Abstract Submitted
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Nano-circuit design in the nonohmic regime VIJAY ARORA, Wilkes University — Ohm's law on the basis of which all electronic circuits are designed and their performance evaluated is not holding its linearity as nanoelectronic devices are scaled down. In a macro-device of twentieth century (typical size L = 1 cm), the critical voltage for triggering nonohmic behavior, $V_c = \frac{V_t}{\ell_o} L$, is 2.6 kV for the room-temperature thermal voltage $V_t = \frac{k_B T}{q} = 26$ mV and a typical ohmic mean free path = 0.1 μm. For the integrated circuits, a 5-V logic voltage was within the ohmic regime. For the twenty-first century nano-circuits, a typical device size, L, is below 0.1 μm, resulting in a critical voltage of 0.26 V. Even for a low logic voltage of 1 V, Ohm's law is not valid. A review of the physical processes behind this breakdown of Ohm's law is reviewed. The paper will show how familiar voltage and current division laws and the transient effects transform in the nano-regime where Ohm's law is not valid. In a circuit environment, the smaller-length resistor is much more resistive as applied voltage is increased. Similarly, RC time constant will be larger than its expected ohmic value. Power consumption in the nano-circuit tends to be linear function of the applied voltage in direct contrast to quadratic dependence for the macro circuits.

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