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Extensible quantum circuit for the surface-code error correction cycle with frequency-tunable transmon qubits[1] RICHARD VERSLUIS, QuTech and TNO, Delft, STEFANO POLETTO, QuTech and Kavli Institute of Nanoscience, Delft University of Technology, The Netherlands, NADER KHAMMASSI, QuTech, Computer Engineering Lab, Delft University of Technology, The Netherlands, KOEN BERTELS, QuTech, Computer Engineering Lab and Kavli Institute of Nanoscience, Delft University of Technology, The Netherlands, LEO DICARLO, QuTech and Kavli Institute of Nanoscience, Delft University of Technology, The Netherlands — We propose an extensible scheme for implementing the surface-code error correction cycle with fast-frequency-tuneable transmon qubits in a circuit QED architecture. This solution consists of a spatially repeating unit cell circuit with four data-carrying qubits, four ancillary qubits, four frequencies for single-qubit control, and eight frequency excursions for conditional-phase (C-Z) gates. By pipelining the interaction and ancilla measurement steps of X- and Z-type stabilizers, we engineer the frequency excursion patterns to avoid transmon-transmon interactions except the $|11\rangle - |02\rangle|$ avoided crossings exploited in C-Z gates. This scheme is amenable to planar and hole-based implementations of the surface code and to lattice surgery. Crucially, it allows the expansion of the surface-code fabric by spatial repetition and maximal exploitation of spatial and frequency multiplexing in the control architecture.

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