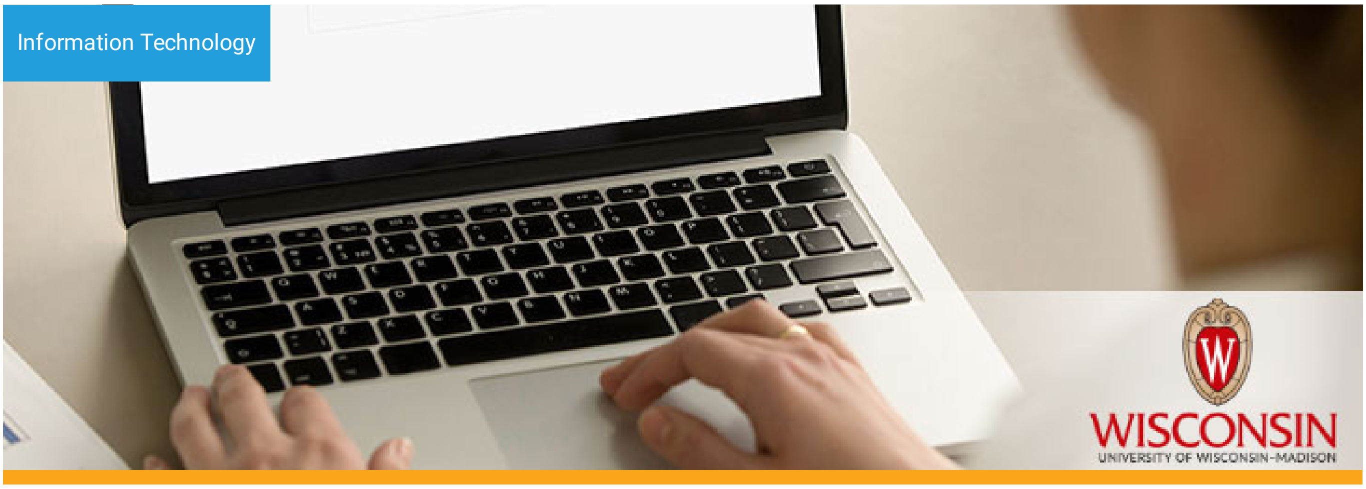

Controlling Superconducting Quantum Circuits

View U.S. Patent No. 9,425,804 in PDF format.

WARF: P140260US01

Inventors: Robert McDermott, Maxim Vavilov

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a system to control superconducting quantum circuits using single flux quantum logic.

Overview

In the exciting field of quantum computation, the performance of quantum bits ('qubits') is advancing rapidly. Among several implementations currently being pursued, superconductor-based circuits are good candidates for constructing qubits given their excellent coherence properties, strong mutual interaction and potential for scaling to large numbers using integrated circuit technology.

A practical superconducting quantum computer may necessitate thousands or millions of physical qubits; the wire-up and control of such systems presents a formidable technical challenge. Another issue is overall system footprint. It is critical to reduce wiring heat load, latency and power consumption of the qubit control circuitry.

There is strong interest in the development of classical Josephson junction-based circuits from the single flux quantum (SFQ) digital logic family for the control of large-scale superconducting quantum circuits. SFQ circuits operate at higher speeds and use less power than semiconducting logic. Up to now, however, there has been no compelling proposal for the coherent control of superconducting quantum circuits using SFQ digital logic.

The Invention

UW–Madison researchers have developed a method for controlling superconducting quantum circuits. In the new method, quantized voltage pulses generated by SFQ circuits are used to coherently control superconducting quantum systems, such as qubits or resonator cavities.

More specifically, the method utilizes coherent rotations obtained using a pulse-to-pulse spacing timed to the period of the target oscillator. Controlling the system in this way may be achieved in a low-temperature cryostat without the need to apply external microwave electromagnetic signals. Also, the SFQ-based gates are robust against leakage errors and timing jitter, with high fidelities achievable for gate times on the order of tens of nanoseconds.

Applications

- Hardware/software for superconducting quantum computers

Key Benefits

- Coherent control
- High gate fidelities (e.g., exceeding 99.9 percent for sequence lengths of 20 nanoseconds)
- Low temperature operation

- Robust against timing jitter
- Leverages great potential of SFQ circuits and Josephson logic for integrated qubit control

Stage of Development

Simulations and preliminary experiments have been performed.

The development of this technology was supported by WARF Accelerator. WARF Accelerator selects WARF's most commercially promising technologies and provides expert assistance and funding to enable achievement of commercially significant milestones. WARF believes that these technologies are especially attractive opportunities for licensing.

Additional Information

For More Information About the Inventors

- Robert McDermott
- Maxim Vavilov

Related Technologies

- WARF reference number P120028US01 describes a low-noise, phase-insensitive linear amplifier capable of accommodating readout signals from quantum computing applications.
- WARF reference number P140246US01 describes a novel qubit measurement system based on counting microwave photons.

Publications

- McDermott R. and Vavilov M.G. 2014. Accurate Qubit Control with Single Flux Quantum Pulses. Phys. Rev. Applied. arXiv:1408.0390

Tech Fields

- Information Technology : Computing methods, software & machine learning
- Information Technology : Hardware

For current licensing status, please contact Emily Bauer at emily@warf.org or 608-960-9842