Comments and Corrections

Comments on Reply to Comments on "Wideband Coupled-Line Microstrip Filters With High-Impedance Short-Circuited Stubs"

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***Index Terms*—Full-wave electromagnetic solver.**

In this short communication we want to discuss the reply given in [1] to our comments in [2]. In [2], we analyzed and corrected the equation proposed in [3] to compute the equivalent characteristic impedance of a short-circuited coupled-line section [Fig. 1(a)], but in [1], the same authors maintain that theory in [3] is correct. Therefore, in this work the analytical equation obtained in [2] is assessed and compared to the equation given in [1], [3] with the help of an electromagnetic solver based on the method of moments.

In [2] the equation to compute the input impedance of a two-line coupled-line section with three of its ports short-circuited to ground [Fig. 1(a)] was given as

$$Z_{\rm in} = jZ_c \tan\theta \tag{1}$$

where

$$Z_c = \frac{2Z_{oe}}{\frac{Z_{oe}}{Z_{oo}}+1} \tag{2}$$

and $Z_{oe} \geq Z_{oo}$. Z_{oe} and Z_{oo} represent the even and odd-mode impedances of a pair of adjacent strips and θ is the electrical length of the strips. Therefore, from (1) it is easy to deduce that this one-port short-circuited coupled lines is equivalent to a single short-circuited stub [Fig. 1(b)], being Z_c its equivalent characteristic impedance. However, while in [3] and [1] this structure is presented as an equivalent high impedance short-circuited stub, in [2] we demonstrated that this is incorrect and that the short-circuited coupled-line section is equivalent to a low-impedance short-circuited stub. Besides, it is important to remark that (1) is valid for any value of θ.

Furthermore, we would like to point out that circuits analyzed in [3] and [1] are completely different. In [1] a capacitor is included at the input port of the coupled lines that is not used in [3] (see [1, Fig. 2] and [3, Figs. 2 and 4]). Therefore, the new content in [1] is not related to the work presented in [3], and our comments in [2] refer to the same situation without capacitor as was described in [3]. Authors in [1] allege that their equations are valid only at $\theta = 90^\circ$ but, for this particular θ value, because of the dependence on $\tan\theta$ (1) any value of Z_c (2) can be assumed as correct because the function tends to infinity. In that sense, at $\theta = 90^\circ$ any short-circuited stub could be used regardless of its characteristic impedance value.

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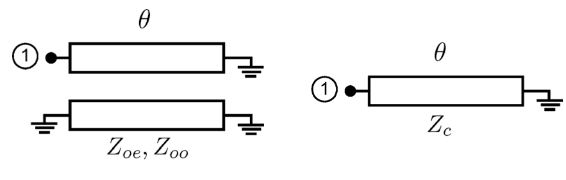

Fig. 1. Short-circuited coupled-line section (a) and equivalent circuit (b).

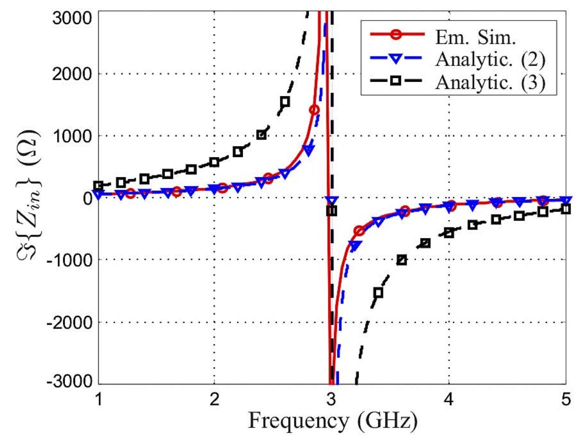

Fig. 2. Simulated and analytical imaginary part of the input impedance of a short-circuited coupled-line section [Fig. 1(a)]. The section has two lines 18.4 mm long and 885 μm wide with a gap of 409 μm.

Notwithstanding, it is straightforward to infer that equation given in [3, eq. (2)] as

$$Z_c^{[3]} = \frac{2Z_{oe}}{\frac{Z_{oe}}{Z_{oo}}-1} \tag{3}$$

is incorrect if we assume $Z_{oe} = Z_{oo}$. In that particular configuration the lines are sufficiently separated and the coupling level can be neglected. Therefore, according to Fig. 1(a), a single short-circuited stub with a characteristic impedance equal to Z_{oe} (or Z_{oo}) and electrical length θ should be obtained. However, if (3) is used, the characteristic impedance Z_c of the resultant circuit will be infinity, regardless of the electrical length of the lines. On the contrary, by using (2) the proper value is obtained.

Finally, a full-wave electromagnetic solver is used to contrast the results obtained by means of (2) and (3). Therefore, Fig. 2 draws the simulated and analytical imaginary part of the input impedance of a short-circuited coupled-line section 18.4 mm long and 885-μm line-width with a gap of 409 μm on the substrate RT/Duroid 5870. This coupled-line section is the same shunt section used in [3] to design and fabricate a band-pass filter. From Fig. 2 it is clear that there is a very good agreement between the simulated and analytical results by means of (1) and (2). However, a considerable error is noticeable if the equivalent characteristic impedance given in [3] is used.

As conclusion, it is possible to affirm that comments in [2] are appropriate and valid and that the theory developed in [1] is not related to the original work presented in [3]. Besides, from (2) it is easy to deduce that the short-circuited coupled-line section [Fig. 1(a)] is not advisable to design high-impedance short-circuited stubs.

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