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A 25-GHz Differential LC-VCO In 18nm CMOS

ABSTRACT

A 25 GHz 18-nm CMOS differential voltage controlled oscillator with tail current source and passive LC filter is presented. Phase noise is -83.23 dBc/Hz at1 MHz offset, with a 1.1 V supply and a power consumption of 3.86 mW.

INTRODUCTION

In the beginning, we chose the basic VCO circuit which consists of LC tank, cross-coupled oscillator, and a tail current source, as illustrated in Fig.1. The LC tank generates the oscillation, and the differential pair forms a positive feedback and provides a negative resistance which compensate the energy loss of the LC tank. Fig.2(a) shows our first simulation in ADS. The FET current source is used because the best phase noise performance is achieved when the amplitude in the resonance tank is on the limit of being current limited. Fig.2(b) shows the output waveform. The phase noise is -114.248dBc/Hz.

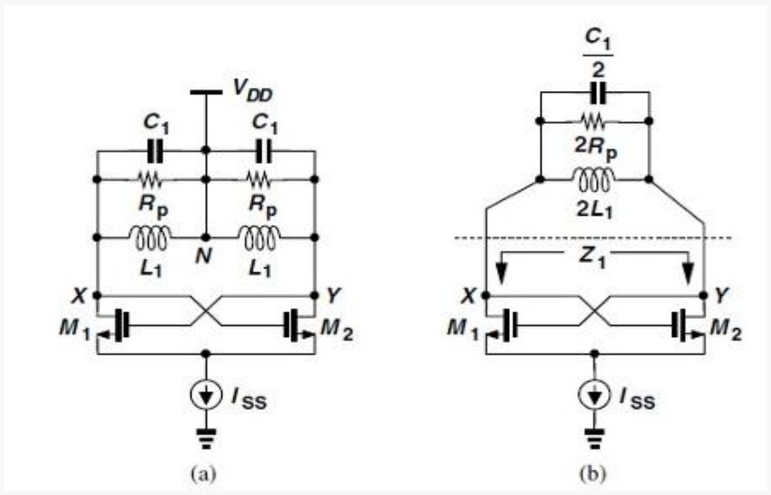

FIG. 1

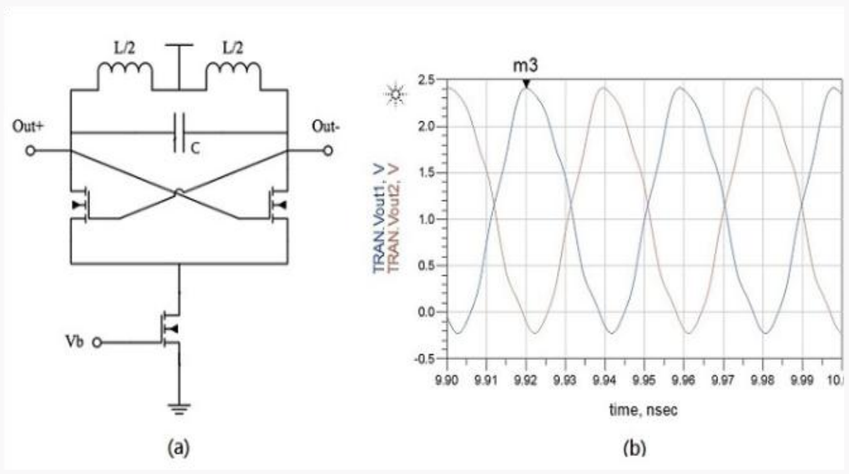

FIG. 2

After our analysis, the dominant noise is caused by the tail current source. In order to reduce the phase noise, we added a LC filter to the current source, as shown in Fig.3(a). A source inductor is used to resonate the parasitic of the source node at 2f0. And a capacitor in parallel with the current source shunts the high frequency noise from the current source to ground.

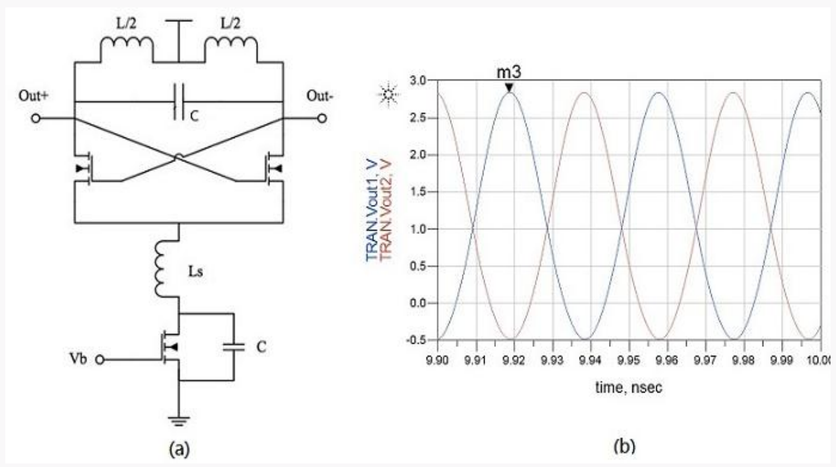

FIG. 3

The LC filter thereby prevents tail current noise at 2f0 from creating phase noise. Fig.3(b) shows the simulation result, the waveform looks nearly like a perfect sine wave, and the phase noise decrease to -129dBc/Hz.

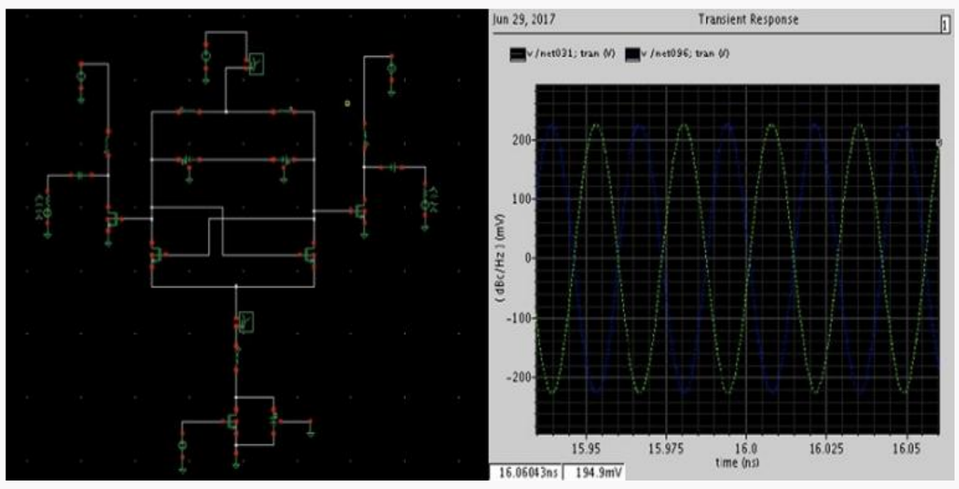

FIG. 4

Fig.4 shows the circuit diagram and simulation result after adding buffer at the output. The simulation is run on EDA cloud. On EDA cloud, we raised the frequency to 35GHz to avoid frequency from dropping after layout. In addition, we changed MOSFETs into TSMC 18nm model and used capacitors of TSMC instead. And the internal resistance of inductor is added. Since the circumstance is not ideal anymore, phase noise becomes -83.23dBc/Hz.

PERFORMANCE

	Process (CMOS)	Freq (GHz)	Power supply	Power consumption (mW)	Phase noise @1MHz (dBc/Hz)
Our work	0.18um	25	1.1V	3.86	-83.23
[1]	90nm	25.3	1.1V	6.6	-105.8
[2]	0.18um	22.6	1.7V	1.7	-95

[1] Markus Tormanen, Henrik Sjoland, “A 25-GHz differential LC-VCO in 90-nm CMOS”.

[2] Yen-Hung Kuo, Jeng-Han Tsai, Tian-Wei Huang, “A 1.7-mW, 16.8% frequency tuning, 24-GHz transformer-based LC-VCO using 0.18-μm CMOS technology”.