Characterization of a Digital SQUID for Magnetic Field Measurements with High Dynamic Range

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Abstract - Measurements of extremely weak magnetic fields in unshielded environments require sensors providing a high dynamic range and slew rate while maintaining a high resolution. At present, analog Superconducting Quantum Interference Devices (SQUIDs) are the most sensitive sensors for magnetic flux. Due to their room-temperature feedback electronics necessary to maintain a stable point of operation, slew rates of those sensors are limited. The dynamic range is usually restricted by the resolution of classical analog to digital converters. The digital SQUID follows a different approach: a change of the magnetic field penetrating the pickup loop is translated by the sensor into a stream of voltage pulses. Each pulse represents the change of the magnetic flux inside the pickup loop by one flux quantum $\Phi 0$. By fast counting of these flux quanta, it is possible to outperform the analog SQUID in terms of dynamic range and maximum slew rate. We present our latest results with respect to the internal mechanisms of the digital SQUID and present a method to compensate the main source for nonlinear behavior of the sensor. The analyzed circuit was fabricated by FLUXONICS Foundry [1] in a 1 kA/cm² niobium fabrication process.

Keywords - SQUID, RSFQ, SFQ, digital SQUID, SQUID hysteresis, switching probability, dead zone

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