Pushing a Non-Volatile Magnetic Device Structure Towards a Universal CMOS Logic Replacement

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The soaring investment costs and the ever increasing severeness of physical limits for upcoming CMOS technology nodes will bring CMOS shrinking to a halt in the foreseeable future. Spintronics is a promising way to circumvent these obstacles, due to its non-volatility, high endurance, and fast operation. Promising results with respect to speed and power consumption have been already shown [1-3]. However, the introduced magnetic tunnel junctions (MTJs) act as mere auxiliary devices and require additional circuits for their operation, while the actual computation is carried out via CMOS transistors.

Our non-volatile magnetic flip-flop is capable of performing logic operations within the magnetic domain, which leads to a very small circuit foot print [4]. An extremely dense layout is achieved, when the device is extended to a non-volatile magnetic shift register [5]. Additionally the device structure intrinsically features a bias field free spin torque nano-scale oscillator [6] and can be combined with spin torque majority gates [7] to further boost the integration density. Thus, the proposed structure constitutes a very versatile and viable building block for a universal post CMOS logic technology.

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1. Everspin Technologies, Jan. 2014. URL: http://www.everspin.com/spinTorqueMRAM.php
2. D. Chabi et al., IEEE Trans.Circ. and Sys. I 61 6, 1755 (2014)
3. W. Zhao et al., in ACM Great Lakes Symposium on VLSI 1973009, 431 (2011).
4. T. Windbacher et al., in Proc. of the SISPAD, 368 (2013).
5. T. Windbacher et al., in Proc. of the IEEE/ACM Intl. Symp. on NANOARCH, 36-37 (2013).
6. T. Windbacher et al., J.Appl.Phys. 115, 17C901-1 - 17C901-3 (2014).
7. D.E. Nikonov et al., Nanotechnology (IEEE-NANO), 1384-1388 (2011).

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