Multiflux modeling of transport in a general transistor structure

A. Reichardt* and G. Varga†,

* Department of BI and Electromagnetic Theory, BUTE, Egry J. u. 18., H-1111 Budapest
† Department of Physics, BUTE, Budafoki u. 8., H-1111 Budapest
E-mail: reich@evt.bme.hu

***Abstract*—We present here a multiflux based modeling of carrier transport in general transistor structure. It is also presented how an equivalent circuit can be calculated using connected scattering-centers based on phase-space partiotioning.**

***Index Terms*—carrier transport, equivalent circuit, scattering-centers**

I. Introduction

Modeling charge carrier transport through a general transistor structure can be modelled using multiflux method [1], [2]. We use a modified version of this model that offers classical transport modeling with the possibility of using classical and quantummechanical effects too. An equivalent circuit representation of the structure can be done using a microscopic model and circuit-theory considerations.

II. Multiflux model

The multiflux method is based on the partiotioning electric flux caused by mobile carriers . A general transistor structure, (Fig. 1), changes movement of the charged carriers in some regions of interest. Our goal is to calculate net electric current caused by transport of charged carriers.

$$I_{\text{out}} = \int_{S_{\text{out}}} \left(\sum_p J_p \right) dA \qquad (1)$$

where S_{out} is total surface of where current flows through, composed of small sections of surface, summation of p runs over all modes of subfluxes.

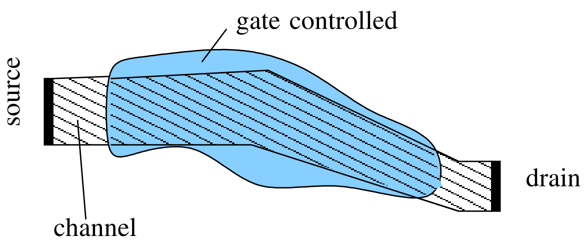

Fig. 1. General transistor structure. Blue region is influenced by gate (controlling) contant, channel (slashed) is the charge transport channel.

Transport of carriers with a given flux is calculated using scattering blocks based on partitioning geometrical space and phase space of impulse (flux) of carriers. If we divide total range of impulse into N partitions and geometrical space into M partitions we get a square layout of nodes and connections. The nodes are scattering-centers and connections between them mean moving in a specific (subflux) mode. In this kind of arrangement every scattering-center is connected only to the scattering-centers right next to it. (It interprets that charge carriers can move in real-space and impulse-space due to low-energy scattering.)

III. Preliminary results

System of scattering-centers connected with others (see Fig. 2) based on partitioning of phase space and using randomly selected scattering events can be used to calculate equivalent circuit applying circuit theoretical considerations.

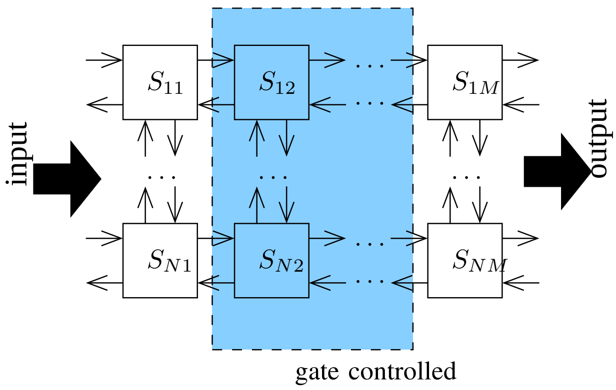

Fig. 2. Partitioned phase space nodes viewed as scattering centers. S_{pq} means p^{th} partition of geometrical partitions and q^{th} partition of fluxes.

Using a large number of simulations (randomly selected scattering events for every scattering-centers in every simulations) a macroscopic equivalent circuit can be calculated. Probability of scattering event depends on the electric potential caused by gate voltage (control voltage).

References

[1] S. Datta, "Electronic Transport in Mesoscopic Systems", Cambridge : Cambridge University Press, 1997.
[2] J.P. McKelvey, R. Longini, and T. Brody,"Alternative approach to the solution of added carrier transport problems in semiconductors", Phys. Rev, vol. 123, pp. 51-57, 1961.
[3] K. Simonyi, "Theoretische Elektrotechnik", Leipzig : Barth, 1993.