

# 基于多值 RRAM 的高能效非易失性 SRAM 设计

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**摘要:** 针对常关即开型应用, 本文利用 RRAM 的多值存储特性, 提出了一种基于多值 RRAM (MLC) 的高能效非易失性 SRAM (nvSRAM) 单元电路. 通过引入新型的多比特数据备份电路, 本文提出的 MLC-nvSRAM 单元实现了将 2-bit SRAM 数据值同时备份到一个四值 RRAM 中, 明显减小了电路中 RRAM 的器件个数和平均写入电流, 进而有效降低了数据备份能耗. 仿真结果表明, 与传统基于单值 RRAM 的 SLC-nvSRAM 单元相比, 所提出的 MLC-nvSRAM 单元在保持正常 SRAM 高读写性能的基础上, 数据备份能耗和系统盈亏时间的降幅分别高达 76.80% 和 74.01%.

**关键词:** 非易失性 SRAM; 多值 RRAM; 数据备份能耗; 数据恢复能耗; 盈亏时间

## Energy-efficient nonvolatile SRAM design

### based on multilevel RRAM

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**Abstract:** A novel energy-efficient nonvolatile static random access memory (nvSRAM) design utilizing the multi-level cell (MLC) characteristics of resistive RAM (RRAM) cell is proposed for frequent-off and instant-on applications. The multi-bit data store circuitry is designed to enable the storage of every two-bit SRAM data into a single 4-level MLC-RRAM to achieve low store energy with reduced number and suppressed average write current of RRAM devices. Simulation results show that high data access speed is maintained with the proposed MLC-nvSRAM circuit when performing the SRAM operations. As compared to the previously published SLC-nvSRAM cells, the store energy and break-even time of the proposed MLC-nvSRAM cell are reduced by up to 76.80% and 74.01%, respectively.

**Key words:** nonvolatile SRAM; multilevel RRAM; store energy; restore energy; break-even time

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