MMIC PIN-DIODE LIMITERS OPERATE TO 20 GHz

TO PREVENT DAMAGE to highly sensitive receiver front ends, limiters are used to sink extra RF power away from sensitive circuits. Limiter circuitry performs as a low-loss, broadband, and compact component. PIN diodes are attractive devices for limiter design, as they enable key performance features while exhibiting high power handling. Plextek offers an application note detailing a design example of a monolithic-microwave-integrated-circuit (MMIC) PIN-diode limiter labeled, "Technology Overview: Broadband, Low-Loss Limiter MMICs."

PIN diodes are offered in discrete packages or integrated into IC processes. The benefit of using an integrated PIN diode for limiter design is the elimination of packaging parasitics, which degrade the receiver's noise performance. PIN diodes are built from an intrinsic (I) region of high resistivity in between a P- and N-type semiconductor.

When the PIN-diode structure is forward biased, carriers are injected into the I region. The resistance of the region is lowered as a result. This unique response enables a PIN diode to operate as a current-controlled resistor and switch at RF/microwave frequencies. Imperfections in the diode's I region cause charge accumulation, which generates a direct-current (DC) rectified from the RF signal. A DC return path is necessary for proper function of the limiter.

An example of the design and simulation of a fifth-order limiter modeled after a fifth-order low-pass filter (LPF) is provided in the application note. The shunting configuration of the diodes uses a back-to-back approach composed of antipodal pairs. This method allows for operation from 0.5 to 20.0 GHz.

An LPF structure designed to absorb the parasitic capacitance of the zero-biased diode pairs increases the limiter's broadband capability. Integrated DC-blocking metal-insulator-metal (MIM) capacitors are used at the RF input and output. The low-pass filter also comprises high-impedance metal tracks for constructing inductors.

An electromagnetic (EM) simulation using practical bond-wire parasitics yields return loss of greater than −18 dB above 2 GHz. Return loss degrades to −13 dB below 500 MHz. To simulate the operation of the limiter in a small-signal method, the forward conduction state is triggered by a high-level RF signal. The diodes are then switched to the DC-induced forward bias state.

The power handling of the limiter typology is dictated by the power-handling capability of the primary diodes. For this typology, which is implemented with TriQuint's VPIN process, it is suggested that the structure can handle continuous-wave (CW) power of 5 W.

Plextek Ltd., London Rd., Great Chesterford, Essex CB10 1NY UK, +44 (0) 1799 533200, www.plextek.com

WIRELESS POWER TRANSFER RESONATES TO EXTEND REACH

EVER SINCE NIKOLA Tesla introduced the prospect of wireless power transfer almost 100 years ago, there has been considerable investment in implementing such systems in the US. Now, it appears that society and market demands are finally in place to make Tesla's vision a reality. There are currently many methods to power devices wirelessly. All of these approaches invite concerns over distance, efficiency, safety, power-handling capability, and cost. Dr. Morris Kesler shares the ins and outs of highly resonant wireless power transfer in a 32-page application note titled, "Highly Resonant Wireless Power Transfer: Safe, Efficient, and over Distance."

Highly resonant wireless power transfer (HR-WPT) uses high-quality-factor resonators to enable the efficient, long-range, and non-radiative transfer of electromagnetic (EM) energy. This method proposes to solve a significant portion of the safety and efficiency concerns surrounding other wireless-power-transfer methods. HR-WPT requires a power source, AC/DC converter, DC/RF amplifier, impedance-matching network, and resonant antenna for the transmitter. The receiver uses the same components in a receiver configuration. This construction allows efficiencies that are close to optimal.

There are key benefits to HR-WPT from a flexibility and modularity perspective over other WPT technologies. With HR-WPT, the orientation of the receiving device and its relative scale compared to the transmitter only minimally affects the efficiency of the transfer. This is not the case with inductive coil or radiative technology. Additionally, two enabling benefits of HR-WPT are its ability to charge multiple devices from a single transmitter and use highly efficient resonant repeaters. The increased capabilities of HR-WPT could put high levels of RF energy in close proximity to the end user.

In addition, HR-WPT has the capability to transfer energy from watts to kilowatts. Naturally, this aspect raises the concern of human bodies and other devices being harmed by wireless power. In simulations, the HR-WPT method of transfer has been found to exhibit levels of tissue heating, nerve/muscle stimulation, and specific absorption rates that are far below the FCC SAR and ICNIRP electric field guidelines.

WiTricity, 149 Grove St., Watertown, MA 02472; (617) 926-2700, www.witricity.com