Simulation Study of RSFQ D/A Converter

Hyung-Gon Chu [a], Kyu-Tae Kim [b], and Joonhee Kang [*,a]

[a] *Department of Physics, University of Inchon, Korea*

[b] *Korea Research Institute of standards and Science, Daejeon, Korea*

Josephson array voltage standard is known to be the most exact among the presently available voltage standards. However, this voltage standard uses an RF signal of very accurate frequency to produce dc voltage. Therefore, it may not be used to the accurate ac voltage standard, the accurate waveform analysis, and the analysis of an accurate digital-to-analog converter (DAC). With Rapid Single Flux Quantum (RSFQ) logic circuits based on Josephson junctions it is possible to construct digital circuits operating at above 100 GHz. This very fast logic can be used to produce very accurate ac signals. In this work, we have designed an RSFQ DAC and RSFQ voltage multipliers and examined their performance through computer simulations. Various Josephson simulators were used. To design an RSFQ DAC, Non-Destructive Read-Out (NDRO) circuits, Toggle Flip-Flop (TFF) circuits, D Flip-Flop (DFF) circuits, Splitters, and Confluence Buffers were used. To construct voltage multipliers two methods were used. One was to use a direct coupling scheme to multiply single flux quantum, and the other was to use a magnetic coupling scheme. Through the simulation studies of the RSFQ DAC circuit we observed that the designed circuits operate correctly and the circuit margins were sizable. When the pulse multiplication with small gain is required the direct coupling scheme was more effective. However, the magnetic coupling scheme was much more stable for the practical cases when the pulse multiplication with large gain is required.

keywords : Josephson, voltage, standard, RSFQ, digital, analog, converter, multiplier