

Development of Superconductive Arithmetic and Logic Devices

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Due to the very fast switching speed of Josephson junctions, superconductive digital circuit has been a very good candidate for future electronic devices. High-speed and Low-power microprocessor can be developed with Josephson junctions. As a part of an effort to develop superconductive microprocessor, we have designed an RSFQ 4-bit ALU (Arithmetic Logic Unit) in a pipelined structure. To make the circuit work faster, we used a forward clocking scheme. This required a careful design of timing between clock and data pulses in ALU. The RSFQ 1-bit block of ALU used in this work was consisted of three DC current driven SFQ switches and a half-adder. We successfully tested the half adder cell at clock frequency up to 20 GHz. The switches were commutating output ports of the half adder to produce AND, OR, XOR, or ADD functions. For a high-speed test, we attached switches at the input ports to control the high-speed input data by low-frequency pattern generators. The output in this measurement was an eye-diagram. Using this setup, 1-bit block of ALU was successfully tested up to 40 GHz. An RSFQ 4-bit ALU was fabricated and tested. The circuit worked at 5 GHz. The circuit size of the 4-bit ALU was 3 mm x 1.5 mm, fitting in a 5 mm x 5 mm chip.

keywords : RSFQ, superconductor, digital, microprocessor