An Approach to Optimization of the Superconducting Quantum Interference Device Bootstrap Circuit

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Abstract – Recently, we demonstrated and analyzed the superconducting quantum interference device (SQUID) bootstrap circuit (SBC). It is a direct readout scheme for dc SQUID in the voltage bias mode permitting one to suppress the preamplifier noise. The SBC enables us to control the two key parameters of a voltage-biased SQUID: the flux-to-current transfer coefficient and the dynamic resistance. The flux-to-current, $I – \Phi$, characteristics of SBC is made asymmetric by introducing the additional current feedback. Depending upon the choice of the working point, this feedback can be positive (working point W2 on steeper $I – \Phi$ slope) or negative (W1 on the less steep slope). The dynamic resistance is controlled by the additional voltage feedback. In our publications to date we presented only the SBC operation at W2, while in this paper we demonstrate operation at W1 and show that also in this regime the preamplifier noise suppression is possible. We used a liquid-helium-cooled Nb SQUID with loop inductance of 350 pH and attained white flux noise of 2.5 $\mu\Phi_0/\sqrt{Hz}$ both at W2 and at W1. In the latter case, the linear flux range exceeded one half flux quantum Φ_0. This large linear range should lead to a significantly improved stability and slew rate of the system and also make the tolerable spread in circuit parameters much wider than in all SQUID direct readout schemes known to date. Consequently, operation in this regime opens a new path to possible SBC optimization.

Keywords – dc SQUID, SQUID noise, SQUID readout, voltage bias, feedback

Submitted January 20, 2011; accepted February 1, 2010. Reference No. ST252; Category 4.
The final version of this paper was published and should be cited as Supercond. Sci. Technol. 24 (2011) 065023