authors in other parts of their letter. Our work is certainly confirmed by more experimental data. What is given in our paper is only for indicating the degree of agreement we obtained between theory and experiment, since emphasis in this publication is given primarily to the mechanisms of intermodulation in HBT's. Similar good agreement between theory and experiment has also been obtained for a different device reported in another publication [3].

Finally, the impact of second harmonic loading on IMD3 was not possible to validate experimentally, since no equipment providing harmonic loading capabilities is available in our Laboratory. This is evident in our paper since our assumption on the source load, for example at the second harmonic, shows that it was not possible to control harmonic loads during our measurements. We do not see how Maas *et al.* came to the conclusion that we do have the experimental capability for this.

2. *The applicable range of the Volterra Series model has not been exceeded.* Our analysis was performed at output power levels well below (by at least 10 dBm) the 1-dB compression point.

3. *All frequency components necessary in a 3rd order Volterra Series model were included.* Our statement simply implies that we deal with three groups of signals, centered in the vicinity of the DC, the first harmonic and the second harmonic respectively. Around each of these frequencies, we assumed the load responses to be equal due to the small frequency separation of the input harmonics. Furthermore, the third order current was obtained through the linear combination of two components, one proportional to the second derivative and one proportional to the third derivative of the nonlinear element.

4. *The frequency was low to observe extensive cancellation phenomena.* In our paper, assuming $R_b = R_{b1} + R_{b2} + R_e = 21.971\Omega$, $f_1 = 8$ GHz, $c_1 = 1$ pF, one finds that $2R_b c_1 \omega_1 = 2.2$. Since the input of our device was conjugately matched with a load of small resistive component, the above sum would not change significantly. Therefore our cutoff frequency "for cancellation phenomena" is $f_{TC} = 7.243$ GHz i.e. close to the input signal frequencies, and cancellation effects are not expected to be strong. This does not by any means contradict or questions the validity of the results by Maas *et al.*

We would like also to take this opportunity to clarify that our study dealt with the third order nonlinear current sources generated by the four HBT nonlinearities and the way they interact at the internal base node. The sum of all these sources at this node constitutes an excitation of the circuit at the higher harmonics. On the other hand, Maas *et al.* investigated the interactions of components in the current, I_e, flowing through the resistive junction, R_{je} at higher harmonics (see Fig. 2 in [2]). These include both, a nonlinear current source ($I_{g,2}$ or $I_{g,3}$) and a component flowing through R_{je}. Both approaches are similar in explaining the IM behavior of HBT's in the sense that a small nonlinear product at the output can be attributed to cancellation effects either between the excitation sources at the base node or between the current components of I_e.

Finally, the extent of such cancellation effects is a function of the operation conditions such as bias and frequency as well as circuit and device design parameters. Maas *et al.* suggests that the strength of the capacitive nonlinearity must be increased in order to obtain better IMD levels, while in our work we proposed such an improvement through proper termination at the second harmonic.

To conclude, our work clarifies that the IMD3 performance of HBT's is greatly affected by the nonlinear current sources entering the base junction and for the particular device under study g_{je} and α appear to have a dominant role; through interaction of the above nonlinearities, cancellation occurs at the base node resulting in improved IMD3 performance. Furthermore, it's shown that second harmonic loading can be used to improve IMD. Careful reading of our paper shows that the work by Maas *et al.* is not misinterpreted.

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Comments on "Instantaneous Model of a MESFET for Use in Linear and Nonlinear Circuit Simulations"

C. Camacho-Peñalosa and J. T. Entrambasaguas-Muñoz

The purpose of this Letter is to address some issues regarding scientific priority, proper references to previously published work and professional ethics. In particular, we would like to comment on the paper by Corbella et al. published in IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES in July 1992. Hereon, we refer to Corbella et al.'s paper as [1]. In such paper, the authors claim to have proposed a "different approach in nonlinear modeling" [1; p. 1410] and "a new circuit topology for the instantaneous simulation of the transistor" [1; p. 1410]. On the next page of their article [1; p. 1411], however, the authors state "The instantaneous model for a transistor, proposed previously in [8], is shown in Fig. 1." It must be noticed that "new" and "proposed previously" are self-contradictory terms, especially because the authors' "instantaneous model" was published in Dr. Entrambasaguas' Ph.D. thesis in 1990 as referenced by the authors in their [8], here referred to as [2].

It must also be pointed out that the authors of this Letter published two papers [3], [4] in Spanish in 1988 on instantaneous models of MESFET's. Dr. Corbella and co-workers have also published three papers also in Spanish on the same subject in 1989 [5], 1991 [6] and 1992 [7].

In their 1989 paper [5], Corbella et al. refer to our URSI 1988 paper (see Reference [1] of [5; p. 427]) where they state [5; p. 426] "The model chosen for the simulation of the MESFET large signal behavior is that proposed by (sic.) Camacho [4]."

In Corbella and co-workers' URSI 1991 paper [6], the authors use again our MESFET nonlinear model [4] and cite our work in their list of [6; p. 149], although they do not refer to it in the text.

Perhaps not surprisingly, Corbella and co-workers in their URSI 1992 paper state [7; p. 44] "the Barcelona group has its own nonlinear model of FET transistors" and refer to their article in IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES [1], but they do not refer to our previous work which was, however, cited in [5], [6].

Manuscript received June 7, 1993.

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IEEE Log Number 9212744.

Furthermore, we would like to point out that: 1) Section II.A. "Instantaneous Model of a Transistor" and Section II.B. "Small-Signal Equivalent Circuit" of Corbella *et al.'s* [1] are taken from [2], with very small changes; 2) the authors' intrinsic FET models of Figs. 1 and 2 [1] were taken from Figs. 2.5 and 2.9 of [2; pp. 25 and 30]; 3) Eqs. (1) and (2) of [1] are the same as Eqs. (2.1.a) and (2.1.b) of [2; p. 25] except that Corbella et al. [1] use subscripts g and d instead of gs and ds; 4) Eqs. (4)–(6) of [1] correspond to Eqs. (2.3.a), (2.3.b) and (2.4. a–h) of [2; p. 26]; and, 5) Eq. (7) of [1] is identical to Eqs. (2.9.a–h), (2.10) and (2.11) of [2; pp. 30–31].

In addition, we would also like to indicate that Dr. Corbella was a member of the Dr. Entrambasaguas' Ph.D. thesis committee and defense. This defense took place on 25 September 1990. Therefore, Dr. Corbella was fully aware of our research on MESFET nonlinear models.

It seems clear from previous paragraphs that Corbella and co-workers took our model and properly referred to it in [5,6] and, then, they decided: 1) to claim that our model was theirs [1], [7], and 2) not to mention our previously published work [3,4].

In support of the issues addressed in this Letter, we sent copies of the References [1]–[7] to the Editor of IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES and kindly requested from him to send them to the Guest Editors, Drs. Bandler and Jansen, of the Special Issue on Process Oriented CAD and Modelling, where Corbella et al.'s paper was published. We also requested from him to send a copy of this Letter to the authors of [1].

The issues addressed in this Letter should not be considered as criticisms on the review process of IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, because we do not expect the reviewers to know every single paper on MESFET models published in all languages. They do, however, address very important issues on professional ethics, priority and integrity in the scientific community.

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Reply to Comments on "Instantaneous Model of a MESFET for Use in Linear and Nonlinear Circuit Simulations"

Ignasi Corbella

I was very surprised when I received from the editor of the IEEE Transactions on MTT a letter from my friend Carlos Camacho with the comments to the paper I published in these transactions [1]. I had no previous notice from the authors and, at first, I was pleased because I thought that the comments would address some scientific issue, which would be interesting, not only for he and me, but also for all the microwave community. But the aim of the comment was very different and now I am forced to write a rebuttal with arguments and discussions that I am afraid will not be valuable to the readers of these transactions.

When I decided to publish the paper [1], I did it with the intention of summarizing the work I had being carried out since 1987 with the aid of some students, and make it available to the international microwave community, in order to contribute to this difficult subject that is the nonlinear modelling of transistors. It has never been my intention to claim that someone else's ideas are mine, nor to assume a protagonism regarding nonlinear modelling in Spain. In the following paragraphs I will explain the history of the published and unpublished work I have performed since 1987, and it is the responsibility of the reader to discern whether the comments of Dr. Camacho are justified or not. First of all, however, I would like to stress that anyone that in the future want to use the model described in [1] should always refer to it as "model of Camacho-Peñalosa and Entrambasaguas-Muñoz" but never as "model of Corbella." I really don't mind.

By the end of 1987 I was considering the idea of modelling the nonlinear capacitive effects of transistors in terms of charge. The advantage with respect to a variable capacitor approach is that the harmonic balance algorithms can be faster because no convolutions are needed. The complete model would consist then of instantaneous charge generators and, of course, current generators to account for the ohmic current. In this way the elements of the small signal equivalent circuit would be simply the slopes of these nonlinear current and charge functions with respect of the two internal voltages. Assuming the quasistatic approximation, the integration of the small signal model at many different bias points with respect to these voltages would give the instantaneous charge and current functions.

This was the theme of a master thesis of a student that ended in June 1988 and the results were published in a spanish conference [2] not mentioned in the comments above. The model presented there was the precursor of that given in [1], being the only difference that, referring to Fig. 1 of [1], the generators $I_g(V_g, V_d)$ and $Q_d(V_g, V_d)$ were not considered. The integration of the small signal model to obtain the instantaneous charge and current functions was presented, and a harmonic balance load pull simulation was described. The model was applied to a simulation of the optimum load for a power amplifier.

During the Spanish URSI conference, in September 1988, I noticed that there was another paper that presented a similar model [3], with all four current and charge generators, in a very elegant way. In spite of the title, however, the authors did not use it for nonlinear modelling nor explained the way of obtaining the instantaneous current and charge functions. Instead, the article was oriented to the discussion

Manuscript received July 12, 1993.

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IEEE Log Number 9212745.