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A Wideband Monolithic Up-Conversion Mixer with On-Chip Active Baluns

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Abstract

In this paper, a wideband monolithic up-conversion mixer for RF front-end transmitter is designed and fabricated using 0.8 μm SiGe HBT process technology. This mixer is implemented on chip using LO/RF wideband matching circuits, LO/IF input balun circuits, and RF output balun circuit. The measured results of the fabricated mixer show positive power conversion gain from 1 GHz to 6 GHz, bandwidth of 4.5 GHz, LO isolation (LO to IF isolation and LO to RF isolation) between 27 dB and 45 dB, OIP3 between -2 dBm and -12 dBm, current consumption of 29 mA for 3.0 V supply voltage. The chip size of the fabricated mixer is 2.7 mm X 1.6 mm.

I. INTRODUCTION

The rapid growth of wireless communication services has now been extended to higher frequencies and creates an increasing demand for low-cost, low-power, high-integration RF sub-systems in different types of communication systems.

The SiGe hetero-junction bipolar transistor (HBT) has been considered to be more suitable for RF integrated circuits than the Si bipolar junction transistor (BJT) because its electrical properties, such as current gain, power consumption, and small-signal unity-gain frequency, are superior to those of the Si BJT [1]. SiGe HBTs are playing a greater role in a variety of applications such as RF integrated chips, networking chips, etc.

Up-conversion mixers, which convert intermediate frequency (IF) signal to radio frequency (RF) signal, are very important building blocks within a radio system. Their performance affects the performance requirements of the entire system and the performance requirements of other building blocks. In up-conversion mixer, conversion gain and noise figure, which are key parameters for down-conversion, are not that important, because the baseband signal is usually fairly large. Especially, Because LO leakage is critical with up-conversion mixer, a differential mixer is needed to suppress the LO at the output. For RF-SoC, it is necessary that balun and matching circuits are integrated on RF chip. The balun performs conversion of signal between single-ended and balanced signals.

In this paper, a 1~6 GHz up-conversion mixer including LO/RF wideband matching circuits, LO/IF input balun circuits, and RF output balun circuit for wireless communication system is designed and fabricated on chip, using SiGe HBT process technology. The measured results of the fabricated mixer showed positive power conversion gain from 1 GHz to 6 GHz, bandwidth of 4.5 GHz, LO isolation between 27 dB and 45 dB, and OIP3 between -2 dBm and -12 dBm.

II. SIGE HBT STRUCTURE AND ITS CHARACTERISTICS

Performance parameters of SiGe HBT such as cut-off frequency (f_T), maximum oscillation frequency (f_{max}), minimum noise figure (NF_{min}) are critically dependent on not only the base thickness, but also the fabrication process. The standard SiGe HBT is shown in Fig. 1. We used RPCVD system to grow base epitaxial layer, and adopted LOCOS isolation to separate device and device terminals. The maximum values of measured f_T and f_{max} were 41 GHz and 42 GHz at V_{CE} = 2V, I_C = 1.83mA, respectively. Passive elements used in this paper were MIM capacitor, parallel-branch spiral inductor [2], and resistors composed of metal, emitter poly-silicon, and base poly-silicon.

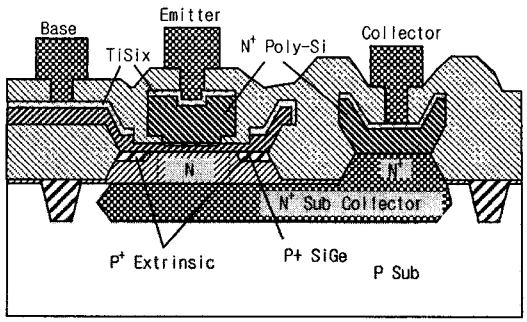

Fig. 1. Schematic of the SiGe HBT fabricated.