Optimization Systems Associates Inc.
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RoMPE™ PRODUCT SUMMARY

Unveiled in New York at the 1988 IEEE MTT-S International Microwave Symposium, RoMPE is the world's first commercially available software system dedicated to nonlinear FET model parameter extraction suitable for microwave circuit design.

OVERVIEW

RoMPE™ (Robust Model Parameter Extractor) is a very powerful program for extraction of FET model parameters from measurement data. It benefits from several years of theoretical research and incorporates the latest results by Bandler, Chen, Ye and Zhang: "Robust model parameter extraction using large-scale optimization concepts", *1988 IEEE MTT-S International Microwave Symposium Digest* (New York, NY), pp. 319-322.

RoMPE accepts measurement data in the form of small-signal S-parameter and/or DC bias measurements. Depending on what type of data is available, RoMPE can be used to extract DC model parameters, small-signal model parameters, or, as a unique feature, both DC and small-signal parameters simultaneously.

RoMPE offers the combined power of novel techniques in device modeling and the state-of-the-art gradient-based ℓ_1 and ℓ_2 optimizers through a friendly and uncomplicated user-interface. The input file adopts a format similar to that of Super-Compact® and Microwave Harmonica™. The program also features high-quality graphics displays.

Currently, RoMPE supports two popular FET models, namely the Materka and Kacprzak model and the Microwave Harmonica™ model.

BACKGROUND

To microwave circuit designers, the ability to simulate FET devices using an equivalent circuit is very important. This requires, first of all, an appropriate topology for the equivalent circuit. Many models, nonlinear and small-signal, have been investigated in recent years. The Materka and Kacprzak model and the Microwave Harmonica model are among the most popular ones.

Given the model topology, the next critical step is to determine the model parameter values. The basic approach is to estimate the model parameters such that the equivalent circuit response will match as closely as possible the actual measurements on the device being modeled. The underlying assumption is that if the model matches the measurements at some selected points, it is deemed valid in a certain operating range and can be used for simulation in that range.

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The type of measurement used for modeling depends on the anticipated application of the model as well as the availability of the measurement. RoMPE accepts small-signal S-parameter and DC bias measurements as input data.

CONVENTIONAL APPROACHES

Conventionally, small-signal parameters are extracted from S-parameters measured at a single bias point. Circuit designers relying on this approach are often frustrated by nonunique solutions. Usually there exist a family of solutions, all of which produce a similar match between model response and measurement. As a consequence, the particular solution obtained depends on the initial guess: using a different starting point will probably result in a different solution.

Additional difficulties arise for large-signal nonlinear modeling, since we need to determine parameters that may vary with bias, such as the drain-to-source nonlinear current source. It is obvious that small-signal S-parameter measurements at a single bias point are not adequate for extracting bias-dependent parameters.

A common practice in an attempt at "large-signal modeling", in the absence of anything better, is to extract *separately* DC and small-signal parameters. DC parameters are extracted from curve fitting, and small-signal parameters are extracted from S-parameters measured at *a single bias point* while holding the DC parameters constant. Such an approach can be an improvement from "pure small-signal modeling", since the extraction of DC parameters from curve fitting has reduced the number of unknowns to be determined from S-parameter matching. However, two problems may plague such a solution: the results may not be unique, and DC parameters extracted from DC curve fitting alone may not be valid at the operating microwave frequencies.

THE UNIQUE RoMPE APPROACH

The unique approach taken by RoMPE is pioneered by Optimization Systems Associates. It provides two distinct advantages. One is to process simultaneously measurements at multiple bias points, and another one to optimize simultaneously small-signal and DC parameters.

The motivation of multi-circuit modeling, i.e., modeling through simultaneous processing of multiple sets of measurements, is to strengthen model identifiability and to enforce a unique solution. This principle has been amply demonstrated as being applicable to *all* engineering modeling problems. In our case, measurements at multiple bias points can be utilized to achieve a robust solution, and this can be applied to small-signal modeling, DC modeling and large-signal modeling.

The other unique feature offered by RoMPE is the *simultaneous* extraction of DC and small-signal parameters by processing DC and small-signal measurements *simultaneously*. This approach takes into account the dependence, explicit and implicit, of small-signal parameters upon the bias. It implements the theoretically established relationship between some small-signal parameters and DC parameters, such as the one between CGS (a small-signal parameter) and CG0 and VBI (DC parameters). It also allows the user to specify explicit bias-dependence or bias-independence for other small-signal parameters.

We realize that the classification of DC and AC parameters is somewhat arbitrary. Therefore, by simultaneously optimizing all the model parameters using all the available measurements, we can avoid neglecting the possible dependence of DC parameters on AC measurements, and vice versa. In other words, the DC parameters may be adjusted based on the small-signal measurements, and the small-signal parameters may be constrained by the actual biasing conditions.

POWERFUL OPTIMIZERS

Two state-of-the-art optimizers are employed by RoMPE. The 2-stage ℓ_1 optimizer has a proven track record in circuit optimization in general and device modeling in particular. The ℓ_2 optimizer implements a conventional least squares objective and combines the power of the Levenberg-Marquardt and the quasi-Newton methods.

The computational efficiency of RoMPE is further enhanced by adjoint sensitivity calculations which provide exact gradients for the optimization. The adjoint analysis is implemented not only for small-signal simulation, but also for the solution of the DC nonlinear equivalent circuit.

RoMPE is very flexible. It accommodates various problems ranging from simple, conventional single-bias small-signal parameter extraction to sophisticated multi-bias simultaneous AC-DC modeling.

PC PLATFORM

RoMPE currently runs on the IBM PC/AT (80286/80386) platform. It requires DOS version 3.0 or higher, 80287/80387 Math Coprocessor, EGA card, Enhanced Color Display, and 640K RAM.

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