Comments

Comments on "Electromagnetic Analysis for Microwave FET Modeling"

Rolf H. Jansen

The concept of EM-based microwave field-effect transistor (FET) modeling, as outlined in the above letter,[1] is not new and has been published before. A first version was published by Jansen [1] and includes measurement results and implementation into the commercial LINMIC+ software version 2.0, Oct. 1987. The agreement between measured and predicted FET data given there is excellent. The method of analysis, particularly the "localized access," has been used in that paper.

More details, including the localized access approach (not using the same name), have been published by the same author in [2]. Finally, even a nonlinear version of the EM analysis for microwave FET modeling has been published already by the same group [3]. Virtually the only difference between the published material is using finite-element modeling (FEM) analysis instead of other EM methods for the distributed passive part of the FET/HEMT.

References

[1] R. H. Jansen, "Full-wave analysis and modeling for CAD of mm-wave MMICs," *Alta Frequenz.*, vol. LVIII, nos. 5–6, pp. 551–558, 1989.

[2] ____, Advanced CAD/CAM software for process-related MMIC design," in *Proc. Int. Workshop on Monolithic Microwave Integrated Circuits for Space Applications*, ESA (European Space Agency), Noordwijk, The Netherlands, Session 7, Paper 2/1–12, Mar. 1990.

[3] R. H. Jansen and P. Pogatzki, "Nonlinear distributed modeling of multifinger FETs/HEMTs in terms of layout-geometry and process-data," in *Proc. 21st European Microwave Conf.*, Stuttgart, Germany, 1991, pp. 609–614.

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[1] E. Larique, S. Mons, D. Baillargeat, S. Verdeyme, M. Aubourg, P. Guillon, and R. Quere, *IEEE Microwave Guided Wave Lett*, vol. 8, pp. 41–43, Jan. 1998.

Authors' Reply

E. Larique, S. Mons, D. Baillargeat, S. Verdeyme, M. Aubourg, P. Guillon, and R. Quere

The authors would like with great interest to underline the work on electromagnetic-based microwave component modeling by Prof. R. H. Jansen. The methodology applied in our letter[1] for the modeling of a FET is actually well known, and, moreover, we have not asserted that we were the first to have developed such a solution. Even in our laboratory, research on the concept of modeling distributed linear and nonlinear FET's began before 1989 [1].

Nevertheless, with the development of an efficient electromagnetic solver and the increase of workstation capabilities, we are now able to apply a rigorous method for the treatment of the passive part of the FET, which has not, in our opinion, been done before in previous papers.

In the papers cited by Prof. Jansen, a combination of "subelement approach" for direct prediction of FET parasitic elements and a set of multiple coupled active transmission lines computed by a field theory based on full-wave lookup table generator are used. Our approach is different. The whole passive structure of the component is characterized by a rigorous three-dimensional (3-D) finite-element method. We can then now take into account all the indirect electromagnetic couplings very precisely between via holes, the electrodes, the air bridge, etc. Moreover, the nonhomogeneous field repartition under the electrodes, where the "localized access" are placed, and the influence of this repartition on the component response, can be considered. These effects become important when the frequency increases.

Finally, by this full-wave technique, we could also take into account the indirect interaction between the component and its passive circuit environment, or another component, which is not possible analyzing a complex circuit using a classical segmentation approach.

References

[1] E. Ongareau, "Distributed and non linear field effect transistor for microwave applications," thesis, Nov. 1989.

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