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Circuit design implementing longitudinal coupling: a scalable scheme for superconducting qubits SUSANNE RICHER, DAVID DIVINCENZO, JARA Institute for Quantum Information, RWTH Aachen University, D-52056 Aachen, Germany — We present a circuit construction for a new fixed-frequency superconducting qubit and show how it can be scaled up to a grid with strictly local interactions. The circuit QED realization we propose implements σ_z-type coupling between a superconducting qubit and any number of LC resonators. The resulting *longitudinal coupling* is inherently different from the usual σ_x-type *transverse coupling*, which is the one that has been most commonly used for superconducting qubits. In a grid of fixed-frequency qubits and resonators with a particular pattern of always-on interactions, coupling is strictly confined to nearest and next-nearest neighbor resonators[1]; we note that just four distinct resonator frequencies, and only a single unique qubit frequency, suffice for the scalability of this scheme. There is never any direct coupling between the qubits. A controlled phase gate between two neighboring qubits can be realized with microwave drives on the qubits, without affecting the other qubits. This fact is a supreme advantage for the scalability of this scheme.

[1]P.-M. Billangeon et al., **Phy. Rev. B** 91:094517, 2015

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