A low-phase noise source injection-coupled LC quadrature oscillator with tail noise filter

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Abstract

This paper presents a low phase noise source injection coupled quadrature oscillator (IC-QO). Like most of the works which have been presented for parallel coupled quadrature oscillators (PC-QO), the presented IC-QO using passive components like capacitance instead of noisy active devices with casualties for coupling the oscillator circuits that lead to elimination of the phase noise due to the coupling transistors. The presented IC-QO also uses the re-filtering technique of the sideband noise. Furthermore, the second harmonic of the tail current source suppressed by creating high impedance in the tail, which applied for the proposed IC-QO to be more noiseless. Reducing the noise frequencies around $2\omega_0$, leads to the amplitude of quadrature signals become larger and also the phase noise reaches to the lowest possible amount of noise level. To confirm, a 3.4 GHz proposed design of CMOS source injection coupled quadrature oscillator with LC noise filter structure in the tail is simulated. Using 0.18µm TSMC CMOS technology proved that the proposed structure with passive components and using LC filter shunted with tail current source exhibit a low phase noise of -157 dBc at 3MHz offset frequency and -187.2 dBc at 3GHz frequency. The obtained results show the agreement.

Key words: Injection Coupled, LC Quadrature Oscillator, RF CMOS, Passive Components, Phase Noise, Tail Noise Filter.

1. Introduction

Due to the demand for low cost, small form factor scale and large scale integration of system-on-chip (SoC) wireless transceivers, the image-reject, zero-IF and low-IF receiver architectures have become the main topologies used in mainstream wireless communication systems [1].

The performance of wireless communication systems is strongly depending on the quality of quadrature oscillator (QO). The most significant performance measures of QOs are phase noise, phase error and power consumption [2] which have major impacts on the overall receiver efficiency. There are several different methods to produce quadrature outputs such as RC-CR methods, polyphase filters [3], even-stage ring oscillators [4] and LC QOs. Among these methods, LC tank QOs are attractive, due to their low phase noise [5-9].These types of QOs usually consist of two coupled LC oscillators.

Different methods have been proposed to couple two CMOS LC tank oscillators. The first method is the parallel coupled QO (PC-QO), proposed by A.Rofougaran [10]. Series coupled QO (SC-QO) and source injection coupled QO (IC-QO) are other LC-tank quadrature