Integrated Non-reciprocal Components Based on Linear Time-Varying Circuits

Abstract: Lorentz reciprocity is a fundamental property of linear time-invariant passive circuits and systems constructed from conventional materials. However, non-reciprocal components, such as circulators, enable new wireless communication paradigms, such as full duplex wireless. Conventionally, non-reciprocal circulators have been realized using ferrite materials that exhibit the magneto-optic Faraday effect, and are consequently incompatible with CMOS, bulky, and expensive. Recent research has shown that reciprocity can be broken and non-reciprocal circulators can be built in CMOS using linear periodically time-varying (LPTV) circuits. This represents an interesting and unique property of LPTV circuits beyond the traditionally exploited tunable high-quality filtering in the so-called “N-path filters”. We will describe the fundamental physical principles from our recent 2016 Nature Communications paper, as well as three generations of CMOS circulators and circulator-based wireless systems published in ISSCC 2016 and ISSCC 2017 that target emerging full-duplex and 5G millimeter-wave applications.

Biography: Harish Krishnaswamy received the B.Tech. degree in electrical engineering from the Indian Institute of Technology, Madras, India, in 2001, and the M.S. and Ph.D. degrees in electrical engineering from the University of Southern California (USC), Los Angeles, CA, USA, in 2003 and 2009, respectively. In 2009, he joined the Electrical Engineering Department, Columbia University, New York, NY, USA, where he is currently an Associate Professor and Director of the Columbia high-Speed and Millimeter-wave IC (CoSMIC) lab.

His research interests broadly span integrated devices, circuits, and systems for a variety of RF, mmWave and sub-mmWave applications. In 2017, he co-founded MixComm Inc., a venture-backed startup, to commercialize CoSMIC lab’s advanced wireless research.

Dr. Krishnaswamy serves as a member of the Technical Program Committee (TPC) of several conferences, including the IEEE International Solid-State Circuits Conference (2015/16-present) and IEEE RFIC Symposium (2013-present). He was the recipient of the IEEE International Solid-State Circuits Conference (ISSCC) Lewis Winner Award for Outstanding Paper in 2007, the Best Thesis in Experimental Research Award from the USC Viterbi School of Engineering in 2009, the Defense Advanced Research Projects Agency (DARPA) Young Faculty Award in 2011, a 2014 IBM Faculty Award and the 2015 IEEE RFIC Symposium Best Student Paper Award - 1st Place. He also currently serves as a Distinguished Lecturer for the IEEE SSCS.