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Tunable coupling between fixed-frequency superconducting transmon qubits, Part II: Implementing a two-qubit XX-90 gate DAVID C. MCKAY, IBM T.J. Watson Research Center, Yorktown Heights NY, USA, STEFAN FILIPP, IBM Research Zurich, 8803 Rueschlikon, Switzerland, ANTONIO MEZZACAPO, EASWAR MAGESAN, JERRY M. CHOW, JAY M. GAMBETTA, IBM T.J. Watson Research Center, Yorktown Heights NY, USA — In this talk we will present a two-qubit gate implemented in a tunable coupling architecture which consists of a flux-tunable qubit ("coupler") coupling two fixed-frequency transmons ("qubits"). In this architecture, a resonant SWAP (XX+YY) interaction is generated between the qubits when the coupler is modulated at the qubit frequency difference, typically a few hundred MHz. This interaction has a number of advantages, in particular, it only requires AC flux control and can resonantly address individual qubit pairs. Here we present a protocol which realizes the XX-90 gate based on this interaction. This gate has the specific characteristic that it takes any of the four basis states ($|00\rangle, |10\rangle, |01\rangle, |11\rangle$) to Bell states. We demonstrate gate fidelities greater than 96% characterized by state tomography and randomized benchmarking. Looking forward, this gate is a prime candidate for implementing the surface code because it can couple highly coherent qubits which are spaced far apart in frequency thereby minimizing crosstalk and collisions.
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