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Phase gate operation on a flux qubit via the readout SQUID line¹ X.Y. JIN, S. GUSTAVSSON, J. BYLANDER, F. YAN, Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, F. YOSHIHARA, S. NAKAMURA, The Institute of Physical and Chemical Research (RIKEN), Wako, Saitama 351-0198, Japan, W.D. OLIVER, MIT Lincoln Laboratory, 244 Wood Street, Lexington, Massachusetts 02420 — Detuning a superconducting qubit from its rotating frame is one means to implement a phase gate operation. For superconducting flux qubits, this detuning can be realized by changing the magnetic flux threading the qubit loop, .e.g., by the mutual coupling from a nearby microwave antenna. In this work, we demonstrate an alternative approach: we implement a phase gate by pulsing a current through the readout DC SQUID. While the DC SQUID acts as a qubit flux sensor for readout, we in turn may use it as an actuator to impose the phase-gate flux shift. Using this pulsed current approach, we demonstrated Ramsey-type free-induction with more than 20 oscillation periods. We also studied the impact of the first phase gate on subsequent, sequential phase gates.

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