

Measuring Speed and Energy of Superconductive Logic Circuits

Introduction:

Recently, power dissipation is becoming a dominant factor in choosing the next technology, that's why most figures of merits used now to test the potential of a technology to be the next leading technology in the industry are

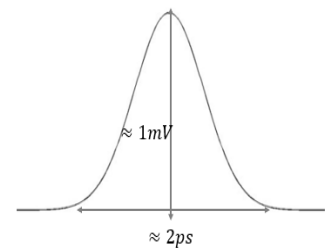
$$\frac{\text{Operation}}{\text{Second} \times \text{Watt}} \text{ or } \frac{\text{Joule}}{\text{bit}} \dots \text{ and not just } \frac{\text{Operation}}{\text{Second}}.$$

Superconductivity is the phenomenon in which we have **zero** DC resistance and is viewed as a technology capable of achieving better energy efficiency than any other.

Superconductive circuits are based on the quantization of magnetic flux

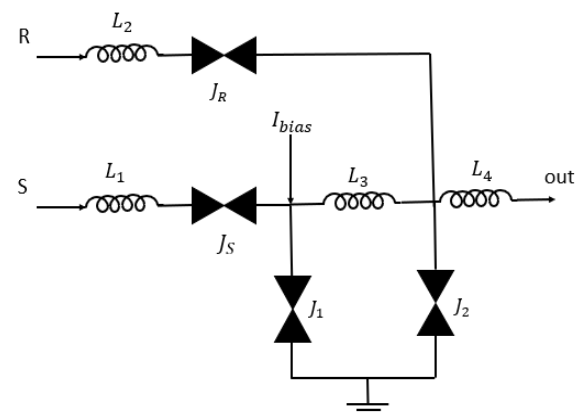
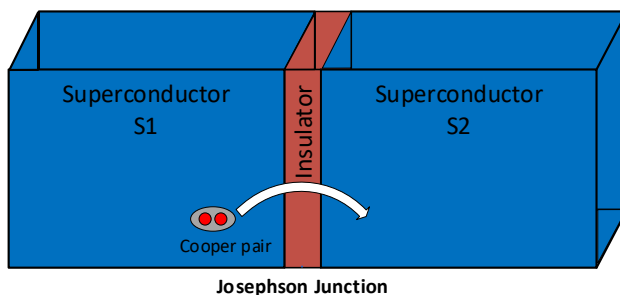
to a single flux quantum (SFQ) $\Phi_0 = \frac{h}{2e} = 2.067 \times 10^{-15} [Wb]$. The information passed in superconductive circuits are voltage pulses which are $\approx 2[\text{picosecond}]$ wide and $\approx 1\text{mV}$ high which is the passing of an SFQ.

Superconductive logic circuits can be extremely fast and energy-efficient. Circuits were tested operating in frequencies exceeding even $100[\text{GHz}]$.



Project:

In this project, the students will be introduced to the superconductive phenomenon, the Josephson Junction, an active device that is used to build circuits, and will build and test circuits in the standard superconductive logic family called Rapid Single Flux Quantum (RSFQ) and measure the speed and energy of the circuits that are built.



Prerequisites:

- Courses:
 - Digital Systems and Computer Structure (044252)
 - Electronic Circuits (044137)

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