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Tunable coupling between fixed-frequency superconducting transmon qubits, Part I: Concept, design, and prospects[1] STEFAN FILIPP, IBM Research - Zurich, 8803 Rueschlikon, Switzerland, DAVID C. MCKAY, EASWAR MAGESAN, ANTONIO MEZZACAPO , JERRY M. CHOW, JAY M. GAMBETTA, IBM TJ Watson Research Center, Yorktown Heights, NY, USA — The controlled realization of qubit-qubit interactions is essential for both the physical implementation of quantum error-correction codes and for reliable quantum simulations. Ideally, the fidelity and speed of corresponding two-qubit gate operations is comparable to those of single qubit operations. In particular, in a scalable superconducting qubit architecture coherence must not be compromised by the presence of additional coupling elements mediating the interaction between qubits. Here we present a coupling method between fixed-frequency transmon qubits based on the frequency modulation of an auxiliary circuit coupling to the individual transmons. Since the coupler remains in its ground state at all times, its coherence does not significantly influence the fidelity of consequent entangling operations. Moreover, with the possibility to create interactions along different directions, our method is suited to engineer Hamiltonians with adjustable coupling terms. This property can be utilized for quantum simulations of spins or fermions in transmon arrays, in which pairwise couplings between adjacent qubits can be activated on demand.

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