Design and Measurement of a Receiver for a Spin-wave Detection System

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Over the last decades, Moore's law has guided the semiconductor industry to integrate more transistors and build more powerful computers. However, in contrast to the increasing computing performance, energy saving through the technological innovation of semiconductors has remained stagnant for about a decade. Thus, researchers and engineers are trying to develop energy-efficient computers based on entirely new concepts, such as in-memory computing and computers based on spintronics devices [1]. The computers based on spintronics utilize spin waves to transmit and control information, which could decrease the unavoidable heat generation induced by the actual transportation of electrons in electronic computers. However, to achieve spintronic computers with better performance, an accurate detection of spin waves is crucial. In previous research, the detection of spin waves was primarily done by external Vector Network Analyzer (VNA) systems, which are bulky, expensive, and, most importantly, unable to be integrated into a single chip. Thus, a small, single-chip spin-wave detection system is required for the next-generation spintronic computers. Besides, the magnet field is necessary for spin wave adjustment [2], meaning that inductors are not suitable to be used in the detection system. To tackle the challenges above, in this presentation, a novel spin-wave detection system is proposed, as Fig. 1 shows. The detection system includes a PLL, phase interpolator (PI), LNA, lock-in amplifier (LIA), and ADCs. The PLL and PI generate two phase-controlled signals for ports 1 and 3 of the spintronic device. The LNA and LIA amplify and down-convert the weak DUT output for noise filtering and ADC-based detection. The feasibility of the proposed system has been demonstrated based on the actual spin-wave device measurement result, which exhibits a similar frequency response compared to the results obtained by Keysight N5222B VNA. This is a first step towards the integration of spin wave devices.

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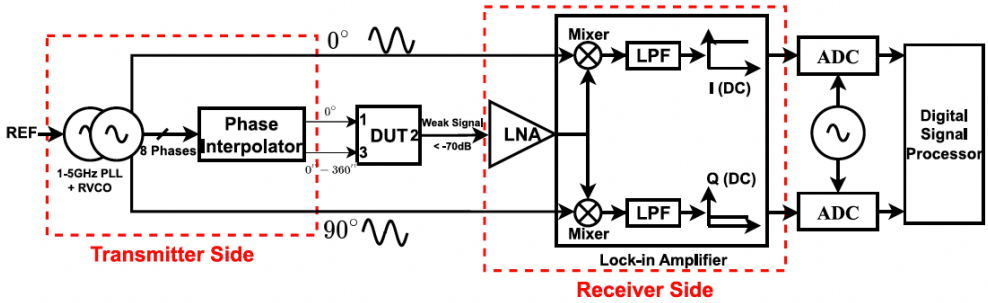

Fig. 1 The proposed spin wave detection system

[1] Mahmoud, A. *et al.,* J. Applied Physics. 128, 161101 (2020).

[2] Sarker, M.S. *et al.,* Scientific Report, 13, 4872 (2023).

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