A General Network Equation to Unify the Analysis of Normal RLC Circuits and Superconducting Josephson Junction Circuits

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Abstract

Josephson junction circuits, such as superconducting quantum interference devices (SQUIDs) and single-flux-quantum (SFQ) circuits, have been successfully applied in both analog and digital electronic domains. Their variables of macroscopic quantum phases are distinct from that of the normal resistor-inductor-capacitor (RLC) circuits; their flux-quantization law (FQL) involving magnetic flux couplings are not well supported by the conventional circuit diagrams. This article presents a general network equation to unify the analyses of both normal RLC circuits and superconducting Josephson junction circuits. This network equation uses the flux contributions of noninductive components as variables to unify the definitions of Josephson junctions and normal RLC elements, and unify the closed-loop law for both superconducting and non-superconducting loops. It simplifies the analysis of the electric circuits with various magnetic flux inputs, and is easily understood by electronic engineers who are trained with the conventional circuit theories.

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