Preface

Since the invention of the integrated circuit, the semiconductor industry has revolutionized the world in ways no one had ever anticipated. With the advent of silicon technologies, consumer electronics became light-weight and affordable and paved the way for an Information–Communication–Entertainment age. While silicon almost completely replaced compound semiconductors from these markets, it has been unable to compete in areas with more stringent requirements due to technology limitations. One of these areas is automotive radar sensors, which will enable next-generation collision-warning systems in automobiles. A low-cost implementation is absolutely essential for widespread use of these systems, which leads us to the subject of this book—silicon-based solutions for automotive radars.

This book presents architectures and design techniques for millimeter-wave automotive radar transceivers. Several fully-integrated transceivers and receivers operating at 22–29 and 77–81 GHz are demonstrated in both CMOS and SiGe BiCMOS technologies. Excellent performance is achieved indicating the suitability of silicon technologies for automotive radar sensors.

The first CMOS 22–29-GHz pulse-radar receiver front-end for ultra-wideband radars is presented. The chip includes a low noise amplifier, I/Q mixers, quadrature voltage-controlled oscillators, pulse formers, and variable-gain amplifiers. Fabricated in 180 nm CMOS, the receiver achieves a conversion gain of 35–38.1 dB and a noise figure of 5.5–7.4 dB.

Integration of multi-mode multi-band transceivers on a single chip will enable next-generation low-cost automotive radar sensors. Two highly-integrated silicon ICs are designed in a 180 nm BiCMOS technology. These designs are also the first reported demonstrations of mm-wave circuits with high-speed digital circuits on the same chip.

The first mm-wave dual-band frequency synthesizer and transceiver, operating in the 24 and 77 GHz bands, are demonstrated. All circuits except the oscillators are shared between the two bands. A multi-functional injection-locked circuit is used after the oscillators to reconfigure the division ratio inside the phase-locked loop. The synthesizer is suitable for integration in automotive radar transceivers and heterodyne receivers for 94 GHz imaging applications. The transceiver chip includes a dual-band low noise amplifier, a shared downconversion chain, dual-band pulse formers, power amplifiers, a dual-band frequency synthesizer, and a high-speed programmable baseband pulse generator. Radar functionality is demonstrated using loopback measurements.

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