Optimized Buffer Analysis for Low Phase Noise in Differential LC-VCOs with InGaP/GaAs HBT Technology

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Abstract

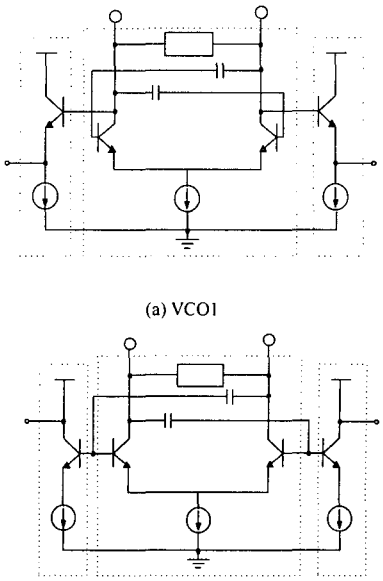
This paper focuses on the reduction of phase noise. Differential LC voltage controlled oscillators (VCOs) are designed using common-collector (VCO1) and common-emitter (VCO2) buffers and fabricated using a high linearity InGaP/GaAs HBT process. The output power and phase noise of the two oscillators were compared. The VCO1 has better phase noise performance than VCO2. This VCO1 has a tuning range of 260 MHz and an output power of -13.46 dBm at 1.708 GHz. Furthermore, the phase noise of this VCO is -110.5 dBc/Hz and -127.64 dBc/Hz at offset frequency of 100 kHz and 1 MHz, respectively. The size of both chips is 0.9 × 0.9 mm^2.

I. Introduction

An oscillator is an essential component for communication system, radar, and instrumentation for down conversion from RF to IF band. In these cases, local oscillation (LO) frequency with high output power is required. However, as the LO power is increased, the quality factor (Q) of the resonator is rapidly decreased and phase noise, which is generated by any local oscillator in the transmit/receive chain, is increased. These cause to data transmission errors [1, 2]. Recent investigations have been directed towards very low phase-noise designs in MMIC technology, especially those using HEMT and HBT devices [3]. In this paper, two fully differential LC VCOs with common-collector (VCO1) and common-emitter (VCO2) buffers are presented for use in an adaptive feedback-interference cancellation system (AF-ICS), which considered low phase noise. Both VCOs use a cross-coupled differential configuration that has been widely adapted in low gigahertz regimes due to its simplicity and differential operation [4].

II. Circuit Design

A 50-Ω load of oscillator is directly connected with the LC tank and the base of the core transistor. When testing with a spectrum analyzer, the Q of the LC resonator is significantly reduced. For this reason, an output buffer was added to the circuits.



(a) VCO1

(b) VCO2

Fig. 1. Schematic diagram of differential LC VCOs

Figure 1 shows schematic diagram of the VCO circuits The core of both circuits is based on the differential configuration with cross-coupled structure and the LC tank was used as a resonator. Transistors Q3 and Q4 are in the common-collector configuration for appropriate output impedance and reduction of the phase noise. On the other hand, Q7 and Q8 consist of common-emitter configuration to provide enough power for the mixer in AF-ICS