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Electronically-controlled one- and two-qubit gates for transmon quasicharge qubits

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The transmon qubit, in which a qubit is encoded in the anharmonic spectrum of a superconducting circuit, is a leading hardware platform for building utility-scale quantum computers. Thanh Le, Cole and Stace propose an alternative encoding for transmon qubits and demonstrate that a 4π-periodic inductive element can be used to access states which are forbidden in the traditional encoding. However, they did not provide a physical system that realises such an element. We show that a topological superconducting junction realises this 4π-periodic inductive element by employing a minimal model to simulate the dynamics of the system. A single-qubit gate can be applied to the qubit by electronically controlling the tunnelling potential across the junction and an identical mechanism enables entangling two-qubit gates. Therefore, one- and two-qubit gate speeds are identical. The coupling to a topological junction requires the transmon to be treated as a topological-transmon hybrid.

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