Reduction of the Supply Current of Single-flux-quantum Time-to-digital Converters by Current Recycling Techniques for the Operation in Cryo-cooler

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***Abstract*—We have been developing superconducting time-of-flight mass spectrometry systems that utilize superconducting strip particle detectors and single-flux-quantum (SFQ) time-to-digital converters (TDCs). We previously demonstrated a 24-bit SFQ TDC with a 3 by 24-bit first-in first-out (FIFO) buffer using the AIST Nb standard process (STP2) with a time resolution of 100 ps. In this study, we improved the SFQ TDC by using a current recycling technique. The technique enables us to increase the FIFO buffer capacity without increasing the total supply current, and the result is an improvement of ion count rates. We designed and demonstrated the SFQ TDC with a 12 by 24-bit FIFO buffer, whose total supply current was reduced by 71% with the current recycling technique.**

***Index Terms*—SFQ circuits, TDC, FIFO, current recycling, TOF MS, superconducting detectors.**

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