High-Fidelity Operations with Composite Microwave Pulses in Superconducting Quantum Systems

Syed Farhan Ahmad [1,2,3]
1. Department of ECE, RVCE, Bangalore, India
2. Department of Chemistry and Biochemistry
3. Center for Quantum Science and Engineering
University of California, Los Angeles, USA
syedfarhana.ec18@rvce.edu.in

Kajsa Williams [1,2]
1. Department of Chemistry and Biochemistry
2. Center for Quantum Science and Engineering
University of California, Los Angeles, USA
kajsawilliams@g.ucla.edu

Louis Bouchard [1,2]
1. Department of Chemistry and Biochemistry
2. Center for Quantum Science and Engineering
University of California, Los Angeles, USA
lsbouchard@ucla.edu

***Abstract*—The performance of superconducting qubit systems, an emerging platform for near-term quantum computing, depends on the fidelity of single- and two-qubit gates. Executing high-fidelity qubit operations requires some degree of control over the microwave field. Pulse waveform design techniques in the frequency range of 4-10 GHz are an active area of research in the quantum hardware domain. We implemented single-qubit Gaussian and DRAG pulse gates based on composite Levitt-Freeman schemes and compared their fidelities against that of single isolated pulses. Gate fidelity was assessed on a single-qubit pulse backend from the IBM Quantum Experience. It involved mapping the probability of the principal transition $|0\rangle \rightarrow |1\rangle$ and its robustness with respect to fluctuations in offset frequency and microwave power. Results indicate that composite pulses offered increased robustness over single pulses. This enables us to run circuits on quantum hardware with lesser noise thereby solving optimization or search problems with greater efficiency.**

***Index Terms*—quantum computing, microwave pulse, composite pulse, qubit, fidelity, robustness, DRAG, IBM Quantum**