IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 73-79

Design of Differential Ring Oscillator Implemented Using CMOS Technology

[1]S.S.Uparkar, Asst.Professor, Dept.of E&TC, [2]S.D.Jirapure, Asst.Professor,
[3]V.V.RathiAsst.Professor,
SipnaCOET, Amravati, India, 9028848742
suchitauparkar2511@gmail.com
Dept.of E&TC, SipnaCOET, Amravati, India, 9011324248
jirapure.smitu@gmail.com
Dept.of E&TC, Sipna COET, Amravati, India, 9763333202
vishal.rathi@gmail.com

Abstract: *A oscillator can be defined as an electronic circuit producing square or a sine wave as an output. The oscillator thus converts direct current (DC) to alternating current (AC) signal. Its applications are not confined to the generation of sinusoidal output signals but it is widelyused in radio and mobile communication applications. The paper focuses on the design and study of CMOS oscillators such as voltage controlled oscillators (VCO's).*
We have designed a VCO consisting of a multistage differential Ring oscillators .The design is verified and analysed by simulation process on both schematic and layout level in submicron process.
Keywords: *Voltage controlled oscillators, direct current, Alternating current, Differential Ring oscillators.*

I. Introduction

Voltage Controlled Oscillators (VCOs) are one of the indispensable element in all communication systems, wired or wireless. They appear in many analog and RF signal processing systems. Wireless and optical communication systems have shown a explosive growth during the last few years. This exponential growth has driven the need for more compact, cost-effective, fully integrated, low noise, low power voltage-controlled oscillator (VCO). Not only in communication systems but alsoVCOs are integral part of various biomedical applications. As the feature size getting smaller,[5] CMOS technologiesare becoming very attractive for the realization of high speed and high frequency ICs. Electronic industries have produced wide range of applications in the industries of telecommunication,biomedical appliances.Typically, the required computational power (or, in other words, the intelligence) of these applications is the driving force for the fast development of this field .The role of oscillators is to create a periodic logic or analog signal with a stable and predictable frequency. Oscillators are required to generate the carrying signals for radio frequency transmission, but also for the main clocks of processors. The output is equal to the input, and the phase difference is equal to one fourth of the period according to the phase Detector principles[3].

The Software Microwind 3.1 used in project allows us to design and simulate an integrated circuit at physical description level. The package contains a library of common logic and analog ICs to view and simulate. It also includes all the commands for a mask editor as well as original tools never gathered before in a single module such as 2D and 3D process view, Verilog compiler, tutorial on MOS devices. You can gain or access to Circuit Simulation by pressing one single key. The electric extraction of your circuit is automatically performed and the analog simulator produces voltage and current curves immediately

II. VCO Architecture

Design Of Voltage Controlled Oscillator (VCO)

Oscillators are required to generate the carrying signals for radio frequency transmission, but also for the main clocks of processors. The ring oscillator is a very simple oscillator circuit, based on the switching delay existing between the input and output of an inverter. VCOs are generally of the form of a ring oscillator, relaxation oscillator or a resonant oscillator. The ring oscillator, common in monolithic topologies takes the form of an odd number of inverters connected in a feedback loop.

If we connect an odd chain of inverters, we obtain a natural oscillation, with a period which corresponds roughly to number of elementary delays per gate. 5 stage ring oscillator

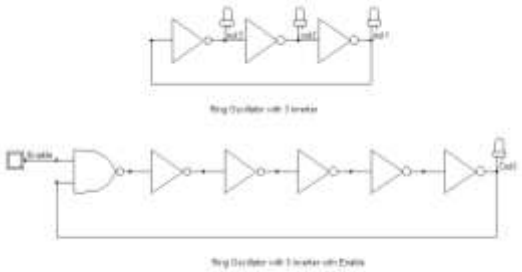

Figure 1.1 A ring oscillator is based on odd number of inverters

The voltage controlled oscillator (VCO) generates a clock with a controllable frequency. The VCO is commonly used for clock generation in phase lock loop circuits. The clock may vary typically by +/-50% of its central frequency. A current-starved voltage controlled oscillator is shown in fig 1.2.

The current-started inverter chain uses a voltage control Vcontrol to modify the current that flows in the N1, P1 branch. The current through N1 is mirrored by N2, N3, N4, N5 & N6. The some current flows in P1. The current Through P1 is mirrored by P2, P3 and P4. Consequent by the change in Vcontrol induces a global change in the inverter currents and acts directly on the delay.

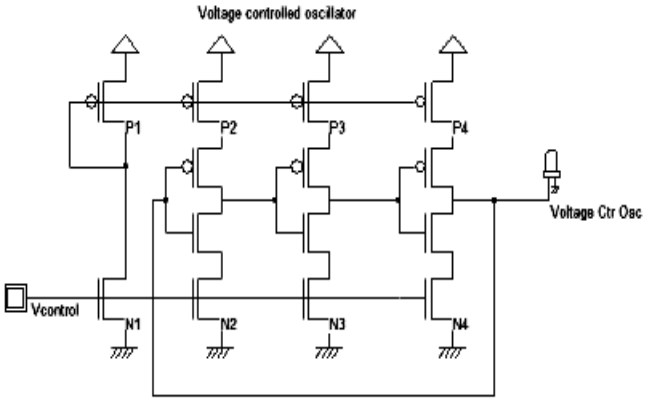

Figure1.2. Schematic diagram of a voltage controlled oscillator

The Bias circuit

In the design of VCO,the biasing circuit is one of the important circuit.It is known as the control circuit.The control voltage given to the bias circuit controls the frequency of the diffrential cell circuit.As the voltage changes the number of oscillation varies and thus the frequency also changes.Thus,we get the stable oscillations with a predictable frequency.The below figure 1.3 shows the schematic diagram of the bias circuit.

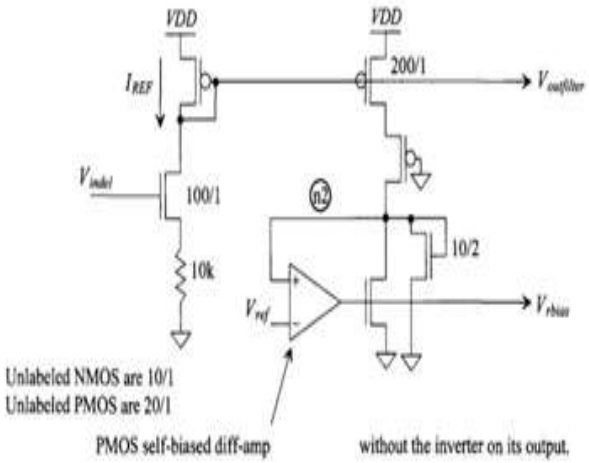

Figure 1.3 Schematic diagram of Bias circuit

Design of bias circuit

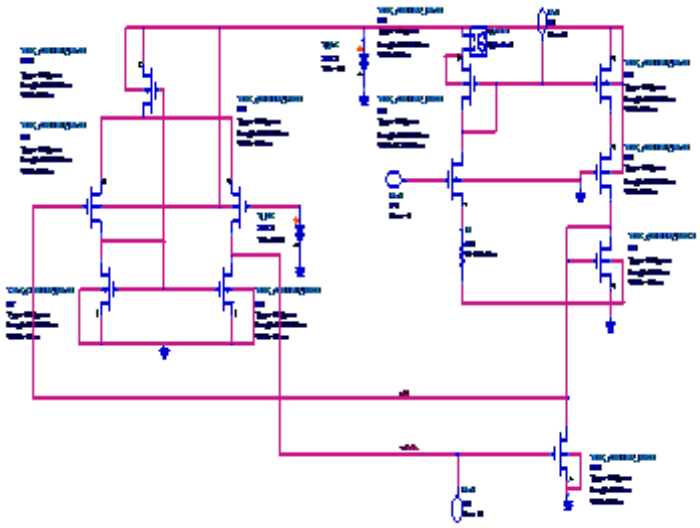

Figure 1.4 Design of bias circuit

Simulation Result

The given figure shows the simulation results for Bias circuit.

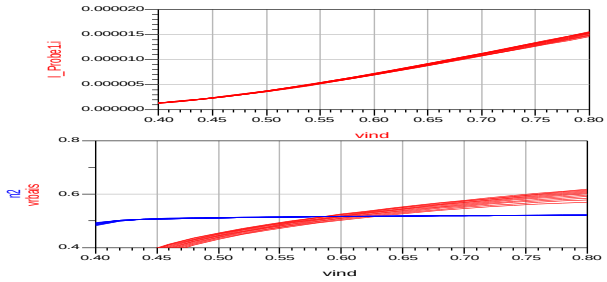

Figure 1.5 Simlulation Result

Design of VCO circuit using inverter

The VCO circuit is the fundamental part of Phase locked loop.It is designed by using 0.18micrometer technology.The VCO circuit is simulated with the help of Advanced design system version 2008 software and layout is drawn with the help of Microwind 3.1 software[17].The target frequency of VCO is 2GHz which is obtained with the help of circuit shown in fig5.9.The design of VCO with the help of inverter provides small circuitary low complexity and there is problem in developing oscillations so to overcome this problem we design VCO with help of differential amplifier as shown in fig.above[15].

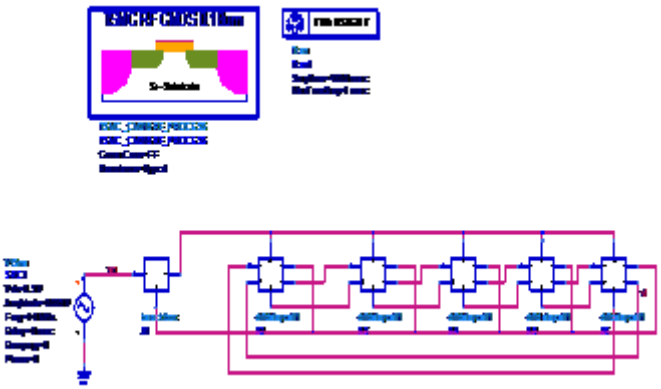

Figure 1.6 Design of VCO circuit

Simulation Result

The given figure shows the simulation results for VCO circuit

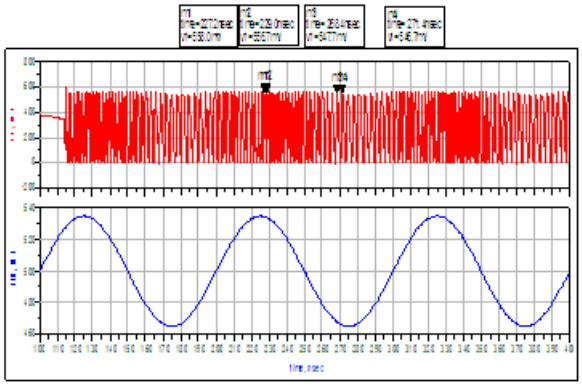

Figure 1.7 Simulation Result

VCO with Comparator as a buffer circuit

In this design of VCO circuit comparator is used as a output buffer. The buffer circuit can drive a substantially higher number of loads.It prevents the cirxcuit from overloading effect which helps the voltage controlled oscillator circuit to provide sustained oscillations.The following circuit shows the simulation results.

Design of VCO with comparator as a bufferx

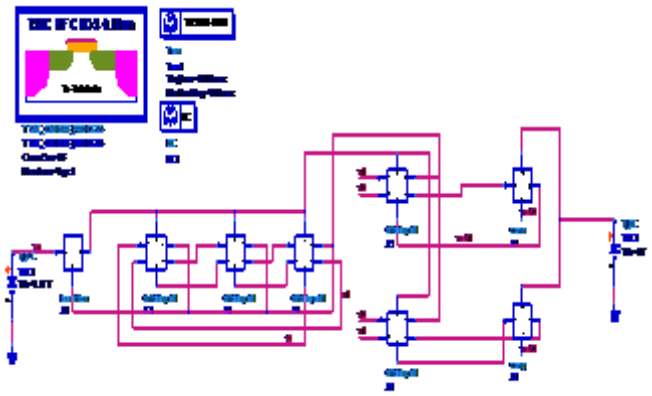

Figure1.8 Design of VCO with comparator as a buffer

Design of VCO using Differential Amplifier

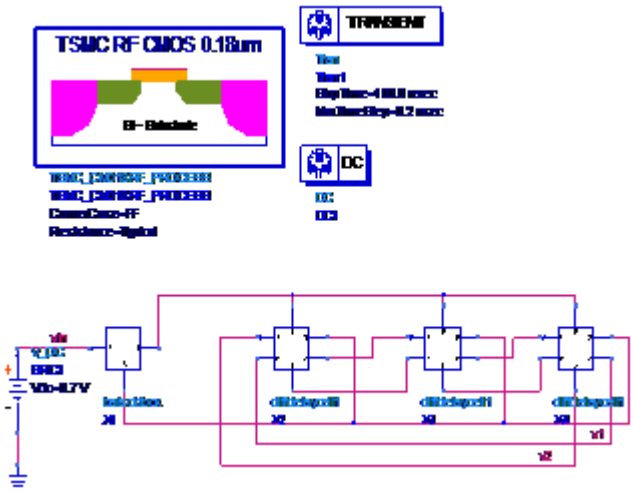

Figure 1.9 Design of VCO

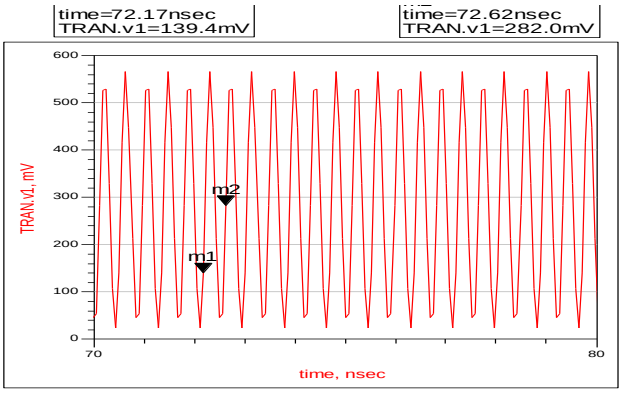

Figure 1.10 Simulation Result

Eqn freq1=1/(indep(m2)-indep(m1))

freq1
2.215 G

The aspect of *f* versus *Vt* is given in the following table:-
The table gives the idea about how the frequency changes with respect to change in voltage. Table 1 Variation OF frequency with respect to Voltage

Sr.No.	Voltage	Frequency
1	0.1V	2.500GHz
2	0.15V	2.500GHz
3	0.2V	2.500GHz
4	0.25V	2.500GHz
5	0.3V	2.500GHz
6	0.35V	2.500GHz
7	0.4V	2.500GHz
8	0.45V	2.500GHz
9	0.5V	2.500GHz
10	0.55V	2.500GHz
11	0.6V	2.525GHz
12	0.65V	2.293GHz
13	0.7V	2.215GHz
14	0.75V	2.845GHz
15	0.8V	2.338GHz
16	0.85V	2.384GHz
17	0.9V	2.283GHz
18	0.95V	2.167GHz
19	1V	2GHz

III. Results

The integration of inverter,analog mux,comparator and delay cell circuit forms a complete VCO circuit which is designed with the help of Microwind 3.1 software.The given figure shows the layout of VCO circuit

VCO Layout

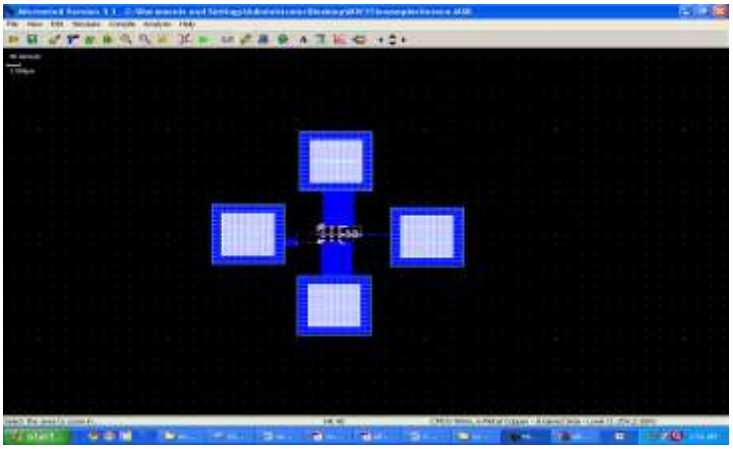

Figure2.1 Layout of VCO

The given figure shows the plot betweenVoltage and Time for VCO circuit.

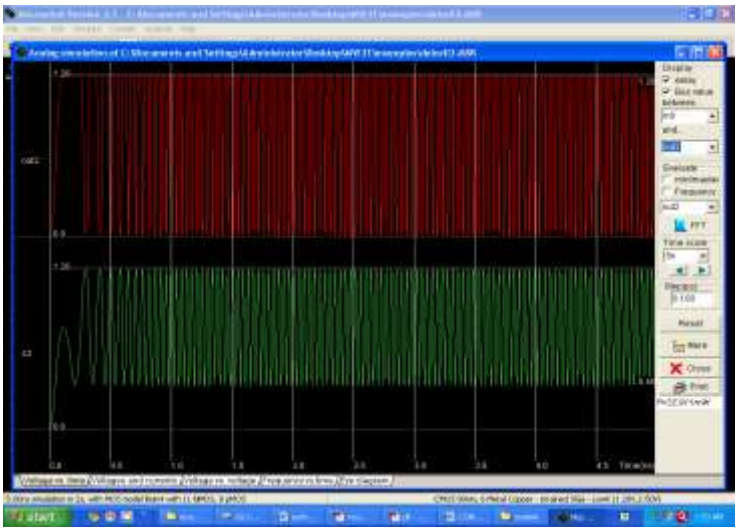

Figure2.2 Voltage vs Tim

The given figure shows the plot between Frequency and Time for VCO circuit

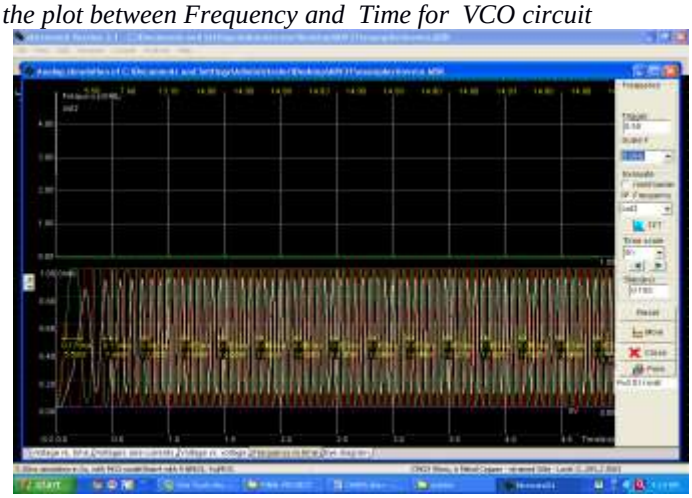

Figure2.3 Frequency vs Tim

APPLICATIONS:

1.As a Frequency generator.

VCO is voltage controlled oscillator and it operates at frequency 'fo'.Here a frequency deviation is directly proportional to the control voltage hence, it is called as voltage controlled oscillator.As it takes different values of control voltage and it thus produces different values of frequency.

2.In Phase locked loop circuit.

In PLL circuit, VCO is used to reduce the frequency difference between input frequency and output frequency 'fo'.Once the action starts we can say that signal is in capture range.VCO plays an important role in phase locked loop.It is basically possessing the properties of free running multivibrator.

3.In TV Remote controlling system.

In TV controlling system ,VCO is used for tuning to different channels having different frequency.As VCO provide different values of frequency according to change in control voltage.

Acknowledgment

We as Authors are always thankful to our hon'ble Principal and Head Dr.A.D.Gawande Sir for the continuous encouragement and support. We are also Thankful to our Guide Dr.A.A.Gurjar for being the ultimate source of inspiration. At last we are thankful to all our colleagues, Friends and family for being our support systems.

References

[1]. A CMOS VCO for lV, lGHz PLL Applications published in 2004 IEEE Asia-Pacific Conference on Advanced System Integrated Circuits(AF'-ASIC2004)/ Aug. 4

[2]. A Tail Current-Shaping Technique to Reduce Phase Noise in LC VCOs published in the Ninth International Conference on Electro Measuremen& Instrumentsof ICEMI'2009

[3]. Proceedings ofIC-BNMT20 10 A 0.18 micremeter Low Power CMOS radio frequency LC oscillator for broadband and wireless communication applications.

[4]. Low-power CMOS integrated circuits for radio frequency applications by M.J. Deen, R. Murji, A. Fakhr, N. Jafferali and W.L. Ngan

[5]. Design of Low-Phase-Noise CMOS Ring Oscillators IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—II: ANALOG AND DIGITAL SIGNAL PROCESSING, VOL. 49, NO. 5, MAY 2002 Liang Dai, *Member, IEEE,* and Ramesh Harjani, *Senior Member, IEEE*

[6]. R. Jacob Baker, 'CMOS Circuit Design, Layout, and Simulation', IEEE Press Series on Microelectronic Systems Stuart K. Tewksbury and Joe E. Brewer, Series Editors. 2009

[7]. A Multiply-by-3 Coupled-Ring Oscillator for Low-Power Frequency Synthesis IEEE JOURNAL OF SOLID-STATE CIRCUITS, VOL. 39, NO. 4, APRIL 2004 709 Shwetabh Verma, *Member, IEEE,* Junfeng Xu, and Thomas H. Lee, *Member, IEEE*

[8]. Phase Noise and Jitter in CMOS Ring Oscillators IEEE JOURNAL OF SOLID-STATE CIRCUITS, VOL. 41, NO. 8, 1803 Asad A. Abidi, *Fellow, IEEE* AUGUST 2006

[9]. A CMOS Frequency Synthesizer with an Injection-Locked Frequency Divider for a 5-GHz Wireless LAN Receiver Hamid R

[10]. Rategh, *Student Member, IEEE,* Hirad Samavati, *Student Member, IEEE,* and Thomas H. Lee, *Member, IEEE*

[11]. C. m. hung and k. o. kenneth A fully integrated 1.5V 5.5 GHz CMOS phase locked loop, IEEE j. solid state circuits,37(4): 521-525,april 2005

[12]. D. ham and A. Hajimiri. Concepts and methods in optimization of integrated LC VCOs IEEE j. solid state circuits,36(6):896-909,june 2004

[13]. S. Levantino C. Samori and v. Boccuzzi A -94dbc/Hz @ 100khz, fully integrated 5Ghz,cmos vco with 18% tuning range for bluetooth applications. In IEEE conf, custom integrated ckts conf, pages 201-204, 2006

[14]. Gardner,f . Charge pump phase lock loops , IEEE trans. Commun. Pp. 1849-1858, nov 2004

[15]. B. Razavi (ed.), *Monolithic Phase-Locked Loops and Clock Recovery Circuits*, IEEE jun 2000

[16]. Sevelto, F., Deantoni, S., and Castello, R.: 'A 1.3GHz low-phase noise fully tunable CMOS LC VCO', IEEE J. Solid-State Circuits,2000, 35, (3), pp. 356–361

[17]. C. Xu, W. Sargeant, K.R. Laker, J. Van der Spiegel,"Fully Integrated CMOS Phase Locked Loop with 30MHz to 2GHz locking range and k35ps jitter", Proc. of the 8th IEEE International Conference on Electronics,Circuits and Systems, September, 2001, Malta

[18]. A. Hajimiri, T. Lee,"Design Issues in CMOS Differential LC Oscillators,"*IEEE Journal of Solid-State Circuits*, Vol. 34, No. 5, May 1999. pp. 717-724.