A Tunable Coupler for Matching MKID Internal and Coupling Quality Factors

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Microwave Kinetic Inductance Detectors (MKIDs) detect radiation using lithographed superconducting resonators. One of the key design parameters is the coupling quality factor Qc of the resonator, which is fixed by the coupler geometry. In an optimal MKID design, Qc should match the internal quality factor Qi under the expected loading condition, in order to maximize the responsivity and achieve the lowest possible NEP. We present a tunable coupler scheme that allows us to tune the Qc of a resonator to accommodate different loading conditions. We connect the feedline to a 1-meter superconducting NbTiN transmission line terminated with a short. By injecting a DC current, the nonlinear kinetic inductance is changed, which changes the electrical length of the line. This creates a periodically varying impedance ranging from a short to an open, shunting the resonator and varying Qc. In our experiment, we have demonstrated Qc tuning for a 6GHz resonator. Our tunable coupler scheme is easy to implement and may provide a powerful tool for MKID characterization under a wide range of optical loading conditions.