ABSTRACT

System and Circuit Design Techniques for Silicon-based Multi-band/Multi-standard Receivers

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Today, the advances in Complementary MetalOxideSemiconductor (CMOS) technology have guided the progress in the wireless communications circuits and systems area. Various new communication standards have been developed to accommodate a variety of applications at different frequency bands, such as cellular communications at 900 and 1800 MHz, global positioning system (GPS) at 1.2 and 1.5 GHz, and Bluetooth andWiFi at 2.4 and 5.2 GHz, respectively. The modern wireless technology is now motivated by the global trend of developing multi-band/multistandard terminals for low-cost and multifunction transceivers. Exploring the unused 10-66 GHz frequency spectrum for high data rate communication is also another trend in the wireless industry. In this dissertation, the challenges and solutions for designing a multi-band/multistandard mobile device is addressed from system-level analysis to circuit implementation. A systematic system-level design methodology for block-level budgeting is proposed. The system-level design methodology focuses on minimizing the power consumption of the overall receiver. Then, a novel millimeter-wave dual-band receiver front-end architecture is developed to operate at 24 and 31 GHz. The receiver relies on a newly introduced concept of harmonic selection that helps to reduce the complexity of the dual-band receiver. Wideband circuit techniques for millimeterwave frequencies are also investigated and new bandwidth extension techniques are proposed for the dual-band 24/31 GHz receiver. These new techniques are applied for the low noise amplifier and millimeter-wave mixer resulting in the widest reported operating bandwidth in K-band, while consuming less power consumption. Additionally, various receiver building blocks, such as a low noise amplifier with reconfigurable input matching network for multi-band receivers, and a low drop-out regulator with high power supply rejection are analyzed and proposed. The low noise amplifier presents the first one with continuously reconfigurable input matching network, while achieving a noise figure comparable to the wideband techniques. The low drop-out regulator presented the first one with high power supply rejection in the mega-hertz frequency range. All the proposed building blocks and architecture in this dissertation are implemented using the existing silicon-based technologies, and resulted in several publications in IEEE Journals and Conferences.