Abstracts

Electromagnetic Wave Effects on Microwave Transistors Using a Full-Wave Time-Domain Model

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A detailed full-wave time-domain simulation model for the analysis of electromagnetic effects on the behavior of the submicrometer-gate field-effect transistor (FET's) is presented. The full wave simulation model couples a three-dimensional (3D) time-domain solution of Maxwell's equations to the active device model. The active device model is based on the moments of the Boltzmann's transport equation obtained by integration over the momentum space. The coupling between the two models is established by using fields obtained from the solution of Maxwell's equations in the active device model to calculate the current densities inside the device. These current densities are used to update the electric and magnetic fields. Numerical results are generated using the coupled model to investigate the effects of electron-wave interaction on the behavior of microwave FET's. The results show that the voltage gain increases along the device width. While the amplitude of the input-voltage wave decays along the device width, due to the electromagnetic energy loss to the conducting electrons, the amplitude of the output-voltage wave increases as more and more energy is transferred from the electrons to the propagating wave along the device width. The simulation confirms that there is an optimum device width for highest voltage gain for a given device structure. Fourier analysis is performed on the device output characteristics to obtain the gain-frequency and phase-frequency dependencies. The analysis shows a nonlinear energy build-up and wave dispersion at higher frequencies.

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