Letters

Comments on "A Fast and Reliable Method for Computer Analysis of Microwave Mixers"

M. E. ADAMSKI

In Section IV of the above paper[1], Schüppert expressed conversion properties of the pumped diode junction in formulas (41)--(44). In general, that description does not satisfy well-known theory (e.g., [1], [2]). The subscript notation for the coefficients of the conversion admittance matrix used by Schüppert in formulas (42) and (44) is inauspicious, and it is probably a source of the mistaken form of the conversion matrix in formula (41).

Correct formulas should have the form[2]

$$\begin{bmatrix} \vdots \\ \underline{I}_2 \\ \underline{I}_1 \\ \underline{I}_0 \\ \underline{I}_{-1} \\ \underline{I}_{-2} \\ \vdots \end{bmatrix} = \begin{bmatrix} & \vdots & \vdots & \vdots & \vdots & \vdots & \\ \cdots & Y_{2,2} & Y_{2,1} & Y_{2,0} & Y_{2,-1} & Y_{2,-2} & \cdots \\ \cdots & Y_{1,2} & Y_{1,1} & Y_{1,0} & Y_{1,-1} & Y_{1,-2} & \cdots \\ \cdots & Y_{0,2} & Y_{0,1} & Y_{0,0} & Y_{0,-1} & Y_{0,-2} & \cdots \\ \cdots & Y_{-1,2} & Y_{-1,1} & Y_{-1,0} & Y_{-1,-1} & Y_{-1,-2} & \cdots \\ \cdots & Y_{-2,2} & Y_{-2,1} & Y_{-2,0} & Y_{-2,-1} & Y_{-2,-2} & \cdots \\ & \vdots & \vdots & \vdots & \vdots & \vdots & \end{bmatrix} \cdot \begin{bmatrix} \vdots \\ \underline{U}_2 \\ \underline{U}_1 \\ \underline{U}_0 \\ \underline{U}_{-1} \\ \underline{U}_{-2} \\ \vdots \end{bmatrix} \tag{41}$$

$$\underline{I}_m = \sum_{\mu=-\infty}^{\infty} Y_{m,\mu}\underline{U}_\mu, \qquad m = 0, \pm 1, \pm 2, \cdots \tag{42}$$

$$f_m = mf_p + f_{IF} \tag{43}$$

$$Y_{m,\mu} = G_{m-\mu} + j2\pi f_m C_{m-\mu}. \tag{44}$$

It can be easily shown that the conversion admittance matrix has symmetry properties defined by Schüppert in formula (41) only when $C_j(u_D) \equiv 0$, i.e., for a case of resistive junction. In this case, the conversion matrix reduces to the form given by

$$\begin{bmatrix} \vdots \\ \underline{I}_2 \\ \underline{I}_1 \\ \underline{I}_0 \\ \underline{I}_{-1} \\ \underline{I}_{-2} \\ \vdots \end{bmatrix} = \begin{bmatrix} & \vdots & \vdots & \vdots & \vdots & \vdots & \\ \cdots & G_0 & G_1 & G_2 & G_3 & G_4 & \cdots \\ \cdots & G_1^* & G_0 & G_1 & G_2 & G_3 & \cdots \\ \cdots & G_2^* & G_1^* & G_0 & G_1 & G_2 & \cdots \\ \cdots & G_3^* & G_2^* & G_1^* & G_0 & G_1 & \cdots \\ \cdots & G_4^* & G_3^* & G_2^* & G_1^* & G_0 & \cdots \\ & \vdots & \vdots & \vdots & \vdots & \vdots & \end{bmatrix} \cdot \begin{bmatrix} \vdots \\ \underline{U}_2 \\ \underline{U}_1 \\ \underline{U}_0 \\ \underline{U}_{-1} \\ \underline{U}_{-2} \\ \vdots \end{bmatrix} \tag{41'}$$

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[1] B. Schüppert, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-34, pp. 110–119, Jan. 1986.

[2] Symbols not defined here have the same meaning as in Schüppert's paper.

In Section V-B of the paper in question, small-signal properties of a balanced mixer with identical diodes are expressed in terms of the conversion matrix of a single diode. All the remarks made in connection with formula (41) also apply to formulas (54) and (55) of that section and to a similar formulation in another paper by the same author [3].

Reply[3] by B. Schüppert[4]

The comments by M. E. Adamski concerning the misleading description of the conversion matrix are appreciated. In fact, the subscript notation in (41) for the coefficients of the conversion matrix is inauspicious and should be changed to that given in [1]. The subscript notation in (54) and (55) should also be changed. For consistency, the admittance $Y_{m-\mu}$ in (42) and (44) should be changed to $Y_{m,\mu}$.

However, the results which are given in the companion paper, "Analysis and Design of Microwave Balanced Mixers," are not affected, because the elements of the conversion matrix have been calculated in agreement with the correct description.

References

[1] D. N. Held and A. R. Kerr, "Conversion loss and noise of microwave and millimeter-wave mixers, Part 1—Theory, and Part 2—Experiment," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-26, pp 49–61, Feb. 1978.

[2] M. T. Faber and W. K. Gwarek, "Nonlinear–linear analysis of microwave mixer with any number of diodes," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-28, pp. 1174–1181, Nov 1980.

[3] B. Schüppert, "Conversion loss of an MIC balanced mixer: Calculation and measurements," Electron. Lett., *vol.* 18, *pp.* 823–824, 1982.

[3] Manuscript received November 12, 1986

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