Chapter 1
Introduction

It is well known that wireless transceivers are implemented in mobile devices such as smart phones, laptops, tablets, etc. Wireless transceivers are also critical circuit blocks for sensors in the Internet of Things (IoT) era. IoT is being represented as a worldwide network interconnecting things/objects. IoT is a kind of technology that realizes the communication and information exchange between machine and human and machine by embedded RFID, GPS, and sensors technologies into physical equipment, and achieve transition, cooperation, processing of information according to some protocols and so that achieve the goal of intelligent identification, tracking, monitoring, computing, and management. IoT is made up of sensing layer, network layer, and application layer. Sensing layer is responsible for accumulation of data and information. Network layer realizes the management of connection of network and data and transmits information to application layer. Application layer processes information in order to realize monitoring, identification, control, and other functions. Network layer mainly guarantees the connection of network. It can support the network protocols of internet and provide efficient channel for voice and data. To sum up, IoT is a combination of many kinds of networking technologies, and at the same time, IoT cannot be developed without the support of communication network.

Clearly, wireless technologies are very important in IoT area due to the convenient and low cost wireless connections between IoT nodes. RF transceiver is the critical block in wireless nodes and consumes the majority of energy. A typical super-heterodyne architecture transceiver is widely used in RF transceivers with better sensitivity and higher gain. For a super-heterodyne topology in RF transceiver, for example in the receiver (RX) path, the RF signal coming from the antenna and RF switch goes to the front-end low-noise amplifier (LNA). The RF signal is amplified by the LNA and down converted to the intermediate frequency (IF) signal using the mixer and local oscillator (LO). The IF signal then passes through the analog-to-digital (A/D) converter for base band digital signal processing. On the other hand, for the transmitter (TX) path, the digital signal passed through the digital-to-analog (D/A) converter to produce the analog signal. The IF

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is then up-converted to RF signal using the up-converting mixer and LO at desired frequency. The RF signal is amplified by the power amplifier (PA). The RF switch connects the large-signal RF waveform to the antenna for signal transmission.

RF transceiver circuits including low noise amplifiers, mixers, oscillators, and power amplifiers are usually made using mixed-signal CMOS technology. CMOS is an ideal candidate for high density, low cost, low power, and high integration chip solution. Today, silicon CMOS are scaled down to 22 nm and beyond to increase density and performance further. The well-known reliability mechanisms such as hot carrier injection (HCI), negative bias temperature instability (NBTI), and gate oxide breakdown (GOB) become very important knowledge for the design of advanced RF and digital circuits. For state-of-the-art nanoscale circuits and systems, the local device variation and uncertainty of signal propagation time have become crucial in the determination of system performance and reliability. Yield analysis and optimization, which take into account the manufacturing tolerances, model uncertainties, variations in the process parameters, and aging factors are known as indispensable components of the circuit design procedure. Therefore, circuit designers, device engineers, and graduate students need to have clear understanding on how device reliability issues affect the RF circuit performance subjected to operation aging and process variations. This book is unique to explore typical reliability issues in the device and technology level and then to examine their impact on RF wireless transceiver circuit performance. Analytical equations, experimental data, mixed-mode device, and circuit simulation results will be given for clear illustration.