

A 60-GHz Active-Integrated Antenna Oscillator

Chuan-Chang Liu*, Renaud Moussounda, and Roberto G. Rojas
ElectroScience Laboratory, Dept. Electrical and Computer Engineering
The Ohio State University, 1320 Kinnear Rd., Columbus, OH 43212, USA
E-mail: liu.1077@osu.edu, moussounda.1@osu.edu, rojas-teran.1@osu.edu

An active-integrated antenna (AIA) consists of active circuits and an antenna. Instead of considering the antenna as a $50\text{-}\Omega$ load, the passive radiating element can provide different functions such as resonating, filtering, and radiating. AIA oscillators are especially attractive for spatial power combining systems with beam-steering capability such as coupled oscillator arrays (COAs). AIA-based architectures solve some problems in a traditional array architecture including lossy power distribution network, high power sources at high frequencies, etc.

Recently, the unlicensed band at 57-66 GHz has attracted interest for short-range multi-Gbps wireless communications. The millimeter wavelength makes it possible to realize phased-array system with on-chip antennas thus improving the system integrity and reliability. With the rapid progress in semiconductor technology, several AIA designs have been demonstrated. However, the low resistivity of silicon substrate, which can seriously affect the radiation efficiency, makes AIA design more challenging at millimeter-wave frequencies.

This work presents the design of 60-GHz active-integrated antenna oscillator in $0.13\text{-}\mu\text{m}$ SiGe BiCMOS process using a novel design methodology previously introduced by these authors (R. Moussounda and R. Rojas, paper 2481, IEEE Int. Symp. Ant. and Propag., Spokane, WA, July 3-8, 2011). The AIA oscillator consists of an on-chip meander line antenna, a cross-coupled oscillator, and varactors. Meander line structures are commonly used to implement small antennas in UHF wireless devices. To save silicon real estate while maintaining reliable radiation characteristics, a meander line antenna is adopted in this work. The input impedance of the antenna is controlled by the width and space of the introduced loading bars. The cross-coupled pair is used as the core structure of the oscillator due to its low phase noise performance, high frequency tuning range, and low power consumption. The oscillation frequency is controlled by varactors. The optimization exploits the nonlinear circuit properties and also uses 3D EM co-simulation. Highly accurate simulated results will be presented in this work to evaluate the performance of an AIA oscillator implemented in VLSI technology.