

HfTi-nanoSQUIDs for Nanoscale Magnetic Detection

Sylke Bechstein¹, Claudia Köhn¹, Jan-Hendrik Storm¹, Dietmar Drung¹, Marianne Fleischer-Bartsch¹, Oliver Kieler², Johannes Kohlmann², Thomas Weimann², and Thomas Schurig¹

¹Physikalisch-Technische Bundesanstalt, (PTB), Abbestraße 2-12, 10587 Berlin, Germany

²Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, Germany

E-mail: sylke.bechstein@ptb.de

Abstract — As recently reported [1], we have developed different types of Nb/HfTi/Nb-nanoSQUIDs with a lateral junction size of about 200 nm x 200 nm and an inner loop size of about 840 nm x 840 nm. These nanoSQUIDs were designed as gradiometers, and implemented with gradiometric feedback loops, gradiometric transformers and rf filters to enhance their practical use. The noise in the white frequency range depends on the SQUID loop inductance, and is typically 115 nΦ₀/√Hz for parallel nanoSQUID gradiometers, or about 200 nΦ₀/√Hz for series nanoSQUID gradiometers. In combination with a SQUID series array which acts as a low-noise preamplifier, these nanoSQUIDs can be operated in the flux locked loop mode with high linearity in an ac magnetic field of up to a few mT. In this configuration, the excitation field is orientated either perpendicular or in-plane to the gradiometric SQUID loop. That is an experimental setup used e.g. for particle investigations. For the readout of nano-electromechanical resonator systems (NEMS), the field tolerance to a dc in-plane magnetic field is of considerable interest. We demonstrate the operation in dc in-plane fields of a few tens of mT with several measurements – most of them performed in a two-stage configuration. Finally, we present an experimental setup for NEMS readout which has been developed for investigation of nanoSQUID-NEMS combinations.

[1] S. Bechstein et al., ‘HfTi-nanoSQUID gradiometers with high linearity’, *Appl. Phys. Lett.* 106, 072601 (2015), doi 10.1063/1.4909523.

This work was partly supported by the DFG under Grant No. SCHU1950/5-1 and within the European Metrology Research Programme EMRP ‘MetNEMS’ NEW-08, which is jointly funded by the participating countries within EURAMET and the European Union.

Keywords (Index Terms) — NanoSQUID, linearity, flux noise, magnetic field tolerance.