Single Flux Quantum Logic for Digital Applications

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***Abstract*— It took about twenty years for superconducting single flux quantum (SFQ) digital electronics to progress from the invention, initial proof-principle experiments to the first application system of a practical significance. Rapid Single Flux quantum (RSFQ) logic was introduced in mid-80s as an alternative to then dominant superconducting latching logic and became the main digital and mixed-signal technology by mid-90s. In search for the practical applications, it went through multitudes of projects and attempts to solve real-world problems and find application niches to compete with omnipotent CMOS in heyday of Moore's law. By mid-00s, this was successfully achieved for mixed-signal applications by riding on the superior RSFQ clock speed, quantum properties of superconducting Josephson circuits, and finding a solution for interfacing cryogenic low-power, fast RSFQ electronics with higher power, much slower room-temperature electronic environment. In recent years, CMOS started to lose its unquestionable application luster opening new opportunities for superconducting electronics. Achieving the highest energy-efficiency for high-end computing such as supercomputers and data centers became the priority. This triggered the development of several post-RSFQ logic families with significantly higher energy efficiency. The advent of quantum computing and quantum sensors opened a new application field in a classical infrastructure electronics capable of operating at cryogenic temperatures in a close proximity to quantum circuits. Here, the inherent strengths of SFQ logic including high-speed, low-power, and cryogenic operation offer a significant advantage over other technologies.**

***Keywords (Index Terms)* — Single flux quantum, superconducting digital electronics, RSFQ.**

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