

TITLE

Simulation Method of Transmission-Type Radio-Frequency Single-Electron Transistor (RF-SET) by SPICE

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PROBLEM STATEMENT

The conventional single-electron transistor (SET) is a highly sensitive electrometer, but its large output resistance and high cable capacitance limit its bandwidth to a few kHz. While the radio-frequency SET (RF-SET) was developed to overcome this, simulation methods have only been reported for reflection-type RF-SETs, with no methods developed for the transmission-type. This project introduces an efficient simulation method for transmission-type RF-SETs using the conventional circuit simulator SPICE.

ABSTRACT

An efficient simulation method for transmission-type radio-frequency single-electron transistors (RF-SETs) is developed. The conventional SET suffers from a large output resistance, which limits its operational bandwidth. The RF-SET increases this bandwidth by using a tank (LC) circuit for impedance matching. This work proposes a new method that introduces equivalent circuits for the propagating microwaves, allowing the master equation for the RF-SET to be solved self-consistently using the SPICE simulator. By examining the transmitted waves, the developed method is shown to successfully reproduce the results of numerical reference methods. This method provides a simple and fast way to simulate RF-SETs, even in complex circuit geometries and at high frequencies over GHz.

PROPOSED CIRCUIT / MODEL

