Letters

Comments on "Analysis and Design of a Circular Disc 3-dB Coupler"

M. D. Abouzahra

In a recent paper, [1], Bialkowski and Jellett discussed the design of a broadband 3-dB quadrature hybrid. This hybrid is comprised of 4-port microstrip disc. It appears that the authors were able to increase the operational bandwidth of the circular disc 3-dB quadrature coupler [2] to about 20%. Open and short-circuited stubs were introduced to the periphery of the coupler in order to realize a broader bandwidth. This technique was applied previously by Riblet [3] and Ohta [4] on planar components and broader operational bandwidth were realized. In addition to listing few corrections, I would like to respond to some inaccurate statements made in [1] by offering the following comments.

1) Contrary to the introductory comments in [1] regarding the narrow operational bandwidth of rectangular-disc-shaped hybrids, Ohta and his coworkers in Japan [4]–[7] have shown that such hybrids can offer 20–27% in operational bandwidth. Ohta's results are indeed very comparable to, and perhaps better than, the results presented in Figs. 5 and 6 of [1].
2) The analysis as well as (9) in Section II is not new. The disc results have been reported earlier, first by Ohta in [8] and later by myself in a tutorial chapter [9]. Reference [10] provides an update to the results that were presented in [9]. Incidentally (9) appears to be missing a 2π factor in the denominator of the term preceding the summation sign. The term $p_m(kr)$ in (5) also need to be changed to $P'_m(kr)$. Furthermore, in the interest of clarity it would have been worthwhile mentioning that the derivative in (5) is with respect to the argument of the Bessel function.
3) The spikes (around $f = 2.3$ GHz) in Figs. 3 and 4 are peculiar; it is unfortunate that the authors did not comment on them.

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The author is with Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, MA 02173-9108 USA.
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Reply to Comments on "Analysis and Design of a Circular Disc 3-dB Coupler"

M. E. Bialkowski and S. T. Jellett

As mentioned by M. D. Abouzahra, our work presented in [1] concerned the analysis and design of a 3-dB quadrature hybrid in the form of a circular disc that has increased operational bandwidth. Because our investigations primarily involved a 3-dB quadrature circular disc hybrid, we did not attempt to provide a full list of references on disc hybrids (these generally include 180° hybrids, 90° hybrids, and other useful hybrids in the form of 4-ports, 5-ports, etc). In comparison with the material presented in [1], Abouzahra in his comments provides a more thorough listing of references on this broad topic, which we will now comment on.

The work of Ohta *et al.* in [3] and [4] concerned 180° hybrids, and these should not be confused with the 3-dB 90° hybrids discussed in our paper [1]. Around the same time as Ohta *et al.* were performing investigations, 3-dB hybrids again of the 180° type were being discussed by Gupta and Abouzahra [5]. An investigation into 3-dB *quadrature* hybrids in the form of circular discs, however, was not really commenced until the work presented in [2]. Subsequently, a discussion on 3-dB *quadrature* hybrids, but now in the form of *rectangular discs*, was continued by Ohta and his co-workers in [6]. Both designs in [2] and [6] were narrow-band. The results of the work being done on 3-dB quadrature hybrids in the form of rectangular discs with increased operational bandwidth appeared in [7] and [8].

In the above context, we feel that we have provided a valid contribution, as our work in [1] was concerned with 3-dB *quadrature* hybrids with increased operational bandwidth in the form of a *circular* disc.

Our reply to the specific comments made by Abouzahra are as follows:

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The authors are with the Electrical & Computer Engineering Department, University of Queensland, St. Lucia, QLD Australia 4072.
IEEE Log Number 9406818.