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Single-qubit gates in frequency-crowded transmon systems

FRANK WILHELM, DANIEL J. EGGER, Saarland University, RON SCHUTJENS, Saarland University and Delft University of Technology, FADI ABU DAGGA, Saarland University — Superconducting transmon qubits in three-dimensional cavities show coherence longer by an order of magnitude compared to their two-dimensional counterparts. To take advantage of these coherence times while scaling up the number of qubits it is advantageous to address individual qubits which are all coupled to the same 3D cavity fields. The challenge in controlling this system comes from spectral crowding, where the leakage transition of qubits ais close to computational transitions in other qubits . Here, it is shown that fast pulses are possible which address single qubits using two -quadrature control of the pulse envelope, while the derivative removal by adiabatic gate method of Refs. [1] alone only gives marginal improvements over the conventional Gaussian pulse shape. On the other hand, a first -order result using the Magnus expansion gives a fast analytical pulse shape which gives a high -fidelity gate, up to a phase factor on the second qubit. Further numerical analysis corroborates these results and yields to even faster gates, showing that leakage -state anharmonicity is not a fundamental quantum speed limit [2]. We will discuss the prospects of experimental implementation. F. Motzoi et al., Phys. Rev. Lett. 103, 110501 (2009). R. Schutjens et al., arXiv:1306.2279

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