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AREA AND ENERGY EFFICIENT MAGNETIC FULL ADDER BASED ON DIFFERENTIAL SPIN HALL MRAM

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The concept of in-memory computing has gained significant attraction with the inception of perpendicular magnetic tunnel junction (PMTJ) device, due to its non-volatility and CMOS compatibility. In the recent past, several magnetic full-adder (MFA) designs based on spin-transfer torque (STT) and spin Hall effect (SHE) magnetic random access memories (MRAMs) have been demonstrated. However, the designs consume higher write energy and occupy larger area. In this work, a novel MFA using differential spin Hall (DSH) MRAM is proposed. The DSH-MRAM provides simultaneous switching of two PMTJ devices using SHE and generates complementary logic outputs. The single Hall metal (HM) shared by these PMTJ devices offers a very low resistance path for write operation. In this work, an external magnetic field (EMF) is used to assist the SHE current for PMTJ switching that eliminates the need of STT current. A SPICE compatible Verilog-A MTJ model is used to mimic the operational behaviour of the proposed MFA. The EMF assisted DSH-MRAM requires a very short pulse (300 ps) of SHE current to switch both the PMTJs. The proposed MFA exhibits 65% less operation time, consumes 93% (18%) less write (read) energy, and saves 23% area compared to recently published STT/SHE-MTJ based MFA designs.

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