

Microcircuit modeling and simulation beyond Ohm's law

Abstract:

Circuit theory textbooks rely heavily on the applicability of Ohm's law, which collapses as electronic components reach micro- and nanoscale dimensions. Circuit analysis is examined in the regime where the applied voltage V is greater than the critical voltage V_c , which triggers the nonlinear behavior. The critical voltage is infinity in the Ohmic regime, but is as low as a fraction of a volt when linear current-voltage characteristics become sublinear and the resistance surges due to current saturation effects. For two resistors of the same Ohmic values but of differing lengths, the shorter resistor is more susceptible to this effect. In addition, the power consumed in this regime is a linear function of voltage as compared to quadratic behavior in the Ohmic regime. Several possible applications are suggested.