ISSN: 2277-9655
Impact Factor: 1.852

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

# Wide-Band Single Stage Source Coupled CMOS Voltage Controlled Oscillator (VCO) using 0.18 µm CMOS Technology

**Rakesh Chaudhari[*1], Arpit Patel[2], Nilesh Patel[3], Amisha P. Naik[4]**

[*1]PG Student, Gujarat Technology University, Electronics and Communication, LCIT-Bhandu, Mehsana, Gujarat, India

[2]PG Student, Charotar University of Science & Technology , Electronics & Communication, CSPIT-Changa,Anand,Gujarat,India

[3]Research Scholar, [4]Associate Professor Institute of Technology, Nirma University, Ahmedabad, Gujarat, India

rakesh.me89@gmail.com

## Abstract

This paper describes a design and implementation of Single Stage Source Coupled CMOS Voltage Controlled Oscillator based on Ring Oscillator. Efforts are made to design a CMOS Voltage controlled oscillator having wide frequency range with High frequency, Low power. So, the CMOS VCO designed here having a Single Stage Source Coupled CMOS VCO. The design is optimization and simulates on TSMC 180nm CMOS process at 1.8 V supply voltages. The results show that the oscillation frequency of VCO varies between 78.46MHz to 287.93MHz and power consumption may varies between 0.03µW to 0.86µW.

**Keywords**: MentorGraphics; voltage controlled oscillator; ring oscillator; source coupled oscillator

## Introduction

` A CMOS voltage controlled oscillator is a critical building block in PLL which decides the power consumed by the PLL and area occupied by the PLL. Voltage Controlled Oscillator constitute a critical component in many RF transceivers and are commonly associated with signal processing tasks like frequency selection and signal generation.

RF transceivers of today require programmable carrier frequency and rely on phase locked loop to accomplish the same.These PLLs embed a less accurate RF oscillator in a feedback loop, whose frequency can be controlled with a control signal. Voltage controlled oscillators play a critical role in communication systems, providing periodic signals required for timing in digital circuits and frequency translation in radio frequency circuits. Their output frequency is a function of a control input usually a voltage. An ideal voltage-controlled voltage oscillator is a circuit whose output frequency is a linear function of its control voltage. Most application required that oscillator be tunable i.e. their output frequency be a function of a control input, usually a voltage.

In recent year, LC-tank oscillators have shown good phase-noise performance with low power consumption. However, there are some disadvantages. First, the tuning range of an LC-oscillator (around 10-20%) is relatively low when compared to ring oscillators (>50%). So the output frequency may full out of the desired range in the presence of process variation. Second, the phase-noise performance of the oscillators highly depends on the quality factor of on-chip spiral inductors.

## Source Coupled CMOS Technology

In a conventional ring oscillator designs, two or more delay elements are employed to satisfy the Barkhausen's oscillation frequency, the number of delay elements should be reduced. In the previous high oscillating frequency architectures, at least two delay cells are used to obtain a 180 phase shift.

MOS transistor is the voltage controlled device in which the current flowing between the source and drain is modified by the voltage applied on the gate terminal. P-Channel device is formed with two heavily doped P+ regions are called drain and source and are separated by a distance L. At the surface between the drain and source lies a gate electrode that is separated from the silicon by a thin dielectric material. Similarly N-channel transistor is formed by two heavily doped N+ regions with in a lightly doped P-substrate. As the gate voltage controls the flow of current through MOS device operates in triode and saturation region.

ISSN: 2277-9655
Impact Factor: 1.852

These circuits can be designed to dissipate less power than the ring oscillator and current-starved voltage controlled oscillator. The operation of the CMOS source coupled VCO in fig. 1 is load MOSFETs M3 and M4 pull the output. The MOSFETs M5 and M6 behave as constant current source sinking a current Id. MOSFETs M1 and M2 act as switches. MOSFET M1 is off and M2 is on, because the voltage of terminal out2 is larger than voltage of terminal out1. Therefore current through MOSFET M2 is 2Id and the capacitor will be changed by current Id, because constant source M6 sinking current Id.

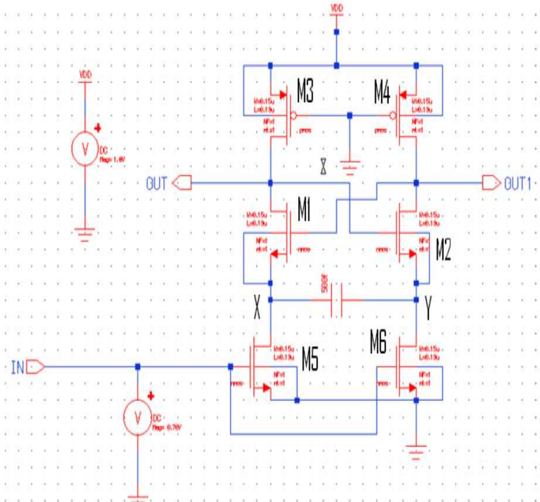


**Fig 1.CMOS Single Stage Source Coupled Voltage Controlled Oscillator**

When point X get down, M1 turn on and M2 turn off. The voltage of point X changed before switching took place the time it takes point X to change 2Vthn is given by,

$$\Delta t = c \; X \; 2 \; X \; \frac{Vthn}{Id} \qquad (1)$$

Since the circuit is symmetrical two of these discharge time are needed for each cycle of oscillator the frequency of oscillation is given by,

$$Fosc = \frac{1}{2} \; X \; \Delta t = \frac{Id}{4} \; X \; c \; X \; Vthn \qquad (2)$$

$$P = cv^2 f \qquad (3)$$

## Simulation Results

**Table I: Simulated Results for Source Coupled CMOS VCO in 180nm Technology**

| Control Voltage (V) | Oscillating Frequency (MHz) |
|---|---|
| 0.75 | 287.93 |
| 0.80 | 221.78 |
| 0.85 | 197.51 |
| 0.90 | 149.99 |
| 0.95 | 134.84 |
| 1.00 | 118.68 |
| 1.05 | 96.46 |
| 1.10 | 83.33 |
| 1.15 | 78.46 |

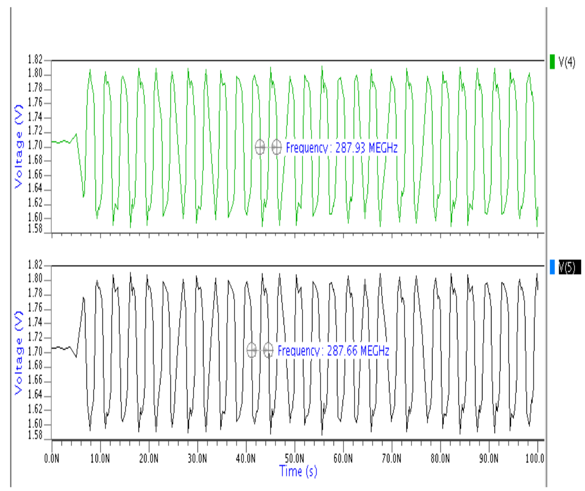


**Fig2: O/P W/F for 0.75V Controlled Voltage of SC VCO of 180nm technology.**

**Table II: Summary of Results for Source Coupled CMOS VCO.**

| **Specifications** | **Proposed Work** | **Ref. [5]** |
|---|---|---|
| Supply Voltage(V) | 1.8 | 1.8 |
| Technology | 0.18μm | 0.18μm |
| Input Tuning Range(V) | 1.15-0.75 | 1.15-0.70 |
| Output Tuning Range(MHz) | 78.46-262.21 | 26.315-110.132 |
| Power Dissipation(μW) | 0.03-0.63 | 5.903 |

## Conclusion

In this paper shows the single stage source coupled CMOS voltage controlled oscillator simulated in ELDO SPICE simulator having high oscillation frequency and low power dissipation. The oscillator can be used for low-voltage low-power application.

## *References*


[1] *Rashmi K Patil, M.A.Gaikwad,"Area Efficient Wide Frequency Range CMOS Voltage Controlled Oscillator for PLL in 0.18μm CMOS Process" International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 2, Issue4, July-August 2012, pp.1696-1699.*

[2] *Rashmi K Patil, Vrushali G Nasre,"A Performance Comparison of Current Starved VCO and Source Coupled VCO for PLL in 0.18μm CMOS Process"ISSN 2277-3754 , International Journal of Engineering and Innovative Technology Volume 1,Issue 2,February 2012.*

[3] *Amit Tripathi1, Dr. Rajesh Nema,"A Low Power Consumption Single Stage Source Coupled CMOS Voltage Controlled Oscillator (VCO) Using 0.18 μm CMOS Technology" ISSN 2250-2459, International journal of Emerging Technology Advanced Engineering, Volume 2,Issue 11,November 2012.*

[4] *Yaayue Dai,Jinfang Zhou,Boyu Nie,Kangsheng Chen, "A 60GHz voltage –controlled oscillator with a 3.6GHZ Tuning Range in 180nm CMOS Technology 2009 IEEE 978-1-4244-4669-8/09*

[5] *Harvinder Singh Saluja, Abhishek Choubey, Abhishek Jain,"A Single Stage Coupled VCO in 0.18 um CMOS Technologies with Low Power Consumption" ISSN 2249-6343 International Journal of Computing Technology and Electronics Engineering, Volume 1,Issue 2.*

[6] *Siti Maisurah M.H, A.Marzuki , Mohd Azmi I , A.I. Abdul Rahim , Mohamed Razman Y,"Design of 900MHz voltage controlled oscillator using 180nm CMOS technology, 2008 IEEE 1-4244-2561-7/08*

[7] *B. P. Panda, P. K. Rout, D. P. Acharya and G. Panda,"Design of a Novel Current Starved VCO via Constrained Geometric Programming"International Symposium On Devices MEMS Intelligent Systems Communications 2011 April 12-14, 2011,Sikkim ISSN 0975-8887.*