

Research Migration Project

National Institute of Technology Rourkela

Name of the participant : Krishnendu Roy

Title of the circuit : Design and Implementation of a Current Starved CMOS Voltage Controlled Oscillator Using eSim

Abstract:

This project focuses on the design and simulation of a Current Starved Voltage Controlled Oscillator (VCO) using 180 nm CMOS technology. The VCO is designed to operate in the GHz frequency range with a tuning range of 0.88 GHz to 2.429 GHz . The circuit is implemented using the eSim, and the design aims to achieve low power consumption, high frequency stability, and a wide tuning range. This document outlines the purpose, working principles, and simulation results, showcasing the performance and efficiency of the designed VCO.

Keywords: VCO, CMOS, Current Starved, eSim.

Introduction :

A Voltage Controlled Oscillator (VCO) is a critical component in modern electronic systems, particularly in communication systems, frequency synthesizers, and phase-locked loops (PLLs). The VCO generates a periodic signal whose frequency is controlled by an input voltage. This project focuses on designing a Current Starved VCO using 180 nm CMOS technology, which is known for its low power consumption and high integration capability. The goal is to achieve a wide frequency range and low power consumption.

Theory/Description :

The Current Starved VCO is based on a ring oscillator structure, consisting of an odd number of inverter stages connected in a loop. The current available to each inverter is limited by additional MOSFETs acting as current sources. This current limitation allows the oscillation frequency to be controlled by varying the input control voltage.

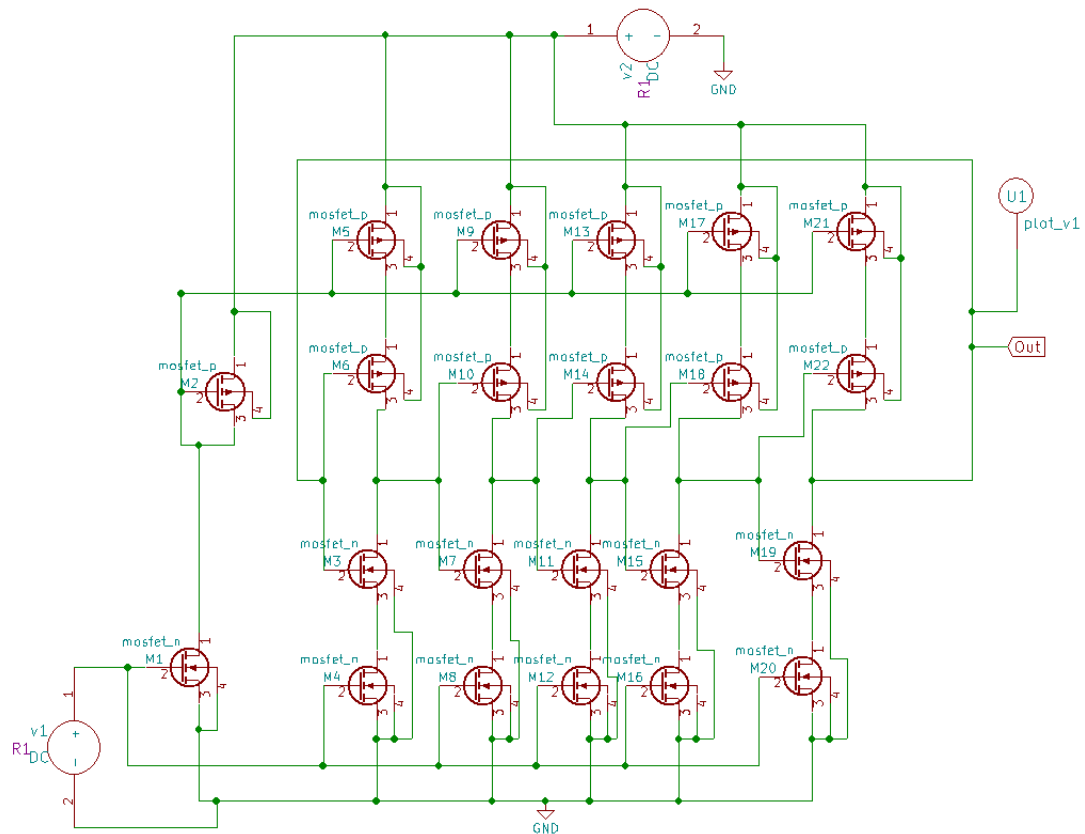
The oscillation frequency (F_{osc}) is determined by:

$$F_{osc} = \frac{I_d}{N \cdot V_{dd} \cdot C_{tot}}$$

Where:

- I_d = Drain current,
- N = Number of stages,
- V_{dd} = Supply voltage,
- C_{tot} = Total capacitance at the inverter output.

Circuit Diagram(s) :

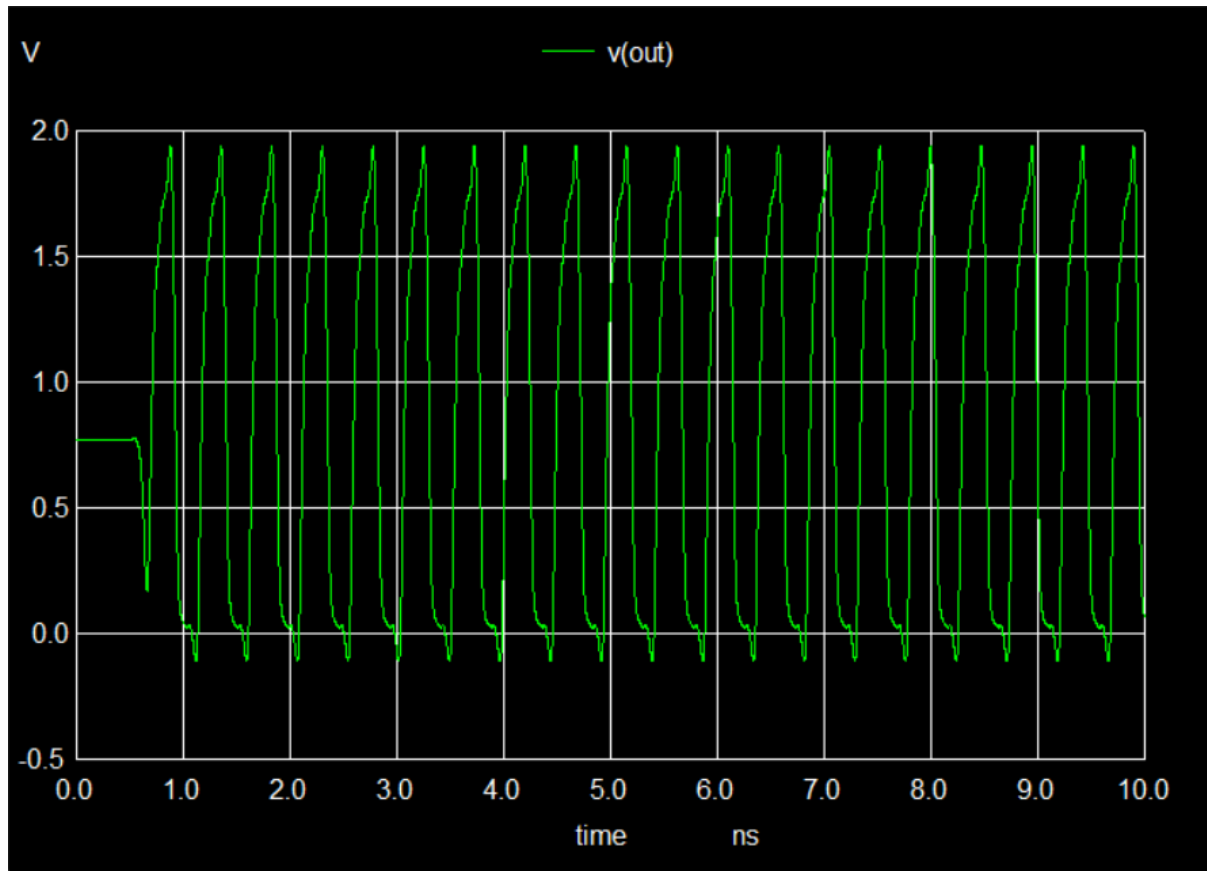


Device Name	Device Type	Aspect Ratio(um/nm)
M2,M5,M9,M13,M17,M21	PMOS	2/180
M6,M10,M14,M18,M22	PMOS	1/180
M3,M7,M11,M15,M19	NMOS	1/180
M1,M4,M8,M12,M16,M20	NMOS	2/180

Aspect ratio of MOSFET

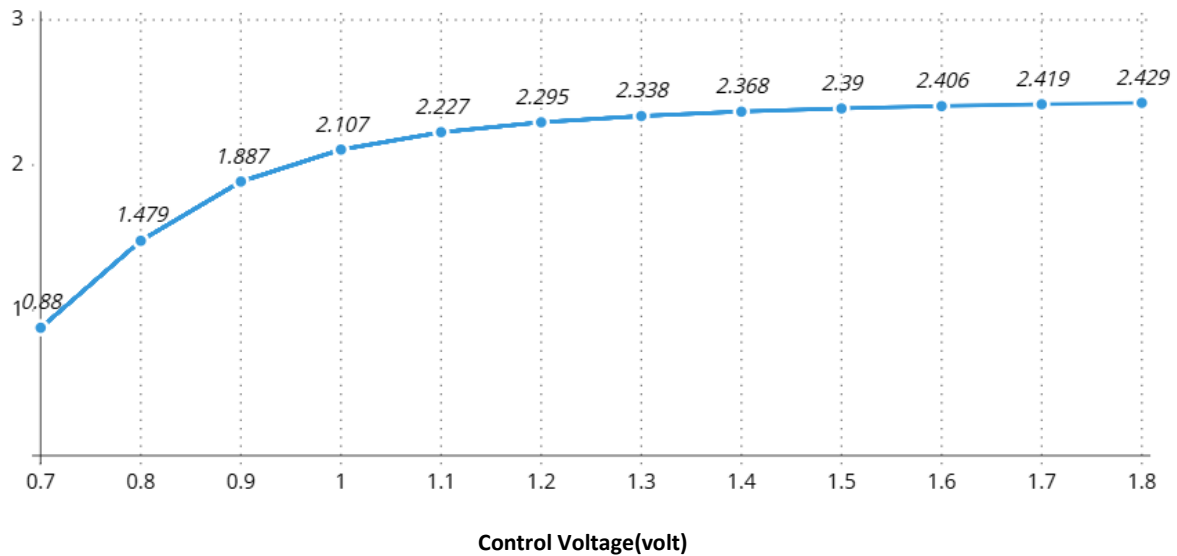
Results (Input, Output waveforms and/or Multimeter readings) :

1. For $v_1=1V$ and $v_2=1.8V$



Control Voltage(Volt)	Frequency(Hz)
0.7	0.88 G
0.8	1.479 G
0.9	1.887 G
1	2.107 G
1.1	2.227 G
1.2	2.295 G
1.3	2.338 G
1.4	2.368 G
1.5	2.39 G
1.6	2.406 G
1.7	2.419 G
1.8	2.429 G

Control Voltage vs Frequency



Graphical Representation of Output Frequency (GHz) VS Control Voltage

Conclusion :

The design and simulation of the Current Starved VCO in 180 nm CMOS technology were successfully implemented using eSim. The circuit achieved the desired frequency range and low power consumption validating its performance. This project highlights the practical application of VCOs in communication systems, demonstrating their effectiveness in generating stable and tunable frequency signals with high precision.

Source/Reference(s) :

Title: Design of Voltage Controlled Oscillator in 180 nm CMOS Technology

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