Letters

Comments on "On the Relation Between Stored Energy and Fabrication Tolerances in Microwave Filters"

Monica Martinez-Mendoza, Christoph Ernst, Jose Antonio Lorente, Alejandro Alvarez-Melcon, and Fabien Seyfert

***Abstract*—In the above paper, the authors propose a new analytical methodology for the sensitivity analysis of microwave filter networks. However, an errata has been found which may affect the readers understanding, and it will be clarified in this comment.**

***Index Terms*—Bandpass filters, resonator filters, sensitivity, tolerance analysis.**

I. Introduction

The above paper [1] proposes a new analytical methodology for the sensitivity analysis of microwave filter networks. Rather than finding the standard sensitivity of the reflection parameter with respect to variations in the diagonal coupling matrix coefficients, the proposed method allows to obtain a new expanded sensitivity function useful not just for infinitesimal changes in the diagonal coupling terms—corresponding to small tolerances in practice—but also for larger variations corresponding to real tolerances.

It has been noticed that there is an error in the text that may affect the readers understanding. The term "reflection poles" has been used instead of the correct term "reflection zeros" three times in the paper. To be precise, the sentence on page 2133 "has two peak values at the frequencies of the reflection poles, which are missing ..." should be "has two peak values at the frequencies of the reflection zeroes, which are missing ...." In addition, there are two other occurrences of error on page 2134, where "frequencies where the reflection poles occur" should state "frequencies where the reflection zeros occur."

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References

[1] M. Martinez-Mendoza, C. Ernst, J. A. Lorente, A. Alvarez-Melcon, and F. Seyfert, "On the relation between stored energy and fabrication tolerances in microwave filters," *IEEE Trans. Microw. Theory Techn.*, vol. 60, no. 7, pp. 2131–2141, Jul. 2012.

Comments on "Quasi-Arbitrary Phase-Difference Hybrid Coupler"

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***Index Terms*—Arbitrary phase difference, branchline hybrid coupler, directional coupler.**

I. Introduction

In the above paper [1], a hybrid coupler structure is proposed for the arbitrary output phase differences without using additional phase-shift elements. The authors presented analysis results and the optimized design procedures based on them. Unfortunately, it appears that the proposed design equations are incomplete with many spurious solutions, which raises serious concerns over the validity of the proposed design and performance optimization methods based on them. This letter tries to fix these problems by presenting the alternative complete solutions.

II. Coupler Solutions for Arbitrary Phase Difference

In [1], the hybrid coupler solutions for arbitrary phase-difference are presented as [1, eqs. (15)–(17)] with $\theta_1 = 90^\circ$. The solution is an under-determined system of equations with three equations in terms of five design parameters ($z_1, z_2, z_3, \theta_2, \theta_3$ with $\theta_1 = 90^\circ$) and allows a few degrees of freedom in the coupler design. However, more careful analysis reveals that these equations are incomplete and produces a lot of spurious design parameters unsuitable for 3-dB hybrid couplers.

The alternative complete solution has been obtained and is given as follows in (1)–(5) for 3-dB hybrid couplers with $\theta_1 = 90^\circ$ and the output phase difference ϕ:

$$z_1 = |\sin\phi| \tag{1}$$

$$\cos\theta_2 = -\frac{|\cos\phi|}{\sqrt{2}} \tag{2}$$

$$z_2 = \frac{|\sin\phi|}{\sqrt{1+\sin^2\phi}} \tag{3}$$

$$\theta_3 = 180 - \theta_2 \tag{4}$$

$$z_3 = z_2. \tag{5}$$

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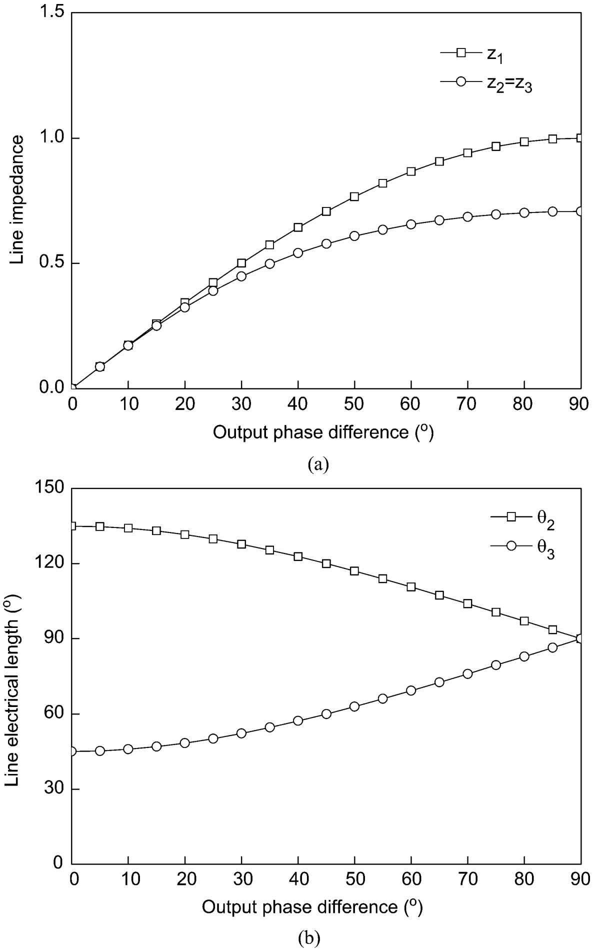

Fig. 1. Calculated transmission-line parameters. (a) Normalized impedance. (b) Electrical length.

These solutions are plotted in Fig. 1 as a function of the required phase difference ϕ.

It can be easily shown the presented solutions (1)–(5) satisfy [1, eqs. (15)–(17)], but the reverse is not true. Therefore, the design equations presented in [1] may be necessary, but not sufficient, conditions for 3-dB hybrid couplers. For example, the authors presented some experimental results for a hybrid coupler with $60^\circ/120^\circ$ output phase differences based on the design parameters $Z_1 = 34.1\ \Omega$, $Z_2 = Z_3 = 28.2\ \Omega$, $\theta_1 = 90^\circ$, $\theta_2 = 108^\circ$, and $\theta_3 = 72^\circ$. In obtaining these parameters, the above condition (5) has been forced into the solution for simplicity argument [1]. Also, condition (4) has been applied automatically as the result of (5). Therefore, the presented solution contains part of (1)–(5) as additional assumptions, which exceed the requirements implied in the design equations of [1]. Even though these additional assumptions have helped to refine the solutions obtained from the equations in [1], the circuit simulation with these parameter values produces some unexpected results. The designed coupler does produce the desired output phase difference. However, two outputs of this coupler have different magnitudes of -2.086 dB/-4.186 dB and it is not a 3-dB hybrid coupler at all. The true 3-dB coupler solution with the same output phase differences can be obtained from (1)–(5) as $Z_1 = 43.3\ \Omega$, $Z_2 = Z_3 = 32.7\ \Omega$, $\theta_1 = 90^\circ$, $\theta_2 = 110.7^\circ$, and $\theta_3 = 69.3^\circ$.

According to the above solution (1)–(5), all the design parameters are determined uniquely from the desired output phase difference ϕ. There is little degree of freedom in selecting the coupler design parameters and the optimized design method, as suggested in [1], may not be possible in practice. For example, the results in [1] suggest that there is a freedom in selecting z_2 or θ_2 value and employs it to optimize the output phase characteristics of the coupler. This will not work according to the results of the present analysis due to the lack of the assumed design freedom.

References

[1] Y. S. Wong, S. Y. Zheng, and W. C. Chan, "Quasi-arbitrary phase-difference hybrid coupler," *IEEE Trans. Microw. Theory Techn.*, vol. 60, no. 6, pp. 1530–1539, Jun. 2012.