MATTER AND TECHNOLOGIES

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Nonlinear demodulation of flux ramp modulated μSQUID multiplexers

Groundbreaking experiments such as QUBIC, which seeks to measure the Cosmic Microwave Background (CMB) radiation, employ highly sensitive superconducting detectors thanks to its very low noise contribution. To readout these detectors, complex cryogenic circuits which involves rf-SQUIDs coupled to microwave resonators and make use of frequency multiplexing technique in order to transmit hundreds and up to thousands superconducting detector signals on the same line are becoming more and more relevant. In order to accomplished it, flux ramp modulation (FRM) technique is fundamental to help reduce the number of cables inside the cryostat. A periodic magnetic flux is generated across all the SQUIDs in the multiplexer. In consequence, each SQUID produce a carrier waveform to which a quasi-constant detector signal phase will be added. Afterall, the detector signal has to be recovered through a phase demodulator. The quadrature demodulation technique for detecting a variation in the signal phase is a well-known and widely used method for flux ramp demodulation. However, in multirate signal processing systems, the inherent nonlinear characteristics of the mixers produce high-frequency components that affect the signal if they are not removed. A mathematical description of this phenomenon is treated in this work and validated with simulations and measurements. A method to overcome this has also been proposed and implemented.

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