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Investigation on the Method to Evaluate the Energy Dissipation of General Adiabatic Quantum-Flux-Parametron Logic Gates

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Adiabatic quantum-flux-parametron (AQFP) logic is an energy-efficient superconductor logic family. In previous numerical studies, we have evaluated the energy dissipation of basic AQFP logic gates, such as a buffer and a reversible logic gate, and demonstrated their sub-$k_B T$ switching energy, where k_B is the Boltzmann's constant and T is the temperature, by integrating the product of the excitation current and voltage associated with the gates over time. However, this method is not applicable to complex logic gates, especially those in which the number of inputs is different from that of outputs. In the present study, we establish a systematic method to evaluate the energy dissipation of general AQFP logic gates. In the proposed method, the energy dissipation is calculated by subtracting the energy dissipation of the peripheral circuits from that of the entire circuit. In this way, the energy change due to the interaction between gates, which makes it difficult to evaluate the energy dissipation, can be deducted. We evaluate the energy dissipation of a MAJ gate using this method.

Keywords: superconducting integrated circuit, adiabatic quanutum-flux-parametron, energy dissipation