calibration difficulties, particularly if the device ports are in different transmission media. This is exemplified by a waveguide-to-microstrip power divider, which served to motivate the work presented in the letter. It was found that the preferable measurement technique for that type of device is one that allows only two specific device ports to be connected to the analyzer, while several known terminations are attached to the third to generate the needed data. In the example cited, this approach facilitated the calibration needed to remove the effects of the coax-to-microstrip transitions.

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[1] M. Davidovitz, *IEEE Microwave Guided Wave Lett.*, vol. 5, no. 10, pp. 349–350, Oct. 1995.

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[2] J. C. Tippet and R. A. Speciale, "A rigorous technique for measuring the scattering matrix of a multiport device with a 2-port network analyzer," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-30, pp. 661–666, May 1982.
[3] S. B. Goldberg, M. B. Steer, and P. D. Franzon, "Accurate experimental characterization of three-ports," in *IEEE MTT-Symp. Dig.*, 1991.

Comment on "A Simple Way to Model Curved Metal Boundaries in FDTD Algorithm Avoiding Staircase Approximation"

T. Weiland

The triangular subdivision of mesh cells as described in the above letter[1] were first published (to the author's knowledge) over 15 years ago [1] in the context of a frequency-domain method. This improvement has been proposed for time-domain computations with particle beams [2] and used in numerous publications for two-dimensional, 2.5-dimensional, and three–dimensional computations for static fields, eddy current fields, high-frequency fields and, last but not least, for time-domain fields (see, e.g., [3]–16]).

Furthermore, the triangular subdivision is not only applicable for metallic boundaries, but also for any type of material boundary.

The formula that have been published many times and have for over 10 years been realized in a commercial software package are now in use in over 25 countries [17], [18]. In various application papers as well as in the demonstration examples of these software packages [17], [18], examples are presented showing the advantage of using graded meshes combined with triangular subcells.

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[1] P. Mezzanotte, L. Roselli, and R. Sorrentino, *IEEE Microwave Guided Wave Lett.*, vol. 5, no. 8, pp. 267–269, Aug. 1995.

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