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Analytical derivation of DC SQUID response

Soloviev I., Klenov N., Schegolev A., Bakurskiy S., Kupriyanov M.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2016 IOP Publishing Ltd.We consider voltage and current response formation in DC superconducting quantum interference device (SQUID) with overdamped Josephson junctions in resistive and superconducting state in the context of a resistively shunted junction (RSJ) model. For simplicity we neglect the junction capacitance and the noise effect. Explicit expressions for the responses in resistive state were obtained for a SQUID which is symmetrical with respect to bias current injection point. Normalized SQUID inductance (where Ic is the critical current of Josephson junction, L is the SQUID inductance, e is the electron charge and $\hbar$ is the Planck constant) was assumed to be within the range $l \leq 1$, subsequently expanded up to using two fitting parameters. SQUID current response in the superconducting state was considered for arbitrary value of the inductance. The impact of small technological spread of parameters relevant to low-temperature superconductor (LTS) technology was studied, using a generalization of the developed analytical approach, for the case of a small difference of critical currents and shunt resistances of the Josephson junctions, and inequality of SQUID inductive shoulders for both resistive and superconducting states. Comparison with numerical calculation results shows that developed analytical expressions can be used in practical LTS SQUIDs and SQUID-based circuits design, e.g. large serial SQIF, drastically decreasing the time of simulation.

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Keywords

current response, DC SQUID, SQIF, voltage response