DESIGN OF VOLTAGE CONTROLLED OSCILLATOR IN 90 NM CMOS TECHNOLOGY

by

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A comprehensive project progress report has been submitted in partial fulfilment of the requirements for the degree of

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Abstract-

Voltage Controlled Oscillator is the heart of the many modern electronics as well as communication system. Hence there is necessity of VCO to operate in the GHz frequency range. This project describes a design and implementation of Five Stage Current Starved CMOS Voltage Controlled Oscillator for Phase Locked Loop. Current starved VCO is simple ring oscillator consisting of cascaded inverters. The proposed circuit is implemented in a 90nm CMOS technology. By varying the control voltage of VCO from 0.5 to 4.5V, the tuning range from 81.85 MHz-2.433GHz is attained. The Phase Noise at 2.4 GHz offset frequency is -89.0307 dBc/Hz. This project focuses on design of Low Power Consumption, High frequency range of VCO. Current Starved Voltage Controlled Oscillator had been designed in GPDK 180 nm CMOS Technology with supply voltage 1.1V using CADENCE spectre tool. Virtuoso Analog Design Environment tool of Cadence have used to design and simulate the schematic for the post-layout of the schematic.

INTRODUCTION

CMOS is also sometimes referred to as complementary symmetry metal oxide semiconductor (or COS-MOS). The words "complementary-symmetry" refer to the fact that the typical digital design style with CMOS uses complementary and symmetrical pairs of p-type and n-type metal oxide semiconductor field effect transistor (MOSFETs) for logic functions. A voltage controlled oscillator or VCO is an electronic oscillator designed for producing oscillation frequency by a controlled input voltage. The frequency of oscillation is varied by the applied controlled voltage.

A voltage controlled oscillator or VCO is an electronic oscillator designed for producing oscillation frequency by a controlled input voltage. The frequency of oscillation is varied by the applied controlled voltage. A VCO plays a vital role in communication system, providing a periodic signal required for digital circuit and also a frequency transmission in digital circuit. Their output frequency is a function of control input voltage. An ideal VCO is a circuit whose output frequency is a linear function of its control voltage. Most of the application as required a variable control input voltage as they required different frequency.

Phase locked loops (PLLs) are common applications for VCOs based frequency synthesizer is usually used in RF transceivers. PLLs can be used for clock generations, such as in a microprocessor, clock andData recovery, such as in an optical transmission system, or frequency synthesis, such as in a wireless radio. The general characteristic for VCOs used in PLL is wide tuning range so that the entire frequency range is covered. Also the phase noise requirement of the VCO can be loosened due to that when the loop is locked, the noise generated by the VCO at the center of oscillation frequency will be filtered out by the loop bandwidth. As a result, PLLs generally use wide tuning range and noisier ring topology VCO.

The voltage controlled oscillator (VCO) plays a very important role in communication systems due to low power consumption, wide frequency range of operation and its high integration capability. It is an electronic device that uses amplification, feedback, and a resonant circuit to generate a repeating voltage waveform at a particular frequency. The frequency, or rate of repetition per unit time, is variable with an applied voltage. VCOs are important integral part of phase locked loops, clock recovery circuits, frequency synthesizers and in almost all digital and analog systems.

The application requirements of VCO include high frequency, low power consumption, phase stability, large electrical tuning range, linearity of frequency on the control voltage, less area, low cost and large gain factor. The design of ring VCO involves tradeoffs in terms of area, speed, power, frequency and different application domain.

CIRCUIT DESCRIPTION

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. The frequency of oscillation is varied by the applied DC voltage "Vcontrol". Current Starved VCO is a type of VCO based on ring Oscillator with extra CMOS acting as current source for the inverters.

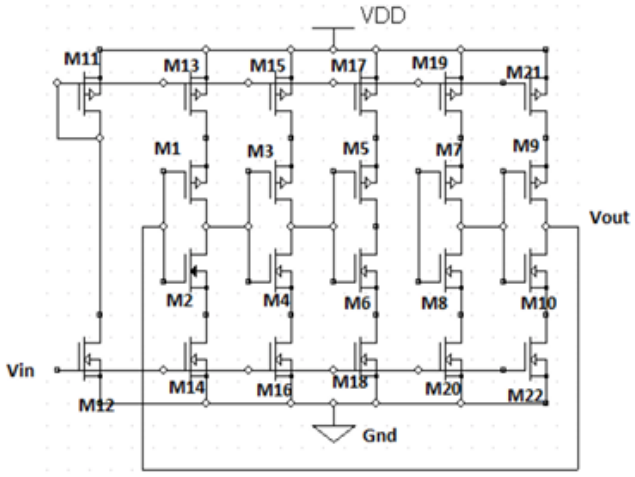
OPERATION:

A ring oscillator is comprised of a number of delay stages, with the output of the last stage fed back to the input of the first. This current starved VCO is designed using ring oscillator and its operation is also similar to that. From the schematic circuit shown in the Figure 7, it is observed that MOSFETs M1 and M2 operate as an inverter, while MOSFETs M13 and M14 operate as current sources. The current sources, M13 and M14, limit the current available to the inverter M1 and M2. In other words, the inverter is starved for the current. The MOSFETs M11 and M12 drain currents are the same and are set by input control voltage. The currents in M11 and M12 are mirrored in each inverter/current source stage. The upper PMOS transistors are connected to the gate of M11 and source voltage is applied to the gates of all low NMOS Transistors. The bias circuit is used to provide correct polarization for transistor M13 and M14. The benefit of this configuration is that the oscillation frequency can be tuned for a wide range by changing the value of control voltage.

To determine the design equations for use with the current-starved VCO total capacitance on the drains of M1 and M2 is given by

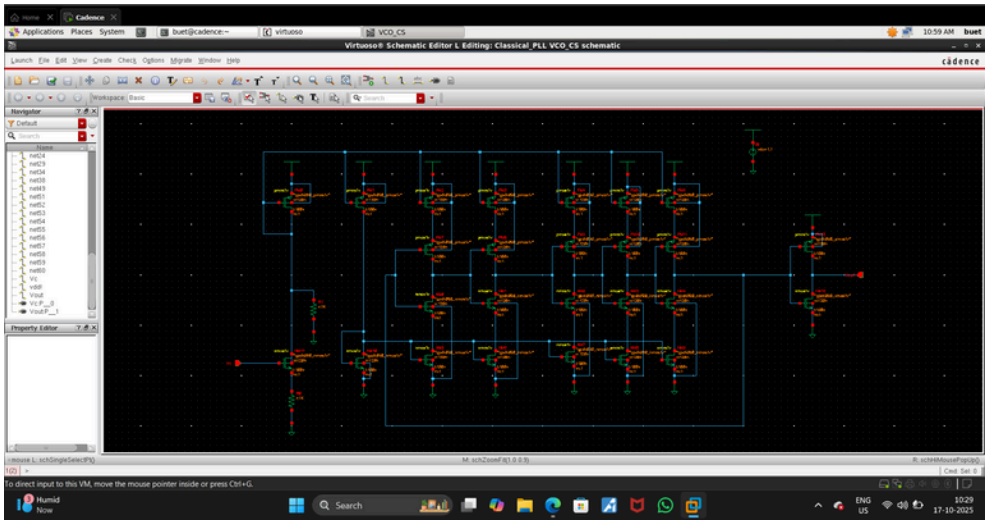
$$C_{tot}=C_{out}+C_{in} \qquad (2.1)$$

$$C_{tot}=C_{ox}*(W_pL_p+W_nL_n)+(3/2)*C_{ox}*(W_pL_p+W_nL_n)$$

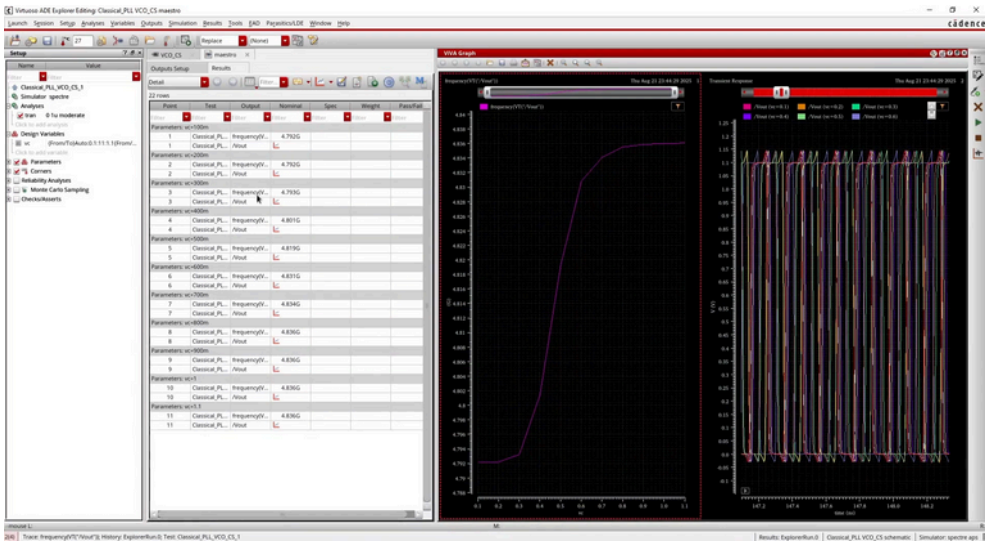


PRELAYOUT DESIGN AND OUTPUT

The heart of the PLL circuit is the voltage controlled oscillator. The circuit is designed to give a center frequency of oscillation of 2.4GHz. The frequency of oscillation of the output signal for the different input control voltage is mentioned in the Table 3. The center frequency of oscillation at an input control voltage of 1.8 V. The schematic view of VCO &the output signal of the VCO.



OUTPUT OF VCO



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