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Quantum information processing with surface acoustic waves

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Quantum computation with superconducting circuits is one of the approaches for the realization of a future quantum computer. More specifically, the field of circuit quantum electrodynamics (circuit QED) is of central importance for the realization of a qubit, where the interaction between microwave photons and the artificial atom, here the superconducting qubit, is investigated. There is also another possibility similar to the case of circuit QED, where the phonons replace the role of photons in such as system. In the present work, a novel superconducting surface acoustic wave (SAW) transducer with a spiral geometry is proposed. This transducer is particularly useful for quantum information processing at cryogenic temperatures. Compared to an interdigital transducer (IDT), which launches acoustic waves in two directions, a spiral transducer (SPT) is capable of launching waves in four directions. This property allows utilizing the substrate surface in a more efficient way due to the transition from a line to a surface. Most importantly this kind of transducer gives us new possibilities for quantum information processing as it can be used as a superconducting transmon qubit, which can be coupled to two cavities simultaneously. Moreover, it can be used for acoustic transport of quantum dot qubits, which could improve the means for long-range coupling of the qubits. Another word the proposed SAW transducer in this work finds applications in both low power and high power regimes. The SPT has been simulated using COMSOL simulator and it is also modeled using P-matrix and delta function model.

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