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Design of LC Oscillator and VCO for ISM and WI-FI Band Applications

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ABSTRACT
The last decade of this century has seen an explosive growth in the communicationsindustry. People want to be connected all the time using wirelesscommunication devices. In addition, the demand for high bandwidth communicationchannels has exploded with the advent of the internet.
Thanks to thehigh density available on integrated circuits, sophisticated digital modulationschemes can be employed to maximize the capacity of these channels. This haschanged the design of wireless and wire line transceivers. We focus on the designof a critical sub-block: the voltage controlled oscillator (LC oscillator, VCO). We reviewthe requirements for VCOs and evaluate the advantages and disadvantages ofVCO.
The proposed work is aimed to achieve the desired operating frequency, high stability. Power has become one of the most important paradigms for microprocessor & ASIC/SOC designs. Hence to have very low power consumption, this paper work is decided to implement using VLSI technology.

Keywords
LC oscillator, VCO (Voltage Controlled Oscillator),Microwind3.5, ISM (Industrial, Scientific and Medical radio bands), WI-FI Band.

1. INTRODUCTION
We have decided to study oscillators, because we were interested in this type of Structure as it is useful in many different types of electronic equipment. Their role is to create a periodic logic or analog signal (sinusoidal or not) with a stable and predictable frequency. They are used in different fields and especially in radio-frequency transmission in order to generate the carrying signals. We also need this structure to generate the main clock of processors. Moreover, there are many different types of oscillators.We chose to study LC oscillator and Voltage controlled oscillators.
Here our study particularly focuses on the frequency parameter.

2. DIFFERENTIAL LC OSCILLATOR
Differential LC oscillator the operating frequency is decided by the capacitor and inductor value.
The operating frequency is given by:

$$f_0 = \frac{\omega_0}{2\pi} = \frac{1}{2\pi\sqrt{LC}}$$

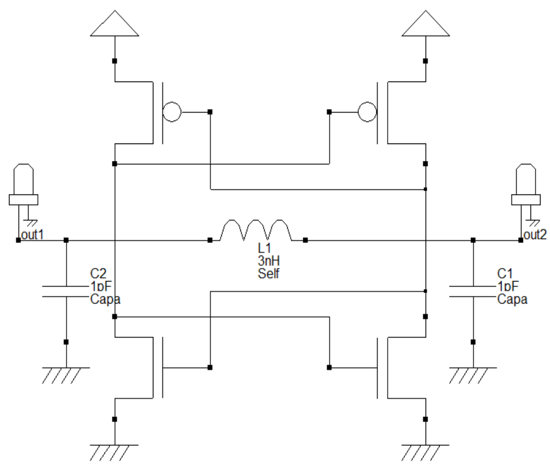

Fig 1: LC Oscillator schematic

Here, in our implementation layout as shown in fig.1, we added some virtual capacities and inductor because their values are easy to change during the simulation. Once the good values of the capacities and inductor were known, we could implement these components.[9]

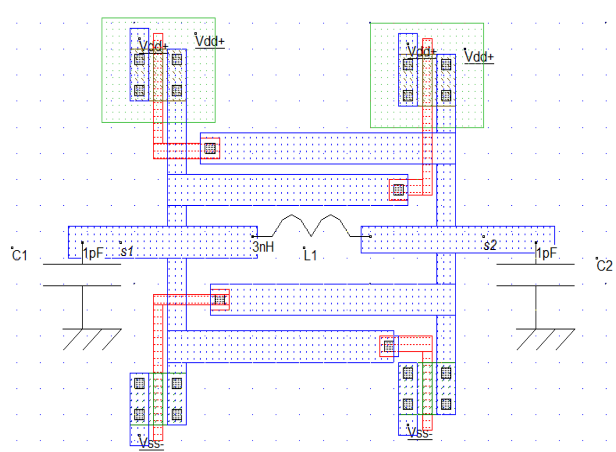

Fig.2: Implementation of LC Oscillator - Layout

Width: 9.1µm (151 lambda)
Height: 4.9µm (82 lambda)
Surf: 44.6µm2 (0.0 mm2)

The fig. 3 (a) showsthe simulation result of LC oscillator with its voltage Variation. Both the outputs oscillate and a permanent regime is reached after some eight nanoseconds (8 ns). A simulation model displays as in fig. 3 (b) shows the frequency variations versus time together with the voltage variations. We can notice on Fig. 3(b) that the frequency is stable around 4.05 GHz. This is an ISM band.

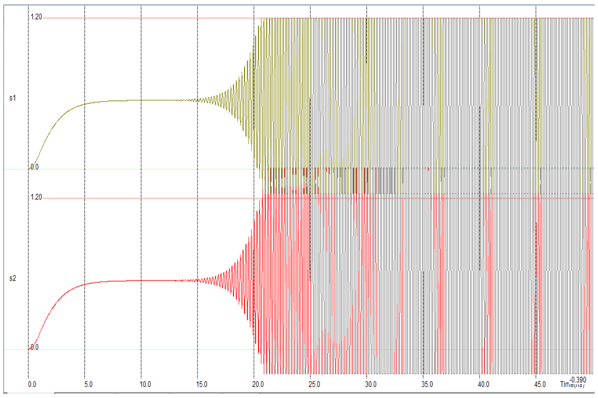

Fig.3 (a): Oscillator Frequency Variation

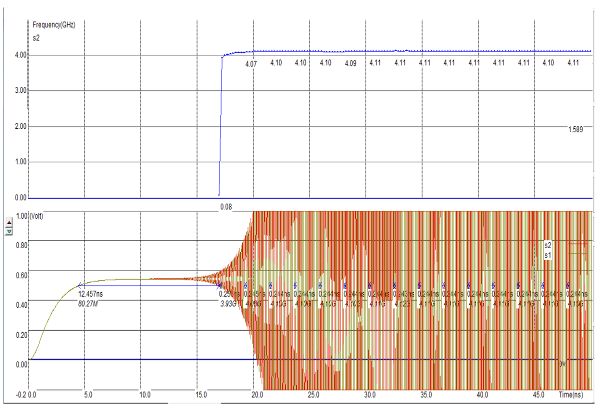

Fig.3(b): LC Oscillator Frequency and Voltage Variation

Fig: 3 (c) represents a Monte Carlo Simulation, which consists in studying frequency variation when Vdd is varying in a random way. We can easily conclude that any supply fluctuation has a significant impact on the oscillator frequency. [2][3]

In parametric analysis, we study the power dissipation on the particular node, paretic capacitance of the node. Montecarlo analysis pro window and observing variations on the frequency by changing the samples values to 20.

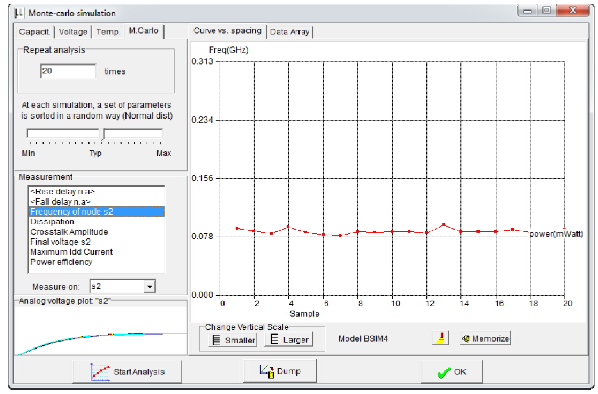

Fig. 3(c): Monte Carlo analysis (effect on frequency)

3. VOLTAGE CONTROLLED OSCILLATOR

A voltage-controlled oscillator or VCO is an electronic oscillator designed to be controlled in oscillation frequency by a voltage input. It generates a clock with a controllable frequency from -50% to +50% of its central value. Here in Fig. 4, we studied a current-starved VCO. The frequency of oscillation is varied by the applied DC voltage 'V_control' which is used to fix the current in NMOS as N1, N2, N3, N4 and PMOS as P1, P2, P3, P4. A change on V_control will modify the currents in the inverters and act directly on the delay.

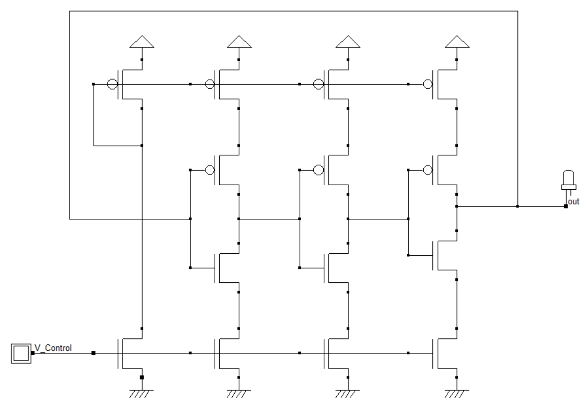

Fig 4: Voltage Controlled Oscillator Structure

Here, we have three inverters in the loop but it is possible to put more, it depends on the oscillating frequency required. The voltage variations of input signal 'V_control' and output signal 'Voltage_ctr_osc' are given in Fig.6. We chose to modify V_control very slowly, in order to see the influence on the oscillations. We put Control higher than 0.5 V, because there arenoanyoscillations under that value.

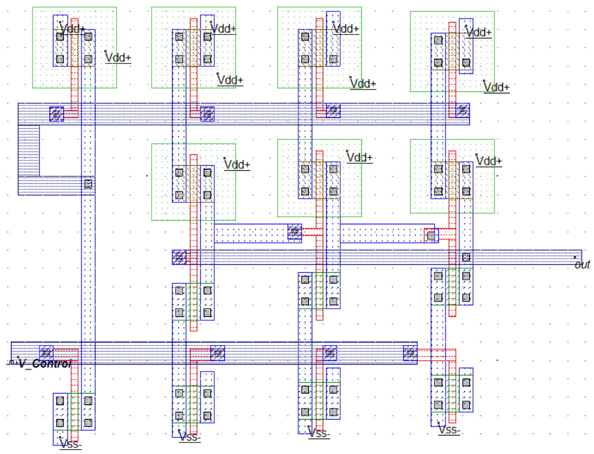

Fig 5: Implementation of Voltage Controlled Oscillator– Layout

Properties for the .MSK file provided above
Width: 9.8µm (163 lambda)
Height: 7.1µm (119 lambda)
Surf: 69.8µm2 (0.0 mm2)

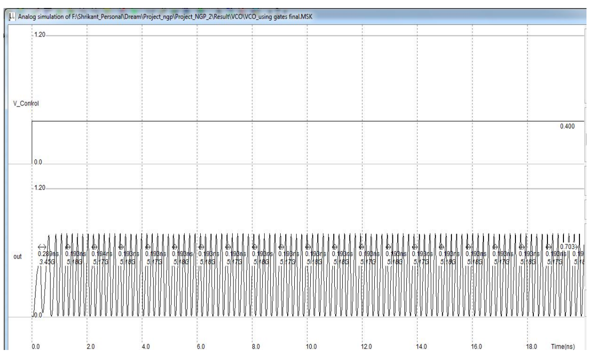

Fig.6 (a) : Voltage Variations of Input Signal 'V_control' andOutput signal 'Voltage_ctr_osc'

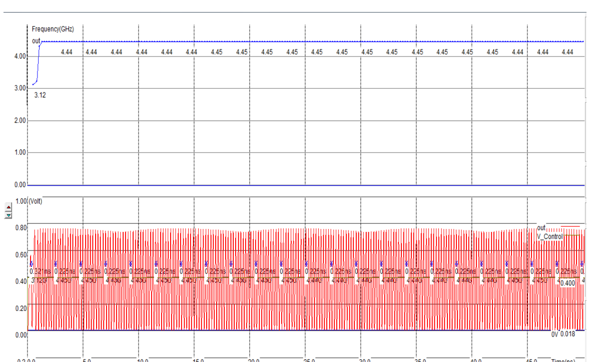

Fig.6 (b): Frequency and Voltage variation in VCO

Fig: 6 (c) represents a Monte Carlo Simulation, which consists in studying frequency variation when Vdd is varying in a random way. We caneasily conclude that any supply fluctuation has asignificant impact on the oscillator frequency. [2][3]

In parametric analysis we study the power dissipation on the particular node, paretic capacitance of the node. Montecarlo analysis window and observing variations on the frequency by changing the samples values to 20.

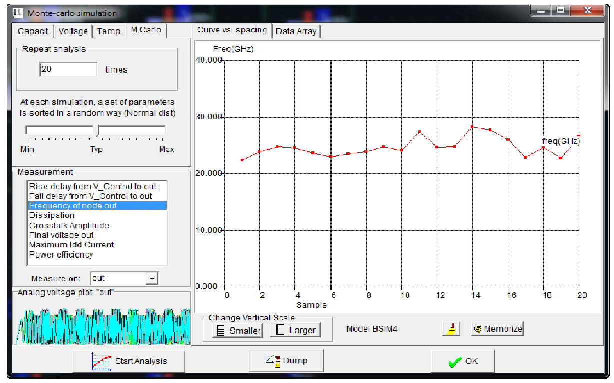

Fig.6(c): Monte Carlo analysis (effect on frequency)

As we can notice on Fig. 8, the oscillation frequency's variation is not linear. The maximum frequency upto 8.67 GHz is obtained when V_control is maximal. It is possible to modify these values by implementing more inverters.

Table 1. Key Features of 45 nm Technology

Mos Level parameters			
Parameter	**Definition**	**Typical Value 45nm**	
		NMOS	**PMOS**
VTO	Threshold Voltage	0.18V	-0.15 V
U0	Carrier Mobility	0.016 m2 /V-s	0.012 m2 /V-s
TOXE	gate oxide Thickness	3.5 nm	3.5 nm
PHI	Surface Potential	0.15 V	0.15 V
GAMMA	Bulk threshold Parameter	0.4 V^0.5	0.4 V^0.5
W	MOS Channel Width	80 nm minimum	80 nm
L	MOS Channel Length	40 nm minimum	40 nm

Table: Parameter of MOS level implemented

4. ANALYSIS

Oscillators are the important part of many electronics designs. As in VLSI area and power plays a vital role**.** Table will extract the both values.

Table2: Result Analysis

Parameters	**VCO**	**Differential LC**
Area	**69.8µm2**	**4.6µm2**
Power	**62.67µW**	**0.289mW**
No. of Gates	**14**	**4**

5. CONCLUSION

In this paper we simulated LC oscillator and voltage control oscillator using Microwind 3.5.

However, for our paper, we decided to use the ISM radio bands of frequency (Industrial, Scientific and Medical radio bands), which are not controlled by national regulations. Their use is free and we don't need any authorization for Industrial Scientific or Medical use. For example, we selected the 2.400 – 2.483 GHz band of frequency which is used by Bluetooth applications, and the 5.725 – 5.875 GHz band for WI-FI applications.

Here, we obtained an oscillation frequency around 8.35 GHz.

For digital and data applications fully integrated oscillators are being widely used. The use of fully integrated tuned oscillators is products. Performance concerns as well as large area still inhibit the widespread acceptance of integrated tuned oscillators.

With the advent of higher communication data rates and digital clock rates and the proliferation of wireless terminals the demand for integrated GHz oscillatorsis growing. The use of fully integrated tuned oscillators is only emerging in wireless products. Performance concerns as well as large area still inhibit the widespread acceptance of integrated tuned oscillators.

VLSI technology is the fastest growing field today. From the continuous survey it is observed that foundry of technology and supply voltage range is continuously decreases with the advancement of technology. By scaling down the technology, we can optimize the parameters like power consumption. The current technology up to 2008-2009 was 90 nm technology. Hence considering the advancement of future technology and the advantage of 45 nm technology over 65 and 90 nm technology, the selection of 45nm technology for the proposed project was the proper choice of technology.

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