适应于动态电压频率调整的抗辐照 SRAM 设计

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摘　要：动态电压频率调整（Dynamic Voltage Frequency Scaling，DVFS）可以使系统在高电压工作时获得高性能，在低电压工作时降低系统功耗，它要求电路能够从正常电压一直到亚阈值区范围内均能正常工作.抗辐照 DVFS-SRAM 的设计面临着低压工作稳定性及工艺、电压、温度偏差（Process，Voltage，Temperature，PVT）的严重影响.本文针对以上问题，设计了一款适应于 DVFS 应用的抗辐照静态随机存储器（Static Random Access Memory，SRAM）.提出了新型抗辐照 DICE 单元结构，其读噪声容限相对于原有 DICE 单元有大幅提升.同时，针对常规分级位线结构时序控制电路存在的问题，提出了改进型复制列技术，增强了 SRAM 存储体在不同 PVT 环境下工作的稳定性.对 SRAM 存储体进行了电路设计及版图设计，后仿真结果表明，设计的 512 bit SRAM 存储体可在　0.6 V~　1.8 V 电源电压下正常工作.在 1.8 V 下，SRAM 的存取速度为 5.1 ns，功耗为 1.8 mW；在 0.6 V 电压下，SRAM 的存取速度为 93.5 ns，功耗为 14.63　μW，比 1.8 V 电源工作时的功耗降低了约 100 倍.另外，设计的 SRAM 对宽度为 300 ps 以下的单粒子瞬态脉冲具有滤除能力，对单粒子翻转效应有良好的抵抗能力.
关键词：SRAM；DICE 单元；动态电压频率调整；防辐照；低功耗

Radiation-Hardened SRAM for Dynamic Voltage Frequency Systems

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Abstract：Dynamic Voltage Frequency Scaling is a method which can not only provide good performance for the system, but also can decrease power consumption. It requires that circuit is able to work in a wide range of supply voltage. However, The design of radiation-hardened SRAM for dynamic voltage frequency systems has faced stability problem because of the process, voltage temperature difference. To cope with these questions, Radiation-Hardened SRAM for dynamic voltage system has been designed. A new DICE cell is proposed for low supply power condition, which has better performance in read static noise margin than the regular DICE cell. In addition, proposed Improved Dummy column has increased the stability of SRAM under various PVT conditions. Post simulation results show that the SRAM circuit can work functionally when the supply voltage changes from 0.6 V to 1.8 V. When the supply voltages are 1.8 V and 0.6 V, the access time of SRAM are 5.1 ns and 93.5 ns, respectively. The power consumption is 1.8 mW and 14.63　μW, respectively. The designed SRAM has good immunity for SEU and could filter the SET pulses with width of 300ps.
Key words：SRAM; DICE cell; DVFS; radiation hardened; low power consumption

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