Preface

There are continuous efforts focussed on improving road traffic safety worldwide. Numerous vehicle safety features have been invented and standardized over the past decades. Particularly interesting are the driver assistance systems, since these can considerably reduce the number of accidents by supporting drivers' perception of their surroundings. Many driver assistance features rely on radar-based sensors. Nowadays the commercially available automotive front-end sensors are comprised of discrete components, thus making the radar modules highly-priced and suitable for integration only in premium class vehicles. Realization of low-cost radar front-end circuits would enable their implementation in inexpensive economy cars, considerably contributing to traffic safety.

Cost reduction requires high-level integration of the microwave front-end circuitry, specifically analog and digital circuit blocks co-located on a single chip. Recent developments of silicon-based technologies, e.g. CMOS and SiGe:C bipolar, make them suitable for realization of microwave sensors. Additionally, these technologies offer the necessary integration capability. However, the required output power and temperature stability, necessary for automotive radar sensor products, have not yet been achieved in standard digital CMOS technologies. On the other hand, SiGe bipolar technology offers excellent high-frequency characteristics and necessary output power for automotive applications, but has lower potential for realization of digital blocks than CMOS.

This work presents the design, implementation, and characterization of microwave receiver circuits in CMOS and SiGe bipolar technologies. The applicability of a standard digital 0.13 μm CMOS technology for realization of a 24 GHz narrow-band radar front-end sensor is investigated. The unlicensed industrial, scientific and medical (ISM) frequency band at 24 GHz is particularly interesting for radar applications, due to its worldwide availability and the possibility of inexpensive packaging in this frequency range.

The low-noise amplifier (LNA) and mixer receiver building blocks have been designed in CMOS and bipolar technologies. These building blocks have been integrated into receiver and transceiver front-ends. The performance stability of the circuits is compared over a very wide temperature range from -40 to 125 °C. Additionally, ESD protection techniques are considered. Further, advanced modeling and de-embedding techniques, required for accurate circuit characterization, are investigated. The presented circuits are suitable for automotive, industrial and consumer applications, as e.g. lane-change assistant, door openers or alarms.

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