MEGAHERTZ-RANGE WIRELESS-POWER-TRANSFER RECTIFIERS RESONANT TO REGULATE

AS MORE PRODUCTS are designed with wireless charging capability, resonant wireless-power-transfer (WPT) technology is increasingly present in the wireless market. Having faster and more reliable charge rates—while using less expensive or space-consuming electronics—is a major goal for this industry. At the Korea Advanced Institute of Science and Technology, Jun-Han Choi, Sung-Ku Yeo, Seho Park, Jeong-Seok Lee, and Gyu-Hyeong Cho designed and tested several resonant regulating rectifiers for enhanced WPT capability at 6.78 MHz.

On 0.35-micrometer bipolar-CMOS-DMOS (BCD) technology, the team is able to design RWPT circuits that can harvest power to 6 W at 86% efficiency using both the continuous conduction mode and discontinuous conduction mode. The proposed resonant-regulating-rectifier designs do not require an additional inductor for switch-mode regulation, as the resonant tanks are operated using phaser-transformed inductance. Only three switches are used in a rectifier design that achieves 6 W of transferable power.

Such a feat is impressive when compared to other resonant-regulating rectifier systems that have been reported, which have less than 1 W of available power at 13.56 MHz. See "Resonant Regulating Rectifiers (3R) Operating for 6.78 MHz Resonant Wireless Power Transfer (RWPT)," *IEEE Journal of Solid-State Circuits,* Dec. 2013, p. 2989.

UPGRADE FREQUENCY-SELECTIVE SURFACE FILTERS FROM 2D TO 3D

BY INCREASING THE selectivity and out-of-band rejection of bandpass filters for frequency-selective surfaces (FSSs), it is possible to enhance the operation of antenna subreflectors, radomes, and polarizers. Such an approach limits the signal-to-noise ratio (SNR) of the incoming RF signals. Most FSS bandpass filters exhibit low selectivity and unstable angular response. Although cascading enhances the filtering characteristics of these spatial filters, it is still difficult to design bandpass FSS filters to obtain wide out-of-band rejection and stable response under a large incidence angle variation.

Adding stubs, coupled lines, or electromagnetic (EM) bandgap structures can add transmission zeroes at finite frequencies. It is therefore possible to enhance the filtering characteristics of two-dimensional (2D) microstrip filters. Bo Li and Zhongxiang Shen of Nanyang Technological University, Singapore, have adopted this technique to design and test three-dimensional (3D) FSS structures with multiple transmission zeroes introduced at desired frequencies.

Using a modern RF substrate (Rogers 4230) and aluminum to fabricate a surface matrix of 30 × 27 unit cells, the team constructed a 3D FSS with T-type, T-shaped, resonant inserts. The 2D unit cells are fabricated on large printed-circuit boards (PCBs) and then cut into the unit cells. The FSS was tested under transverse-electric polarization with two incident angles.

The FSS was observed to be stable under the different incident angles with transmission poles at 7.9 and 8.4 GHz in the passband and transmission zeroes at 6.1, 10, and 17.9 GHz in the stopband. See "Three-Dimensional Bandpass Frequency-Selective Structures With Multiple Transmission Zeros," *IEEE Transactions on Microwave Theory and Techniques*, Oct. 2013, p. 3578.

SIMPLIFY RF IC TESTING WITH ON-CHIP THERMAL FAULT DETECTORS

TRADITIONALLY, IT HAS been difficult and costly to test RF integrated circuits (ICs) under large-scale manufacture. Attractive alternatives include built-in tests, where the testing operations are on-loaded to take place on the IC itself, or built-in self-tests. If non-invasive fault-detection systems could be integrated within the circuitry of the RF IC, for example, wafer-level, die-level, and chip-level testing could be simplified.

In Grenoble, France, a built-in, temperature-based, non-intrusive sensor for fault detection of a linear amplifier has been designed and tested by Louay Abdallah, Haralampos Stratigopoulos, Salvador Mir, and Josep Altet. The concept behind their temperature sensor is that minor changes from the target circuit's ideal operation will cause a different thermal profile than what is expected. This profile can then be monitored and reported on, as long as the thermal sensor is sufficiently robust.

For the temperature sensor, the designers used an open-loop, operational-transconductance amplifier that uses bipolar transistors in a differential configuration. Because the collector current of bipolar transistors has an exponential dependence on temperature, it is suited to applications in which temperature varying operation can occur. Using the two primary bipolar transistors in the differential topology causes a response in the output voltage. Such a response will be dependent upon the temperature, as long as one pair of the differential amplifier's bipolar transistors are placed near the circuit to be monitored while the other remains relatively isolated. The changes in the transistor's power dissipation in proximity to the monitored circuit vary with temperature. These changes allow for highly sensitive temperature readings. See "Defect-Oriented Non-Intrusive RF Test Using On-Chip Temperature Sensors," *2013 IEEE 31st VLSI Test Symposium*, April 2013.