A Comparative Study and Performance Analysis of CMOS based Low Power Voltage Controlled Ring Oscillator

DISSERTATION - II

Submitted In partial fulfilment of the
Requirement for the Award of the
Degree of

MASTER OF TECHNOLOGY
IN
Electronics and Communication Engineering

By

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Under the Esteemed Guidance of

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MAY 2017

DECLARATION

I hereby declare that the work presented in this Dissertation entitled “A Comparative study and performance analysis of cmos baseSd low power voltage controlled ring oscillator” in partial fulfillment of the award of degree of M. Tech (Electronics and Communication Engineering), submitted at department of Electronics and Communication Engineering, Lovely Professional University, Phagwara is an authentic record of my own work, carried out during the period since August, 2016 to April, 2016 under supervision of Sandeep Dhariwal. The matter presented in this Dissertation has not been submitted in any other University/Institute for the award of M. Tech Degree or any other Diploma/Degree.

Signature of the Student

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Signature of the Supervisor

Dr. Sandeep Dhariwal

The M. Tech Viva- Voce Examination of Priyanka Sharma has been held on and accepted.

Signature of H.O.D

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Lovely Professional University, Phagwara.

CERTIFICATE

This is to certify that the Dissertation entitled **"A Comparative study and performance Analysis of CMOS based low power voltage controlled Ring oscillator"** is a record of bonafied work carried out by **Priyanka Sharma** under my guidance and supervision for the partial fulfillment of the degree of Master of Technology in Electronics and Communication Engineering during the academic session August 2016 – April 2017 at Lovely Professional University – Phagwara.

To the best of my Knowledge , the results embodied in this Dissertation work have not been submitted to any university or institute for the award of any degree or diploma.

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ABSTRACT

In our thesis we presents the comparison of diferent types of voltage controlled ring oscillator. Firstly,Oscillator is defined as an electronic device which is used to produce a signal and it efforts the concept of oscillation. What do you mean by oscillation? Oscillation is nothing only a fluctuation or also say that a periodic fluctuation between two objects on different energy. There are various things in which oscillators are used, some of the examples are: wrist watch as well as clock watch, computers etc. Oscillation is a periodic fluctuation means the simple example of oscillators are clock pendulum. It produces a signal on transmitters, Receivers, computers or also music systems. The oscillators are works on some frequency which is determined by the Quartz crystal.

Voltage controlled oscillator is an oscillator in which the output is connected to the input or we can say that oscillator whose output is managed by an input. VCO is very important part in vlsi design. Oscillator are of many types but in this thesis we concentrate only ring oscillator. Ring oscillator are of two types single stage ring oscillator and differential stage ring oscillator.

In this works we presents the different types of VCO's and compare them by its power find transient analysis, after that those circuit which has best power the different technique are added on that circuit because our motive is to reduce the power as low as possible. The comparison of five circuits are done in 180 nm technology and the circuit which has highest power and the technique based circuits are done in 45 nm technology and 180 nm technology and compare both the circuits find its power , frequency. This works are done in cadence virtuoso tool.

CONTENTS

Chapter-I

Introduction

Voltage controlled oscillator is defined as an oscillator,and in VCO there is an oscillation frequency and this oscillation frequency is maintained by an input. In VCO the output is connected to the input, now there is one input and one output and in the input a signal is applied which justify the two modulations, a phase and the frequency modulation. There is a great relationship between a voltage controlled oscillator and the phase locked loop, they both are almost same or may be ay that VCO are included in a phase locked loop. PLL or Phase locked loop is simply an circuit in which the voltage tries to manage the same frequency of an input. Any circuit which has a large number of noise communication in which all the data has been obstructed. Then, in this circuit PLL find the noise then filter after filtering the noise they remake the circuit without any noise communication.

Basically, VCO are of two types:

Linear oscillator: Linear oscillator is an oscillator in which mostly value of a system or device oscillates more or less than the overall value at one, two or more than two value of frequency. Linear oscillator are also known as harmonic oscillator. Let us take an example suppose, there is a spring which is in rest position and we push or pull a spring then the result is after push or pull the spring there is a force which push back in order to obtain its rest position. Harmonic oscillator produces an AC waveform or also called sinusoidal waveform.

Relaxation oscillator: Unwinding oscillator is an oscillator which delivers a triangular waveform or square waveform. It is a non straight oscillator and this oscillator create a less number of parts which are utilized for outer segments and deliver wide scope of frequencies. Incorporated circuits are as often as possible utilized as a part of this oscillator. Presently, this oscillator has three unique sorts : first is the VCO which has capacitor grounded, second is the vco which has producer coupled and last is the ring vco which depend on deferral. In this unwinding oscillator the initial two sorts which are vco which has capacitor grounded and vco which has producer coupled their capacities are same however the last one which is the ring vco which depend on postponement are distinctive. Since in this sort , the phases in which pick up is incorporated are associated in a ring. That is the reason its called Ring vco which depend on postponement.

Consonant oscillator VCOs have these preferences over unwinding oscillators:

•Frequency dependability concerning temperature, clamor, and power supply is vastly improved for symphonious oscillator VCOs.

•They have great precision for recurrence control since the recurrence is controlled by a precious stone or tank circuit.

.**Voltage Controlled Crystal Oscillator**

A voltage-controlled gem oscillator (VCXO) is utilized for fine modification of the working recurrence. The recurrence of a voltage-controlled gem oscillator can be fluctuated a couple of several sections for every million (ppm), in light of the fact that the high Q variable of the precious stones permits "pulling" over just a little scope of frequencies.

There are two purposes behind utilizing a VCXO:

• To alter the yield recurrence to match or maybe be some correct different of an exact outer reference.

• Where the oscillator drives gear that may create radio-recurrence impedance, adding a fluctuating voltage to its control info can scatter the obstruction range to make it less questionable.

A temperature remunerated VCXO (TCVCXO) joins segments that incompletely redress the reliance on temperature of the thunderous recurrence of the gem. A littler scope of voltage control then suffices to balance out the oscillator recurrence in applications where temperature differs, for example, warm development inside a transmitter

Setting the oscillator in a temperature-controlled "stove" at a steady yet higher-than-encompassing temperature is another approach to balance out oscillator recurrence. High dependability precious stone oscillator references frequently put the gem in a stove and utilize a voltage contribution for fine control The temperature is chosen to be the turnover temperature: the temperature where little changes don't influence the reverberation. The control voltage can be utilized to at times modify the reference recurrence to a NIST source. Modern outlines may likewise change the control voltage after some time to make up for gem maturing.

Chapter- 2

Study of Oscillators

2.1 Introduction

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2.2 The Basic Oscillators

An oscillator can be considered as an intensifier that gives itself (through criticism) with an info flag. By definition, it is a nonrotating gadget for delivering substituting current, the yield recurrence of which is dictated by the attributes of the gadget. The basic role of an oscillator is to create a given waveform at a consistent pinnacle abundancy and particular recurrence and to keep up this waveform inside specific points of confinement of plentifulness and recurrence

2.2.1 Requirement for an Oscillator

a) First, enhancement is required to give the vital pick up to the flag. Each oscillator has no less than one dynamic gadget. This dynamic gadget goes about as an intensifier. A speaker gives a yield that is a copy of the information and is fit for enhancing at the recurrence of intrigue.

b) Second, adequate regenerative criticism is required to support motions. In an oscillator, a part of the yield is nourished back to support the contribution, as appeared in Figure 2.1.Enough power must be sustained back to the information circuit for the oscillator to drive itself as does a flag generator. To make the oscillator act naturally determined, the input flag should likewise be regenerative (positive). Regenerative signs must have enough energy to adjust for circuit misfortunes and to look after motions

c) Third, a recurrence deciding gadget or a resonator is expected to keep up the coveted yield recurrence. This gadget goes about as a channel, enabling just the coveted recurrence to pass. The resonator may contain transformers or other impedance changing segments, for example, coupling capacitors. Without a recurrence deciding gadget, the stage will sway in an arbitrary way, and a steady recurrence won't be kept up.

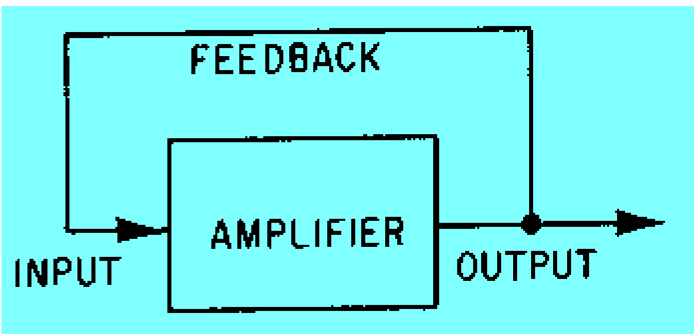

Figure 2.1 Basic oscillator block diagram

Wavering happens when an enhancer is outfitted with a criticism way that fulfills two conditions:

• Amplitude Condition - The fell pick up and misfortune through the speaker/criticism arrange must be more noteworthy than or equivalent to solidarity.

• Phase Condition - The recurrence of wavering will be at the point where circle stage move sums 360 (or zero) degrees.

The oscillator circle pick up is given by:-

$Af = A/(1-A\beta)$… … (2.1)

where Af = increase after input, A= open circle pick up and β = criticism figure

The pick up Af will be boundless when the circle pick up $A\beta$ is solidarity and the stage move is 360°. This is known as the Barkhausen basis for swaying in a positive input circuit. For a negative criticism circuit we require a stage move of 180° and these sort of circuits are utilized as a part of CMOS oscillator plans.

In most oscillator circuits, swaying develops from zero when power is first connected, under straight circuit operation. Be that as it may, restricting speaker immersion and other non-direct impacts wind up shielding the oscillator's adequacy from working up inconclusively. There will be no yield when power is at first connected, however regardless of the possibility that the speaker were sans commotion, clamor would in any case be created in the resonator at the full recurrence. This clamor will be connected to the contribution of the enhancer where it will be opened up and nourished back in stage at the full recurrence and further increased, developing each time. Inevitably the flag will make as far as possible, guaranteeing that the oscillator yield control in the long run crests, for the most part at the soaked yield energy of the intensifier. The fundamental oscillator necessities, notwithstanding the application, decide the sort of oscillator to be utilized. The components that record for the many-sided quality and remarkable attributes of oscillators are portrayed beneath.

2.3 Oscillator Stability

Oscillator dependability can be partitioned into long haul and here and now. Long haul soundness is the moderately moderate change in recurrence with time; it can be measured effortlessly utilizing a recurrence counter. Here and now steadiness is for exceedingly little eras and must be measured in the recurrence space utilizing a range analyzer or stage clamor measuring hardware. Here and now security is examined under oscillator clamor. Long haul soundness is a basic parameter to look at.

2.3.1 Amplitude Stability and Frequency Stability

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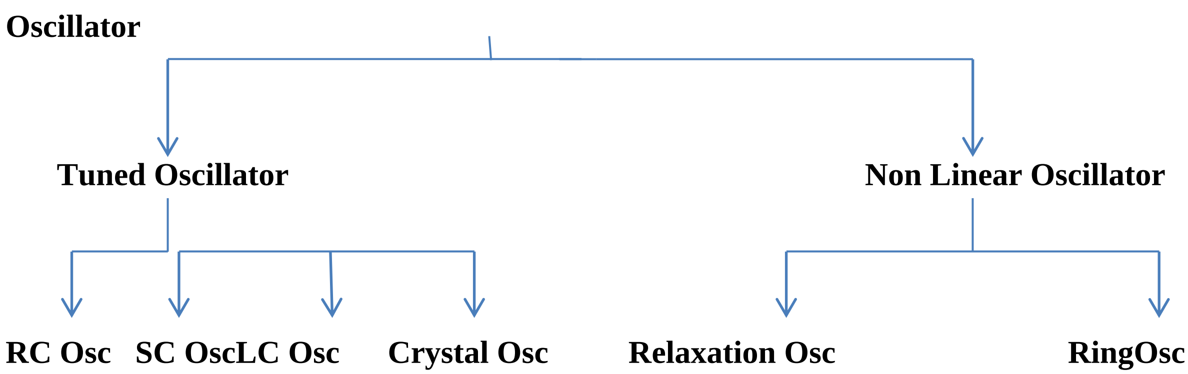


Figure 2.2 Classification of Oscillator

2.5.1 Linear or Tuned Oscillator

These utilize a positive criticism circle comprising of an intensifier and a RC or LC recurrence specific system. The abundancy of produced sine waves is constrained, or set utilizing a nonlinear system, executed either with a different circuit or utilizing the nonlinearities of the intensifying gadget itself. These circuits which produce sine waves using reverberation wonders, are known as straight oscillators or sinusoidal oscillators moreover.

2.5.2 Non Linear Oscillator

Circuits that create square, triangular, beat waveforms are called nonlinear oscillators or capacity generators. These are fundamentally nonsinusoidal oscillators which utilize circuit building pieces known as multivibrator. Unwinding and ring oscillators additionally fall under this classification.

2.6 Classification of Oscillators relying on their Waveshapes

Oscillators are ordered by the waveshapes they create and the prerequisites required for them to deliver motions. Oscillators can be arranged into two general classifications as indicated by their yield waveshapes as beneath

• Sinusoidal Oscillators

• Nonsinusoidal Oscillators

2.7 Sinusoidal Oscillators

A sinusoidal oscillator creates a sine-wave yield flag. In a perfect world, the yield flag is of consistent abundancy with no variety in recurrence. How much the perfect is drawn nearer relies on such elements as class of intensifier operation, speaker qualities, recurrence soundness, and adequacy solidness. Sine-wave generators create signals running from low sound frequencies to ultrahigh radio and microwave frequencies. There are three sorts of sinusoidal oscillators which are as underneath

• RC Oscillators

• LC Oscillators

• Crystal-Controlled Oscillators

2.7.1 RC Oscillator

Electronic oscillators are frequently planned around a LC tank circuit, a tuned circuit framed with an inductor and a capacitor. The tuned circuit can likewise be worked by utilizing just resistors and capacitors. Some low-recurrence generators utilize resistors and capacitors to shape their recurrence deciding systems and are alluded to as a RC oscillators. They are generally utilized as a part of the sound recurrance go. Three setups of RC oscillators are normal which are talked about underneath.

a) Wien Bridge Oscillator

It is a kind of electronic oscillator that creates sine waves without having any info source. It can yield an extensive scope of frequencies In this circuit, two RC circuits are utilized, one with the RC segments in arrangement and one with the RC segments in parallel. This is regularly utilized as a part of sound flag generators since it can be effortlessly tuned utilizing a two-area variable capacitor. The recurrence of swaying is given by:

$f = 1/(2\pi RC)$… … (2.2)

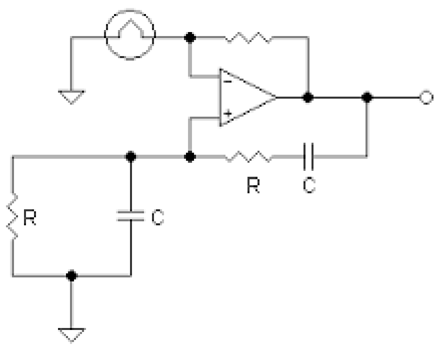


Figure 2.3 Circuit of wien bridge oscillator

a) Phase Shift Oscillator

It is a straightforward sine wave electronic oscillator. It contains a modifying enhancer, and an input channel which "moves" the stage by 180 degrees at the swaying frequency.The channel must be composed so that at frequencies above and underneath the wavering recurrence, the flag is moved by either pretty much than 180 degrees. This outcomes in valuable superposition for signs at the oscillation frequncies, and dangerous superposition for all other frequencies.The most regular method for accomplishing this sort of channel is utilizing 3 fell resistor-capacitor channels, which create no stage move toward one side of the recurrence scale, and a stage move of 270 degrees at the flip side.

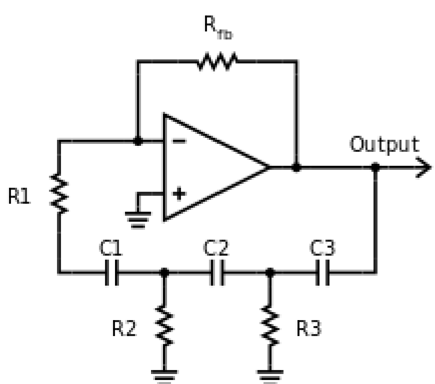


Figure 2.4 Circuit of Phase shift oscillator

In the above figure, if R1 = R2 = R3 = R, and C1 = C2 = C3 = C, then:

fOscillation = $1/(2\pi RC\sqrt{6})$…………………………..(2.3)

and Oscillation criteria: Rfeedback = 29R

Twin-T Oscillator

The second normal outline is known as a "Twin-T" oscillator as it uses two "T" RC circuits worked in parallel. One circuit is a R-C-R "T" which goes about as a low-pass channel. The second circuit is a C-R-C "T" which works as a high-pass channel. Together, these circuits frame an extension which is tuned at the coveted recurrence of wavering. In the event that they are to create an undistorted sine wave, RC oscillators ordinarily require some type of abundancy control. Numerous basic outlines basically utilize a brilliant light in the input circuit. These oscillators exploit the way that the resistance of the tungsten fiber increments in extent to its temperature. Worked well underneath the time when the fiber really enlightens, expanded adequacy of the input flag causes expanded current stream in the fiber in this manner expanding the resistance of the fiber. The expanded resistance of the fiber lessens the criticism flag, constraining the oscillator's flag to the direct range. (That is, cut-out is anticipated.) Moresophisticated oscillators measure the yield level and utilize this as criticism to control the pick up of the voltage-controlled speaker inside the oscillator. On the off chance that the abundancy indicator has a level recurrence reaction, then this negative input of the sufficiency estimation will guarantee that the oscillator has a steady yield plentifulness regardless of what recurrence it is set to produce.

2.7.2 LC Oscillator

Another sort of sine-wave generator utilizes inductors and capacitors for its frequencydetermining system. This sort is known as the LC Oscillator. LC oscillators, which utilize tank circuits, are usually utilized for the higher radio frequencies. They are not reasonable for use as amazingly low-recurrence oscillators on the grounds that the inductors and capacitors would be expansive in size, overwhelming, and exorbitant to produce. There are a few setups for LC oscillators .

The most widely recognized are the Hartley, Colpitts and Clapp oscillators.

Hartley Oscillator

It is a LC electronic oscillator that gets its criticism from a tapped loop in parallel with a capacitor (the tank circuit). A Hartley oscillator is along these lines a sort of inductively coupled variable recurrence oscillator. Hartley oscillators might be arrangement or shuntfed.The wavering recurrence in hertz(cycles every second) for the circuit in the figure 2.5 is

$f=1\div 2\pi\sqrt{L_{eq}C}$… … … .2.4

where $L_{eq} = L1+L2+2M$ and M is the shared coupling between inductors L1 and L2.

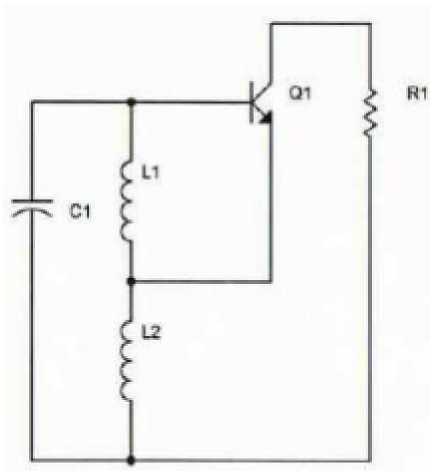


Figure 2.5 Circuit of Hartley LC Oscillator

Advantages

• Frequency varied using a variable capacitor

• Output amplitude remains constant over the tunable frequency range

• Feedback ratio of tapped inductor remains constant

Disadvantages

• Harmonic-rich content

• Not suitable for a pure sine wave

a) Colpitt Oscillator

It is to some degree like the shunt sustained Hartley circuit aside from the way that as opposed to having a tapped inductor, it uses two arrangement capacitors in its LC circuit. With the Colpitts oscillator the association between these two capacitors is utilized as the inside tap for the circuit. The wavering recurrence in hertz (cycles every second) for the circuit in the figure 2.6, is

$$fo = \frac{1}{2\pi\sqrt{LCeq}} \quad \ldots\ldots 2.5$$

where Ceq = C1 C2 /(C1+ C2) [25]

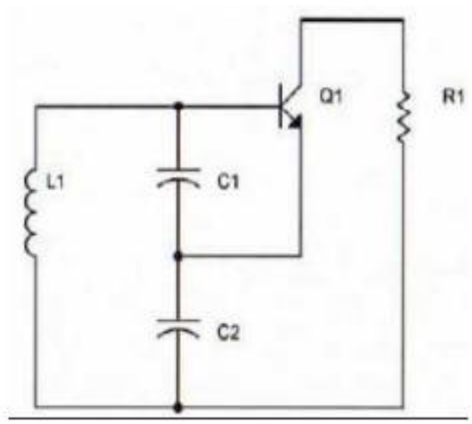


Figure 2.6 Circuit of Colpitt LC Oscillator

Advantage

• Simplicity and robustness

• Capacitively coupled circuit that provides better frequency stability than the Hartley oscillator**s**

Disadvantages

The voltage divider contains the variable capacitor (either C1 or C2) which causes the feedback voltage to be variable as well, sometimes making the circuit less likely to achieve oscillation over a portion of the desired frequency range.

a) Clapp Oscillator

It is one of a few sorts of electronic oscillator built from a transistor (or vacuum tube) and a positive criticism arrange, the system is included a solitary inductor and three capacitors, with two capacitors (C1 and C2) shaping a voltage divider that decides the measure of criticism voltage connected to the transistor input. The Clapp oscillator is a Colpitts oscillator with an extra capacitor put in arrangement with the inductor. The wavering recurrence in hertz (cycles every second) for the circuit in the Figure 2.7, is

$$fo = \frac{\frac{1}{2\pi\sqrt{1}}}{L\left(\frac{1}{C1}+\frac{1}{C2}+\frac{1}{C3}\right)} \qquad \text{.............................2.6}$$

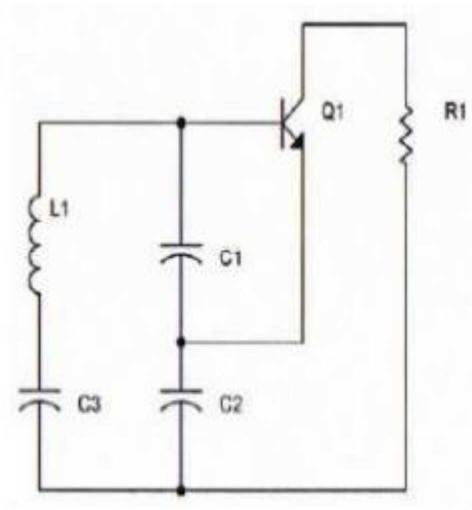


Figure 2.7 Circuit of Clapp LC Oscillator

Advantages

• Preferred over a Colpitts circuit for constructing a variable frequency oscillator (VFO)

• Uses a single variable capacitor to adjust the frequency.

• By using fixed capacitors in the voltage divider and a variable capacitor (C3) in series with the inductor,there is no problem in achieving oscillation over a portion of the desired frequency range.

• Higher loaded Q than the Colpitts oscillator.

The Colpitts and clap oscillators are capacitively coupled circuits that provide better frequency stability than the Hartley oscillator. In each design, a transistor is used as a signal amplifier and a resistor is used as a feedback device.

2.7.3 Crystal Controlled Oscillator

A third kind of sine-wave generator is the Crystal-Controlled Oscillator. A precious stone oscillator (once in a while contracted to XTAL on schematic graphs) is an electronic circuit that uses the mechanical reverberation of a vibrating gem of piezoelectric material to make an electrical flag with an exceptionally exact recurrence. This recurrence is generally used to monitor time (as in quartz wristwatches), to give a steady clock flag to advanced coordinated circuits, and to balance out frequencies for radio transmitters.Using a speaker and input, it is a particularly precise type of an electronic oscillator. The gem utilized in that is now and then called a "timing crystal".This oscillator gives amazing recurrence solidness and is utilized from the center of the sound range through the radio recurrence extend. These are oscillators where the essential recurrence deciding component is a quartz precious stone. On account of the innate qualities of the quartz precious stone the gem oscillator might be held to outrageous precision of recurrence steadiness. Precious stone oscillators are typically, settled recurrence oscillators where security and exactness are the essential contemplations. Temperature remuneration might be connected to precious stone oscillators to enhance warm solidness of the gem oscillator.

Precious stone oscillator sorts and their shortened forms:

• MCXO — microcomputer-repaid precious stone oscillator

• OCVCXO — broiler controlled voltage-controlled precious stone oscillator

• OCXO — broiler controlled precious stone oscillator

• RbXO — rubidium precious stone oscillators (RbXO), a gem oscillator (can be a MCXO) synchronized with an implicit rubidium standard which is run just occassionally to spare power

• TCVCXO — temperature-repaid voltage-controlled precious stone oscillator

• TCXO — temperature-repaid precious stone oscillator

• VCXO — voltage-controlled gem oscillator

2.8 Nonsinusoidal Oscillators

Nonsinusoidal oscillators create complex waveforms, for example, square, rectangular, trigger, sawtooth, or trapezoidal. Since their yields are by and large described by a sudden change, or unwinding, they are regularly alluded to as Relaxation Oscillators. The flag recurrence of these oscillators is generally administered by the charge or release time of a capacitor in arrangement with a resistor. A few sorts, nonetheless, contain inductors that influence the yield recurrence. Along these lines, as sinusoidal oscillators, both RC and LC systems are utilized for deciding the recurrence of wavering. Inside this class of nonsinusoidal oscillators are Multivibrators, Blocking Oscillators, Sawtooth Generators and Trapezoidal Generators.

2.9 Multivibrators

Multivibrators are circuit which change their state continually between various states (normally two states) at predefined rate. These are typically used to produce square wave clocksignals, yet they can be utilized likewise for different applications. These are electronic circuits which are utilized to actualize an assortment of basic two-state frameworks, for example, oscillators, clocks and flip-flops. The most widely recognized shape is the astable or wavering sort, which produces a square wave - the abnormal state of music in its yield is the thing that gives the multivibrator its regular name. In its most straightforward shape the multivibrator circuit comprises of two cross-coupled transistors. Utilizing resistor-capacitor organizes inside the circuit to characterize the eras of the flimsy expresses, the different sorts might be actualized. Multivibrators discover applications in an assortment of frameworks where square waves or planned interims are required, yet the basic circuits have a tendency to be genuinely erroneous, so are once in a while utilized where exactness is required. A coordinated circuit multivibrator, the 555, is exceptionally normal in gadgets. It utilizes a more modern plan to conquer a portion of the accuracy issues with the more straightforward circuits.

There are three sorts of multivibrator circuit:

• astable, in which the circuit is not steady in either state - it ceaselessly wavers from one state to the next. Another name for this sort of circuit is unwinding oscillator.

• monostable, in which one of the states is steady, however the other is not - the circuit will flip into the shaky state for a decided period, yet will in the end come back to the steady state. Such a circuit is helpful for making a planning time of settled length because of some outside occasion. This circuit is otherwise called a one shot. A typical application is in disposing of switch ricochet.

• bistable, in which the circuit will stay in either state uncertainly. The circuit can be flipped from one state to the next by an outside occasion or trigger. Such a circuit is imperative as the principal building piece of an enlist or memory gadget. This circuit is otherwise called a flip-slump.

2.10 Need of Controllable Oscillators

Most electronic flag handling frameworks require recurrence or time reference signals. To utilize the full limit of correspondence channels, e.g. remote, wired and optical channels, transmitters tweak the baseband message motion into various parts of the range to endeavor better proliferation attributes or to recurrence multiplex a few messages, and the recipients downconvert them for demodulation. These operations require exact recurrence reference signals. Advanced circuits and blended mode circuits (A/D and D/A converters e.g.) pace and synchronize their operations utilizing a clock motion as a period reference flag. For the lower end of the range one can utilize the steady properties of quartz precious stones as a resonator to manufacture extremely exact settled recurrence or time reference signals. For higher frequencies (> couple of hundred MHz) the nature of the gem resonators debases because of physical constraints and material properties. Numerous interchanges applications require programmable bearer frequencies and the cost and board space of a huge number of precious stones would be restrictive. Backhanded recurrence union systems in light of a stage bolted circle (PLL) are wanted to create programmable transporters and RF frequencies. A less precise RF oscillator whose recurrence can be controlled with a control flag is inserted in an input circle and its yield recurrence is bolted to an exact low recurrence reference.

These circles are normally executed as a stage secured circle as demonstrated figure 2.8. A stage bolted circle comprises of a voltage controlled oscillator (VCO), recurrence divider, stage indicator (PD), charge pump (CP) and lead-slack circle channel; the VCO's yield recurrence is set to a different of the reference oscillators recurrence relying upon the divider proportions (N and R).

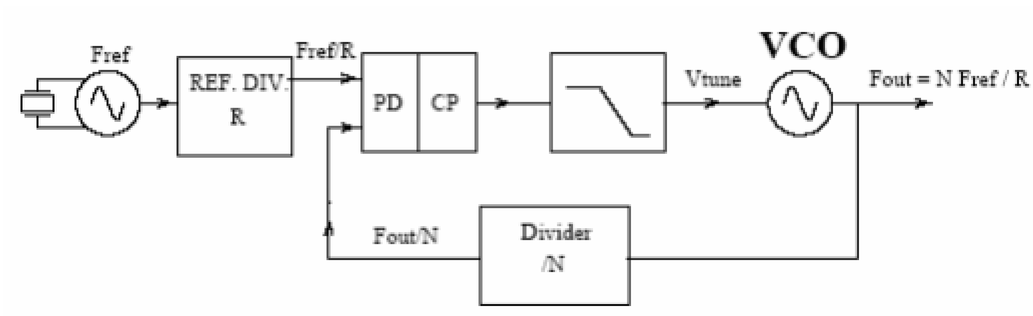


Figure 2.8 A Phase locked loop

Two essential sorts of controlled oscillators exist: voltage controlled oscillators (VCO) with a voltage control flag and current controlled oscillators (ICO) with a present control flag. The primary worry here is on VCOs. In a few occasions like information interchanges, the information rate is precisely institutionalized. Still a neighborhood clock flag is gotten from the approaching information motion with a clock recuperation circuit to track little varieties in the senders clock rate and to adjust the period of the nearby clock for ideal information recuperation [4]. This again requires an oscillator whose recurrence is controllable. Another imperative use of VCOs is for the balance or demodulation of recurrence or point regulated bearers. Open circle regulation and demodulation and additionally shut circle plans are exceptionally well known for convenient remote handsets.

2.11 Voltage Controlled Oscillators

Voltage-controlled oscillator or VCO is an electronic circuit that utilizations enhancement, input, and a full circuit to produce a rehashing voltage waveform. The recurrence, or rate or redundancy per unit of time, is variable with a connected voltage, while substituting current sound or different signs might be bolstered into the VCO to produce recurrence tweak (FM).For high-recurrence VCOs, the voltage-controlled component is normally a varicap associated in a conventional LC oscillator of some shape. For low-recurrence VCOs, different methods can be utilized. A variant utilizing a quartz precious stone is some of the time found in radio transmitters for recurrence tweaking an information flag. The piezoelectric impact of quartz makes it vibrate at a high recurrence, creating radio waves. VCOs are likewise utilized as a part of the creation of electronic music, to produce variable tones.

2.11.1 Design Factors

The outline prerequisites of VCO are:

• Phase steadiness

• Large electrical tuning range

• Linearity of recurrence verses control voltage

• Large pick up variable

• Capability of tolerating wideband balance

• Low cost concerning advanced telephones that utilization these circuits, low power utilization, little size and low manufacture expenses are essential plan variables .

2.10.2 Specifications of a VCO Apart from a controllable recurrence, alternate necessities for VCOs; the detail sheet of a VCO normally has the accompanying sections:

• Center Frequency: It is the yield recurrence f0 of the VCO with its control voltage at its inside esteem and is communicated in [Hz].

\• Tuning Range: It is the scope of yield frequencies that the VCO sways at over the full scope of the control voltage.

• Tuning Sensitivity: It is the adjustment in yield recurrence per unit change in the control voltage, ordinarily communicated in [Hz/V]. VCOs proposed for recurrence amalgamation applications can have a nonlinear connection between control voltage and swaying recurrence so that few qualities are cited or min/max limits are given. VCOs for (de)modulation will cite the linearity of the tuning input and the data transfer capacity of the tuning input.

• Spectral Purity: It can be indicated relying upon the application, in the time space as far as jitter or in the recurrence area regarding stage clamor or transporter/commotion proportion.

• Load Pulling: It measures the affectability of the yield recurrence to changes in its yield stack. In a few applications the yield heap of the VCO is exchanged while the VCO must stay at a similar recurrence to keep away from recurrence blunders when in open circle or to maintain a strategic distance from homeless people in the PLL. This spec depends unequivocally on the confinement given by the yield arrange in the oscillator.

• Supply Pulling: It evaluates the affectability of the yield recurrence to changes in the power supply voltage and is communicated in [Hz/V]. The catalyst or down of different circuits can make huge homeless people in the power supply voltage and it is again alluring that the VCO recurrence stays undisturbed.

• Power Consumption: It indicates the DC control deplete by the oscillator and its yield support circuits.

• Output Power: It is the power the oscillator can convey to a predetermined load. The variety of the yield control over the tuning reach is likewise determined.

• Harmonic concealment: It indicates how much littler the music of the yield flag are contrasted with the crucial part and is regularly communicated in [dBc]

2.12 Classification of VCO

Oscillators are self-ruling circuits that deliver a stable occasionally time shifting waveform. They have no less than two states and they burn through those states at a steady pace.

There are three unique topologies for controlled oscillators on silicon ICs:

• Ring Oscillators

• Relaxation Oscillators

• Tuned or LC Oscillators

2.12.1 Ring Oscillators

Ring oscillators comprise of an odd number of single-finished inverters or an even/odd number of inverters with the fitting associations and this is portrayed in detail in the following part. It is basically utilized in a few applications because of its wide tuning-extend, high coordination and little design territory. The swaying recurrence is specifically identified with the postpone time of every inverter, bringing about high affectability to process and temperature varieties. Its nonlinear voltage-to-recurrence exchange trademark gives high VCO pick up at low frequencies.

2.12.2 Relaxation Oscillator

Unwinding oscillators on the other hand charge and release a capacitor with a consistent current between two edge levels.

2.12.2.1 RC Relaxation Oscillator

It comprises of two cross coupled transistors with their producers associated with two closures of a capacitor . Fig 2.9 demonstrates a bipolar adaptation of the oscillator .Q3 and Q4 are producer supporter cushions. The producers of Q1and Q2 are associated with voltage controlled current sources (ordinarily indistinguishable bipolar transistors Q7 and Q8). At the point when Q1 is on, its authority voltage holds Q2 off and the producer current of Q1 charges the capacitor. At the point when the producer voltage of Q1 transcends two Vbe drops from Vcc Q1 kills, Q2 turns on and the producer current of Q2 charges the capacitor. The measure of current that streams into the capacitor is needy upon the voltage controlled current source (the authority ebbs and flows of Q7 and Q8).

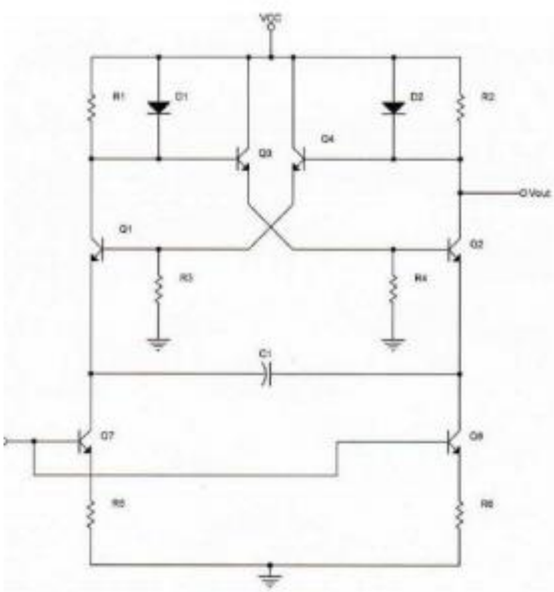


Figure 2.9 An emitter coupled relaxation voltage controlled oscillator

The dynamic segments of the least complex unwinding oscillators comprise of four transistors. The transistors can either be producer coupled or gatherer coupled. Producer coupled circuits show sudden voltage seizes both closures of the capacitor. The voltage hops make exorbitant current spikes and conceivable substrate infusion . Sudden voltage hops don't happen in collector–coupled circuits. Varieties of the circuit have utilized schmitt triggers or SR hooks to drive the capacitor. In the event that the yield is referenced at one of the gatherer hubs then the deliberate flag will be a square wave (with crests amongst Vcc and ground) though the voltage over the capacitor will be a saw-tooth with its mean voltage at zero volts. The yield recurrence of the unwinding oscillators is likewise subject to the circuit temperature. Vbe is contrarily relative to temperature. Consequently, as capacitor temperature expands the swaying recurrence will increment when the info voltage stays consistent. The recurrence at which the capacitor voltage sways is given by

fosc=I*Vin/4*Vbe*C… … .2.7

I (Vin) is the current from voltage controlled current source. Vbe is known as a swing voltage (the greatest voltage crosswise over C before the transistors switch).

Focal points

• Large recurrence tuning range

• Low cost

• An exceptionally straight recurrence verses voltage relationship

• Requirement of just a solitary receptive part

• All of the parts of this oscillator can be created on a solitary IC Detriments

• Poor recurrence dependability at high frequencies

• More helpless to stage commotion contrasted with LC oscillators

• can't create an unadulterated sine wave

Over two acknowledge are anything but difficult to incorporate on a solid IC and are exceptionally reduced. Their recurrence is controlled by a current or voltage and direct tuning qualities can be gotten. Besides, recurrence tuning should be possible more than a few requests of greatness. These are commonly extremely touchy to commotion in the exchanging limits and charging streams.

2.12.3 Tuned or LC oscillator

Tuned oscillators contain an inactive resonator-LC tank, transmission line resonator, gem, SAW - that fills in as the recurrence setting component. They are harder to coordinate essentially as a result of the absence of top notch aloof inductors in standard IC innovations and on account of their huge size. Nonetheless, they have a significantly higher recurrence strength and unearthly virtue since it is set by the latent resonator . They produce their AC waveform with the help of an inductor–capacitor tank. Criticism to an enhancer is utilized to encourage keep up swaying and to decrease damping. The recurrence of the oscillator yield is controlled by the condition:

$f_{osc}=1/(2\pi\sqrt{LC})$… … ..2.8

Favorable circumstances of LC Oscillator

• High stage solidness

• Low helplessness to commotion.Detriments of LC Oscillator

• Lower tuning range

• Higher cost contrasted with unwinding oscillators.

2.13 Application of VCO

VCOs are utilized as a part of:

• work generators

• the creation of electronic music, to produce variable tones

• stage bolted circles

• recurrence synthesizers utilized as a part of correspondence hardware

• spread range, RF and remote frameworks - In the remote transmission frameworks, the VCO is utilized for the recurrence synthesizer to produce the nearby swaying signal for the balance and demodulation of the RF flag .

• optical correspondence frameworks - In computerized optical transmission frameworks, VCOs are utilized as the center circuit of the clock recuperation circuit, whose yield flag is utilized for information choice and recovery.

Chapter 3

Literature Review

In our theory work, we utilize voltage controlled Ring oscillator. We talk about voltage controlled oscillator in the past part and the remaining is the Ring oscillator, Ring oscillator is same as voltage controlled oscillator or additionally says that A ring oscillator is a gadget made out of an odd number of NOT doors in a ring, whose yield wavers between two voltage levels, speaking to genuine and false. The NOT entryways, or inverters, are appended in a chain and the yield of the last inverter is sustained once again into the first.

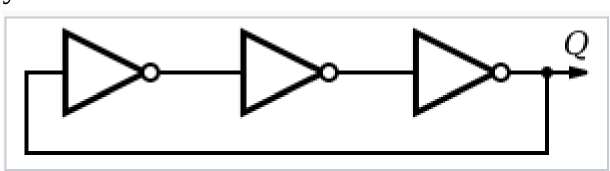


Figure 3.1 Circuit of 3 inverter Ring oscillator

Since a solitary inverter figures the intelligent NOT of its information, it can be demonstrated that the last yield of a chain of an odd number of inverters is the coherent NOT of the main info. The last yield is declared a limited measure of time after the main info is stated and the criticism of the last yield to the information causes swaying. A roundabout chain made out of a much number of inverters can't be utilized as a ring oscillator. The last yield for this situation is the same as the information. A ring oscillator is involved various defer stages, with the yield of the last stage bolstered back to the contribution of the first. To accomplish swaying, the ring must give a stage move of 2π and have solidarity voltage pick up at the wavering recurrence. Each defer organize must give a stage move of π/N, where N is the quantity of postpone stages. The rest of the stage move is given by a dc reversal. Ring oscillator has two sorts as:

Single Ended Ring Oscillator: D1 to Dn speak to the defer cells, which give the pick up and the stage move. They build a shut circle by falling all stages. An odd number of stages are fundamental for the dc reversal.

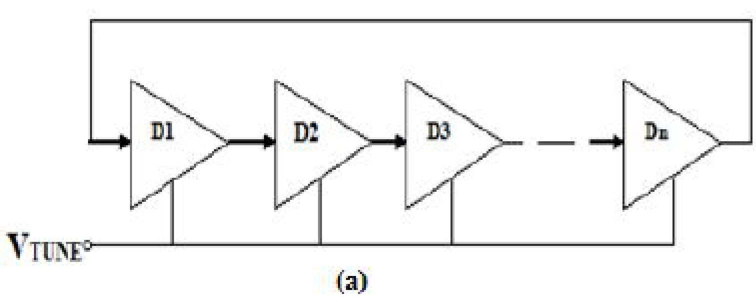


Figure 3.2 Single Ended Ring VCO

a) Differential circle Ring VCO: The Differential ring oscillator is generally utilized, since it has a differential yield to reject regular mode clamor, control supply commotion et cetera. Fig.3.3 delineates N arrange ring oscillator acknowledged utilizing differential cells (which have integral yield). A source coupled combine (SCL) inverter will be a normal execution. Expect that at time t0 the yield of stage 1 changes to rationale 1. At the point when this rationale 1 propogates to the end, it makes a rationale 1 at the Nth stage, which, when criticism to the contribution of the primary stage, makes a rationale 0 in the principal organize yield. At the point when this rationale 0 is propogating through the chain, it flips the yield of stage 1 trigger next stage. It takes two goes through the tie to finish a period. Signifying tp as the propogation delay through each stage , then period T= 2Ntp. For a differential cell N can be odd or even, to begin a swaying.

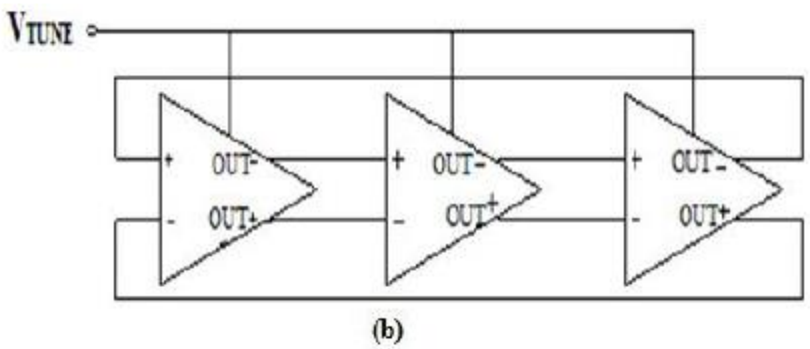


Figure 3.4 Differential loop Ring VCO

In this we use Ring oscillator and there are various types of ring oscillator . Now we have five circuits which are:

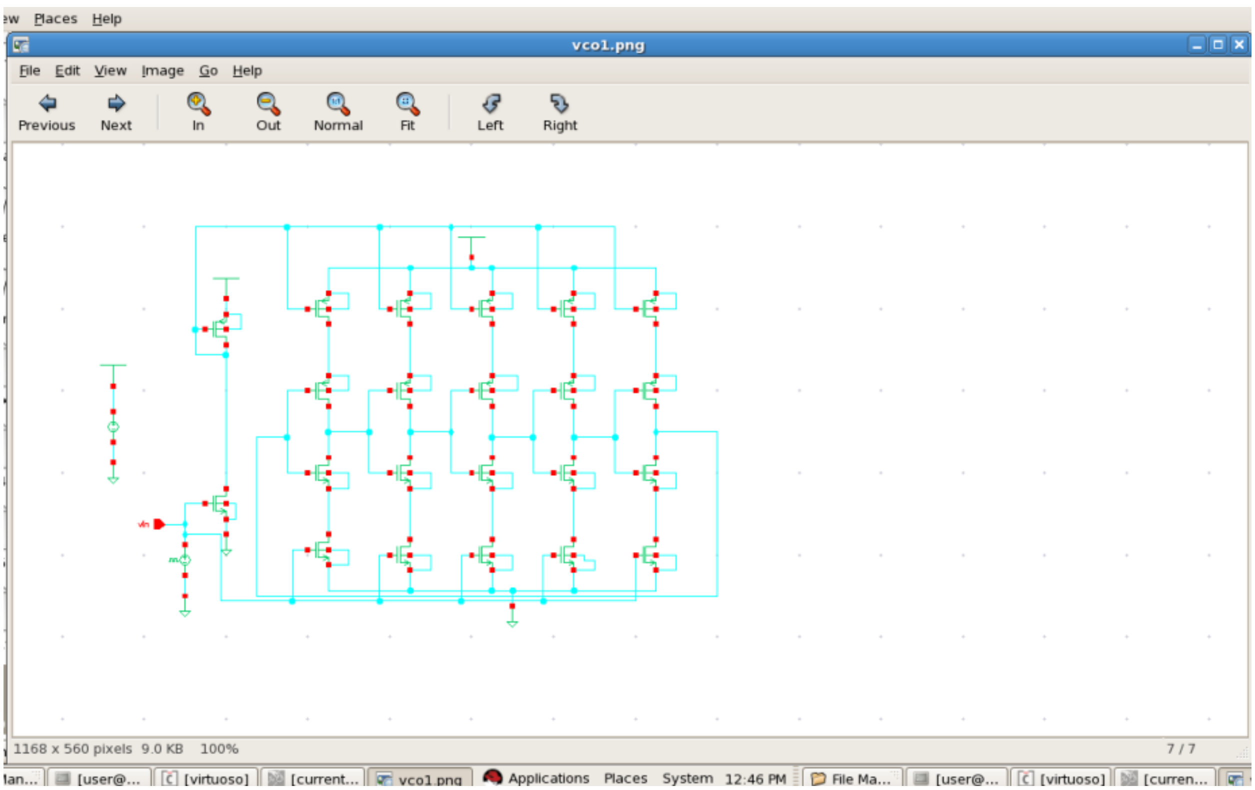
1) Current Starved I
2) Current Starved II
3) VCO with gates of PMOS transistor Grounded
4) VCO with PMOS transistors diode connected
5) VCO with NMOS transistors diode connected

In the next chapter we discuss all the circuits and find power , transient analysis and after that we compare both of five circuits those circuits which has higher power then we added another technique on that circuit by which we make more lass power because our motive is to reduce power dissipation as low as possible. These all the works are done in cadence virtuoso tool and 180 nm technology and after that we compare those two circuits which has highest power from those five circuits and that circuits in which we ass one technique to reduce power dissipation and the comparison of these two circuits are done in 45 nm technology and 180 nm technology.

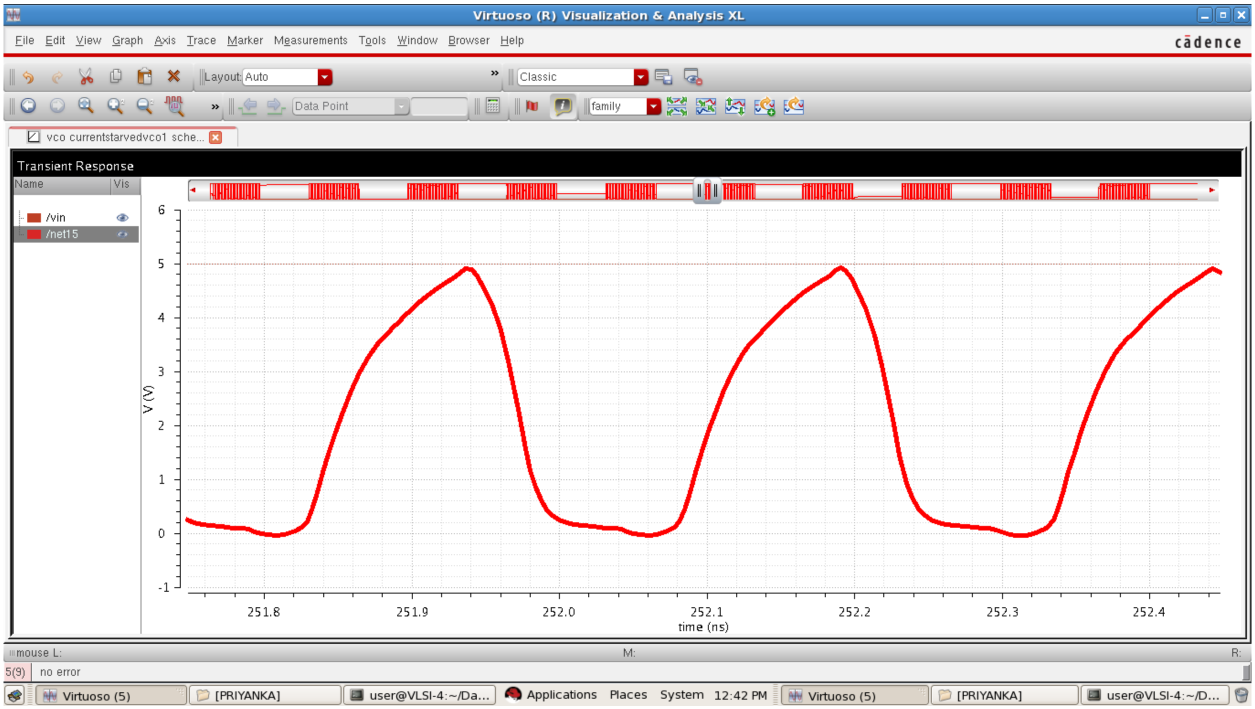
Chapter 4
Results and Simulation

In this thesis work our motive is to compare the circuits and reduce power dissipation. Now we start the simulation.

1) **Current Starved VCO:** The circuit of current starved VCO I is



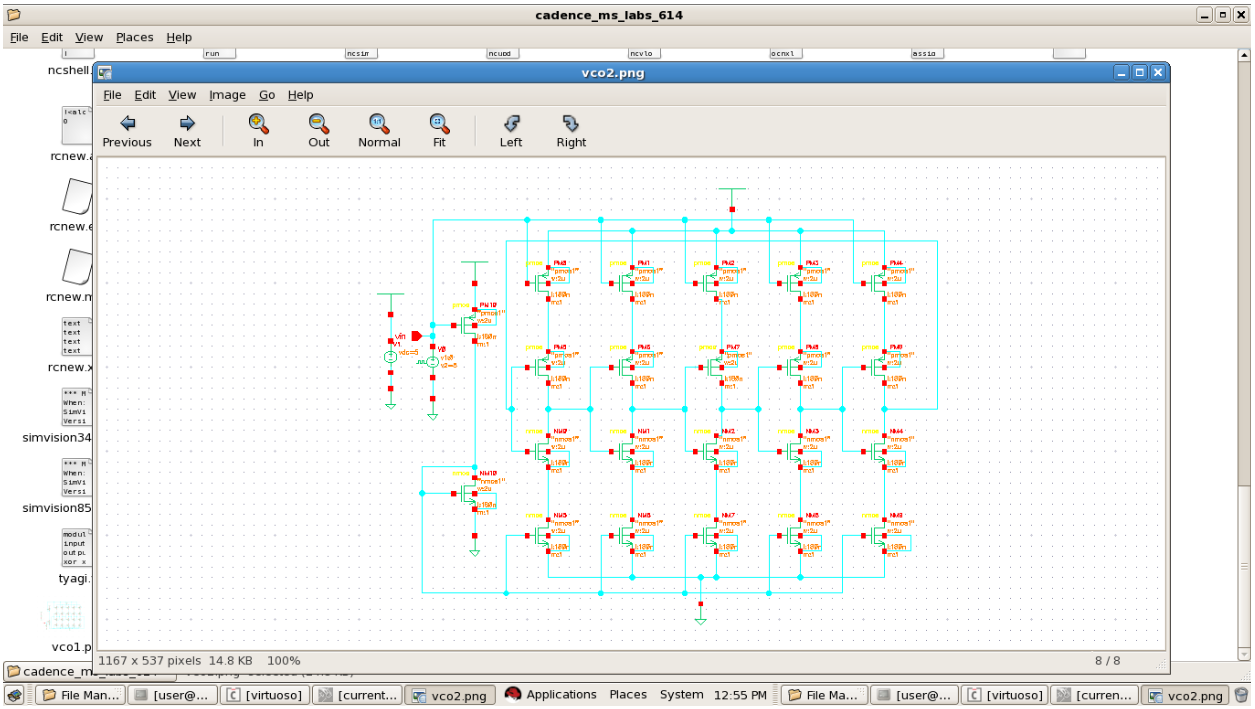
The Transient analysis of this circuit are:



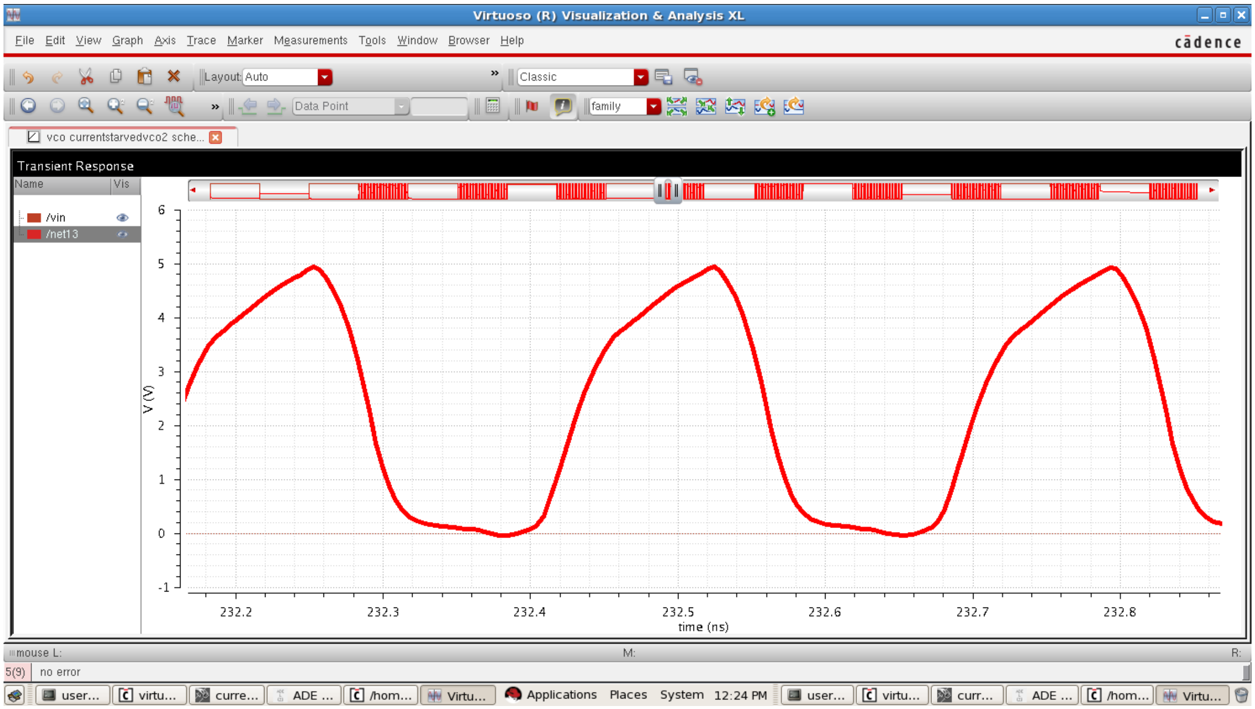
Power Analysis of that circuit are:

Voltage	Power Supply
1 v	60.23722 pw
1.2 v	79.51 pw
1.4 v	101.63 pw
1.6 v	126.25 pw
1.8 v	153.99 pw
2 v	184.93 pw

2) Current Starved VCO II: The circuit of current starved vco II are



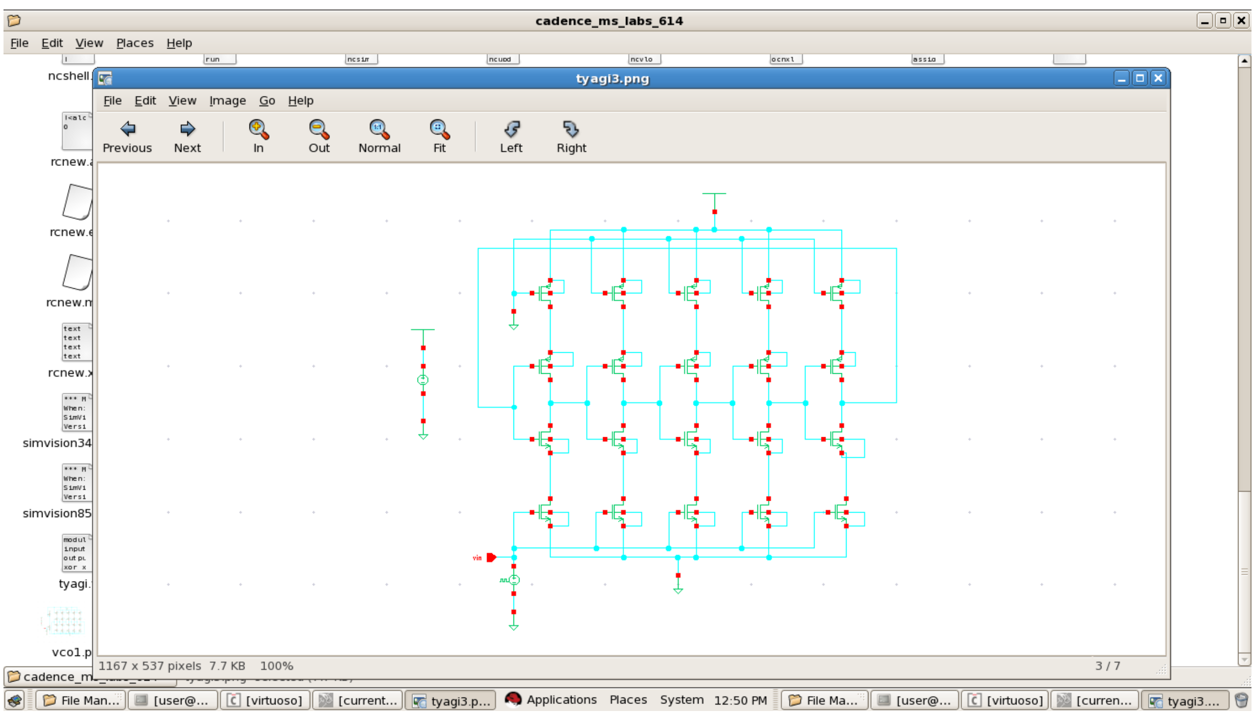
Its Transient Analysis are:



Its Power Analysis

Voltage	Power supply
1 v	75.283 μw
1.2 v	164.012 μw
1.4 v	293.034 μw
1.6 v	463.792 μw
1.8 v	676.586 μw
2 v	930.989μw

3) **VCO with gates of PMOS transistor grounded:** Its circuit are

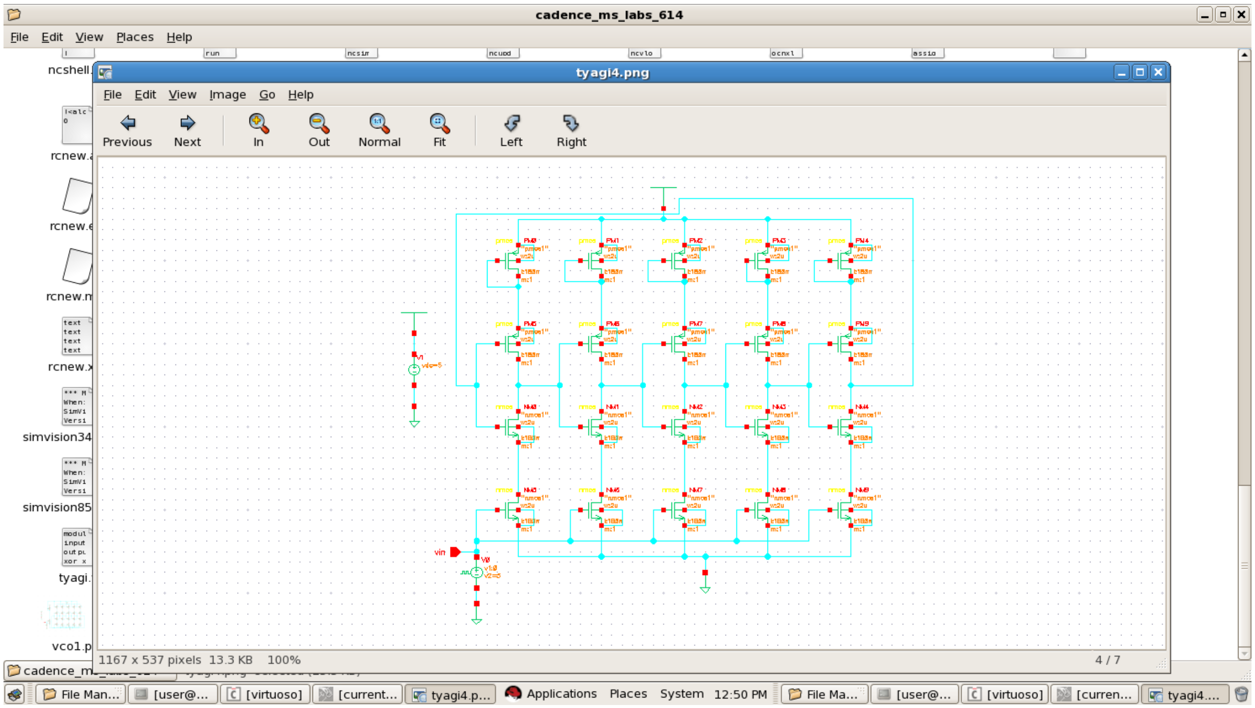


Its Transient Analysis are:

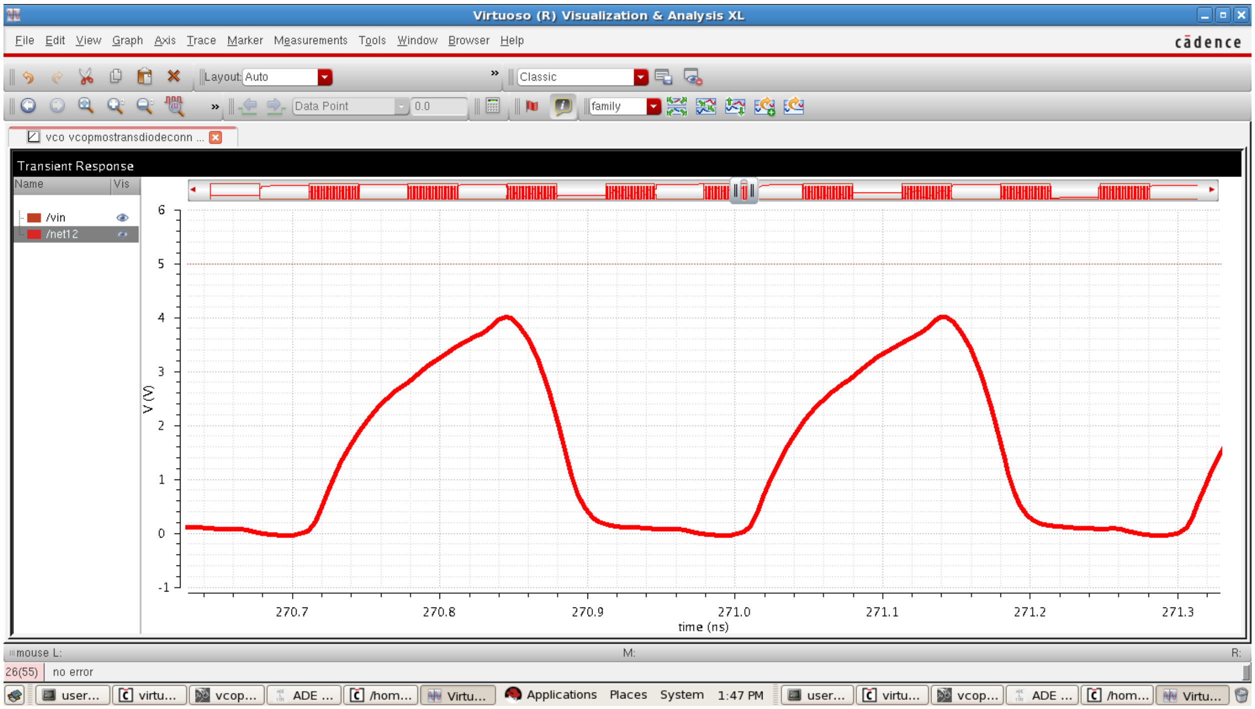
Its power Analysis

Voltage	Power Supply
1 v	51.1074 pw
1.2 v	67.4496 pw
1.4 v	86.043 pw
1.6 v	106.98 pw
1.8 v	130.41 pw
2 v	156.54 pw

4) VCO with PMOS transistor diode connected: Its circuit are



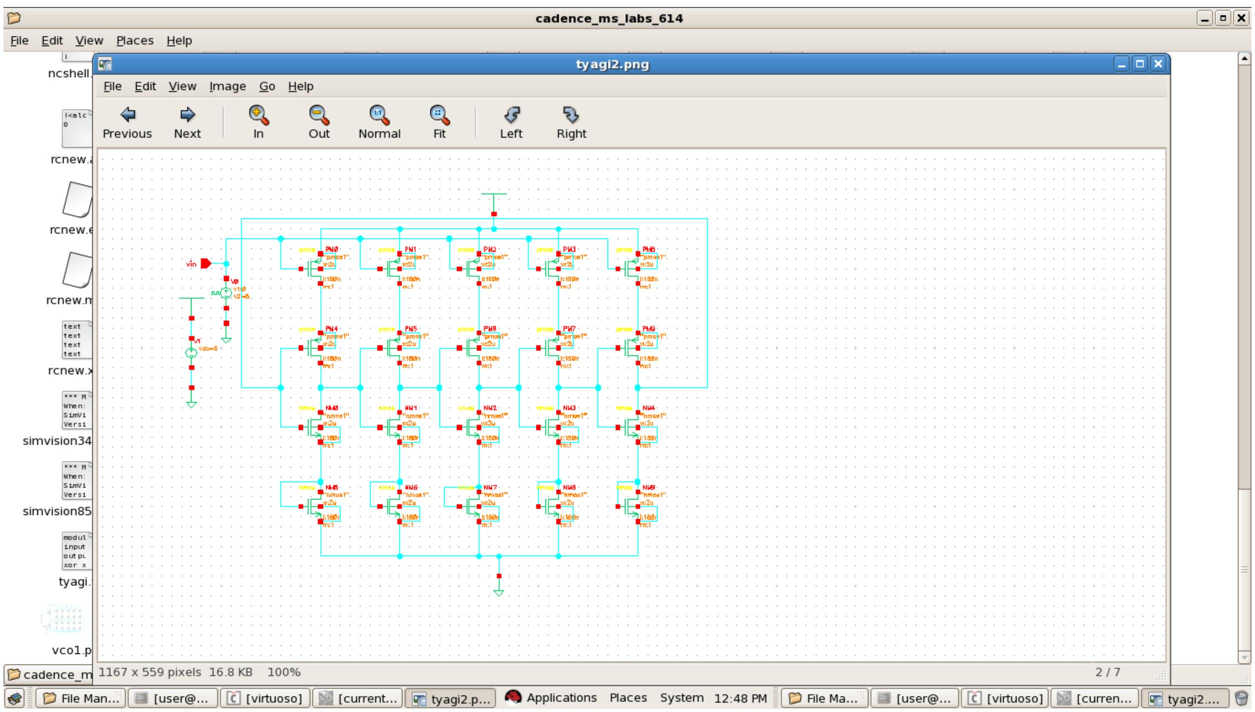
Its Transient Analysis are:



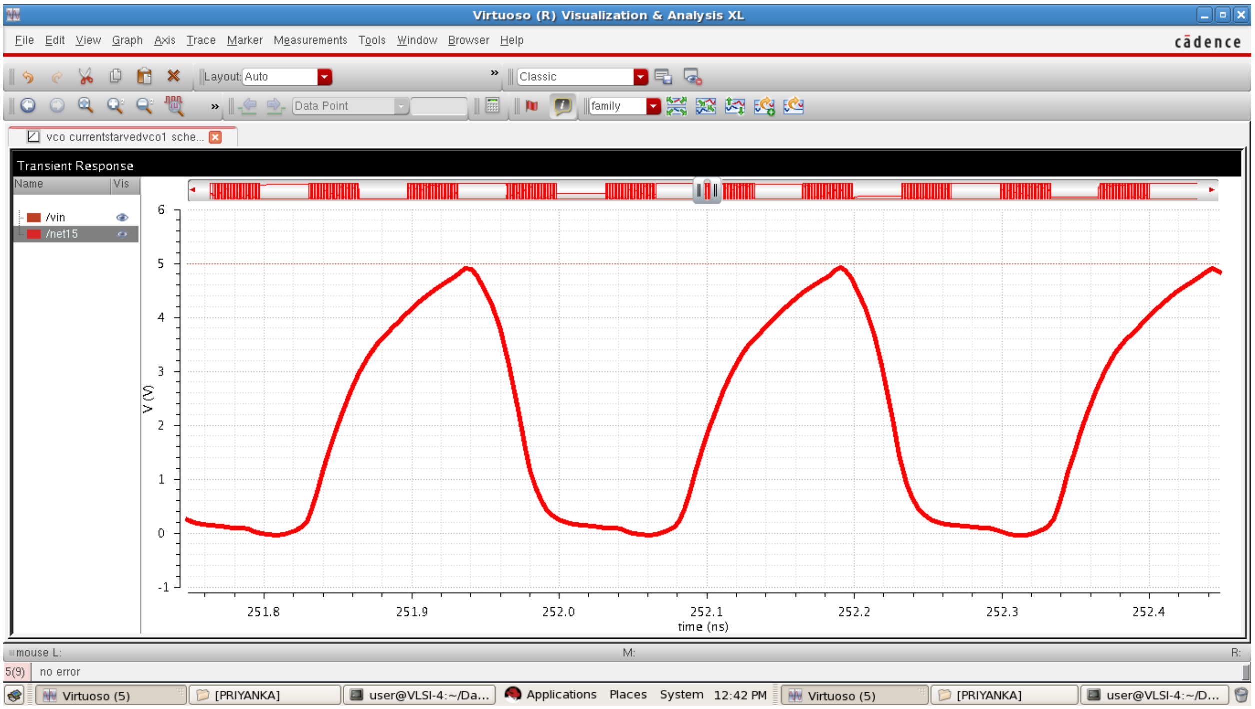
Its Power Analysis

Voltage	Power Supply
1 v	49.4725 pw
1.2 v	65.37221 pw
1.4 v	83.4666 pw
1.6 v	103.84 pw
1.8 v	126.63 pw
2 v	152.0 pw

5) **VCO with NMOS transistor diode connected:** Its circuit are



Its Transient Analysis are:

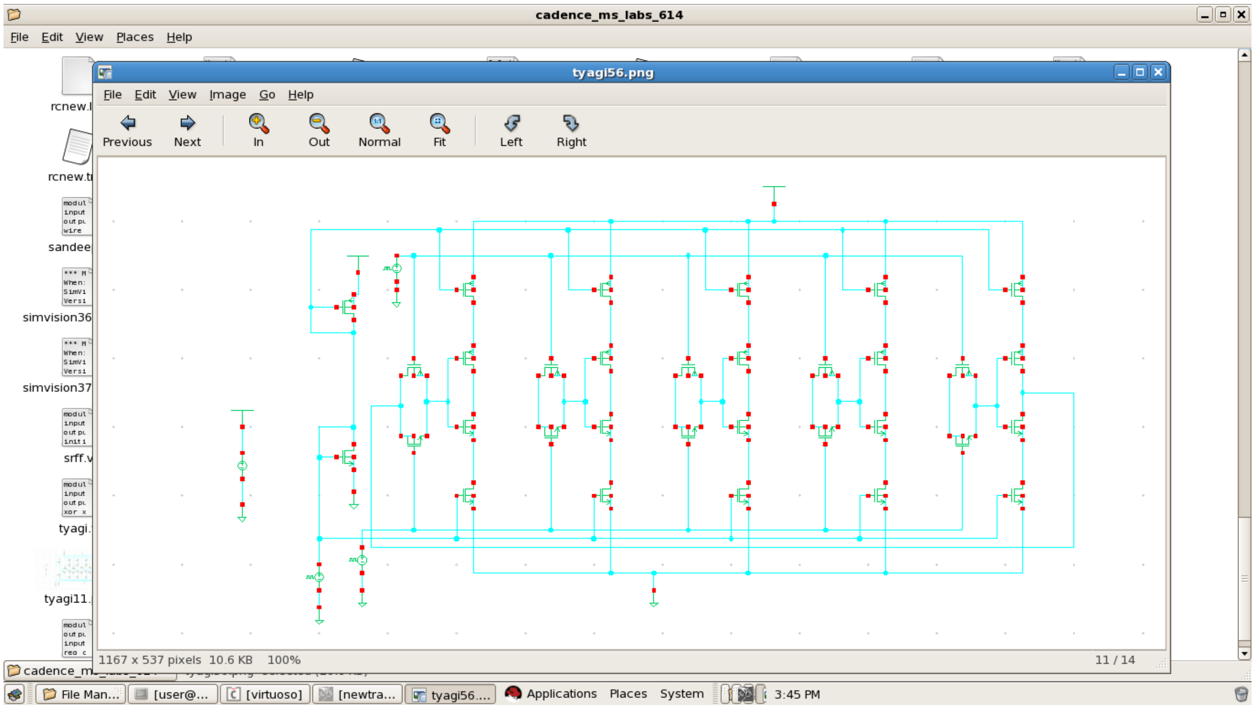


Its Power Analysis:

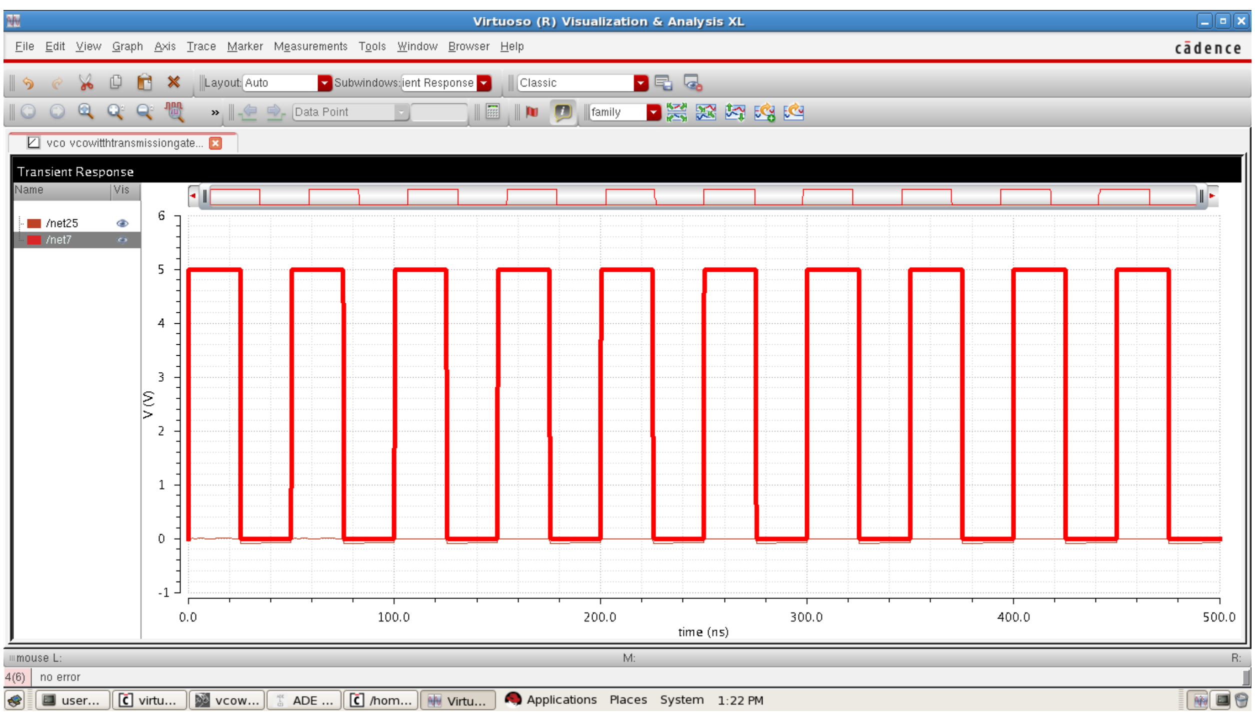
Voltage	Power Supply
1 v	280.35 nw
1.2 v	1.8629 μw
1.4 v	9.98039 μw
1.6 v	41.2705 μw
1.8 v	126.326 μw
2 v	293.315μw

From all the Five circuits, we have realize that **"Current Starved VCO I"** has the highest power. Now, we add one technique in this circuit which is called **" Transmission gate"** we apply transmission gate in that circuit and after that we have one new circuit which reduce the power dissipation. We apply this transmission gate because the properties of transmission gate has to reduce power dissipation and higher speed so to reduce more power dissipation we have apply that circuit.

The new circuit is



Its Transient Analysis



Its Power Analysis and frequency

45nm technology

Voltage	Power Supply
1 v	**34.243 μw**
1.2 V	**65.0318 μw**
1.4 V	**104.224μw**
1.6 V	**151.613μw**
1.8 V	**207.048μw**
2 V	**270.391μw**

180 nm Technology

Voltage	Power Supply
1 v	**15.9272 pw**
1.2 v	**19.159 pw**
1.4 v	**22.2914 pw**
1.6 v	**25.302 pw**
1.8 v	**28.18 pw**
2 v	**30.921 pw**

For Frequency Calculation

100 MHZ = 100×10^6 HZ

$$\frac{1}{10} \times 10^{7}$$

1/10× $\frac{10^{-9}}{10^{-2}}$

100/10× 10^{-9}

Period= 10ns

Pulse width= 5ns

Similarly,

45 nm Technology

Frequency	Period	Pulse Width	Power
100MHZ	**10ns**	**5ns**	**65.03177μw**
200MHZ	**5ns**	**2.5ns**	**65.0318μw**
300MHZ	**3.33ns**	**1.665ns**	**65.0318μw**
500MHZ	**2ns**	**1ns**	**65.0318μw**
800MHZ	**1.25ns**	**0.625ns**	**65.0318μw**

180 nm Technology

Frequency	Period	Pulse width	Power
100MHZ	10ns	5ns	19.15899pw
200MHZ	5ns	2.5ns	19.15899pw
300MHZ	3.33ns	1.665ns	19.15899pw
500MHZ	2ns	1ns	19.15899pw
800MHZ	1.25ns	0.625ns	19.15899pw

Current Starved VCO

Power and its Frequency

45 nm Technology

Voltage	Power Supply
1 v	63.537μw
1.2 v	122.181μw
1.4 v	197.284μw
1.6 v	288.251μw
1.8 v	394.614μw
2 v	515.945μw

180 nm Technology

Voltage	Power Supply
1 v	26.5896pw
1.2 v	464.59pw
1.4 v	40.0643pw
1.6 v	47.3074pw
1.8 v	54.9277 pw
2 v	62.916pw

Frequency

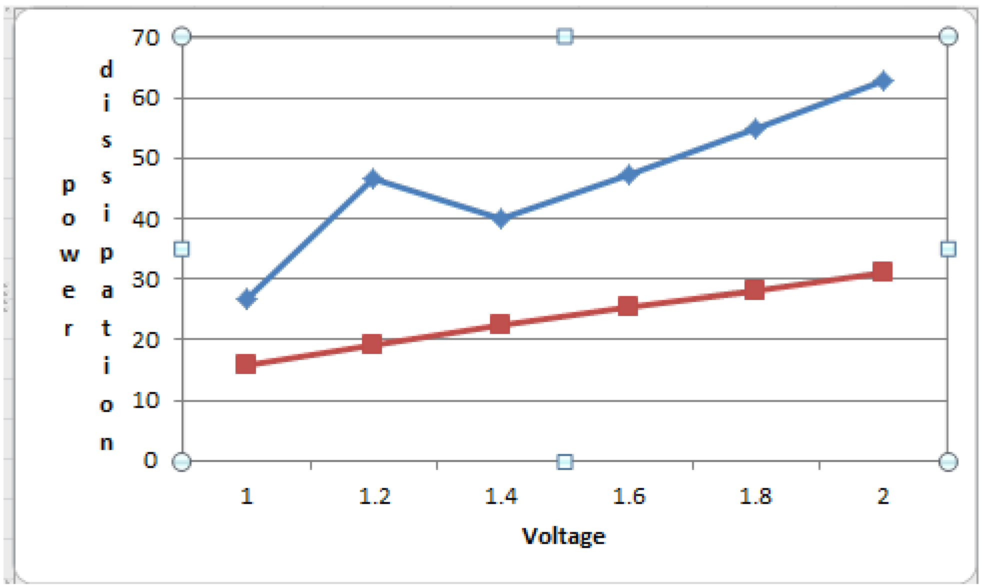
45 nm Technology

Frequency	Period	Pulse Width	Power
100MHZ	10ns	5ns	122.182μw
200MHZ	5ns	2.5ns	122.182μw
300MHZ	3.33ns	1.665ns	122.1818μw
500MHZ	1ns	1ns	122.182μw
800MHZ	1.25ns	0.625ns	122.182μw

180 nm Technology

Frequency	Period	Pulse Width	Power
100MHZ	10ns	5ns	2.1835nw
200MHZ	5ns	2.5ns	79.51pw
300MHZ	3.33ns	1.665ns	79.51pw
500MHZ	1ns	1ns	79.51pw
800MHZ	1.25ns	0.625ns	79.51pw

Comparison between current starved vco and current starved with transmission gate,at 180 nm teachnology.



Chapter 5

Conclusion

In this thesis work, firstly we compare the five circuits of voltage controlled Ring Oscillator which are Current Starved VCO I, Current Starved VCO II, VCO with PMOS transistor grounded, VCO with PMOS transistor diode connected, and VCO with NMOS transistor diode connected. From all the five circuits we assume that the Current Starved VCO I has highest power . After that in this circuit we apply a transmission gate and after apply the transmission gate the power has to reduce . The overall results are we reduce so many power by applying the transmission gate . By applying the transmission gate we compare two circuits first which has highest power from the overall five circuits and second the circuits in which we apply the transmission gate so, from the results the circuit in which we apply the transmission gate has the best results.The properties of transmission gate is to reduce the power dissipation and it speed is also higher.

References

[1] A. A. Abidi and R. G. Meyer, “Noise in Relaxation Oscillators”, IEEE Solid-State Circuits, vol. SC-18, pp. 794-802, 1983.
[2] Adel S. Sedra and Kenneth C. Smith, “Microelectronics Circuits”, 5th edition, Oxford University Press, 2004.
[3] B. Razavi, “A study of Phase Noise in CMOS Oscillators”, IEEE J. Solid-State Circuits, vol. 31, pp. 331-343, 1996.
[4] B. Razavi, “Monolithic phase-locked loops and clock recovery circuits-theory and design”, IEEE Press,pp. 283-377 and 381-483, 1996.
[5] D. A. Hodges and H.G. Jackson, “Analysis and design of Digital Integrated Circuits”, 2nd edition, McGraw-Hill, 1988.
[6] F. M. Gardner, “Phaselock Techniques”, 2nd edition, John Wiley, 1979.
[7] Fogoros and N. Richard “Electrophysiologic Testing”, 2nd edition, Cambridge: Blackwell Science; 1995.
[8] Franco Denoth and Luigi A. Donato, “ Self-Synchronizing Cardiac pacemaker”, IEEE Transactions on Bio-Medical Engineering, vol. BME-14, no. 2, April 1967.
[9] Hamid Rategh, Hirad Samavati, and Thomas H. Lee “A CMOS Frequency Synthesizer with an Injection-Locked Frequency Divider for a 5 GHz Wireless LAN Receiver”, IEEE Journal of Solid-State Circuits, vol.35, no.5, pp. 780-787, 2000.
[10] http://en.wikipedia.org/wiki/Electronic_oscillator
[11] http://www.fairview.org/index.asp
[12] http://www.tpub.com/neets/book 9/35.htm
[13] Jafar Savoj and Behzad Razavi “A 10-Gb/s CMOS Clock and Data Recovery Circuit with a Half-Rate Linear Phase Detector”, IEEE Journal of Solid-State Circuit, vol.36, no. 5, pp.761 767, 2001.
[14] J. Craninckx and M. S. Steyaert, “A 1.8-GHz CMOS Low-Phase-Noise VCO using Optimized Hollow Spiral Inductors”, IEEE J. Solid-State Circuits, vol. 32, pp. 736- 744, 1997.
[15] J. Craninckx and M. S. Steyaert, “A 1.8-GHz CMOS Low-Phase-Noise Voltage Controlled Oscillator with Preseller”, IEEE J. Solid-State Circuits, vol. 20, pp. 1474- 1482, 1995.
[16] M. Banu, “MOS oscillators with multi-decade tuning range and gigahertz maximum speed”, IEEE Journal of Solid-State Circuits, vol. 23, pp. 1386–1393, December 1988.
[17] M. H. Shakiba and T. Sowalti, “Automatic Swing Control in Relaxation Oscillators”, IEEE Solid State Circuits, vol.33, pp. 1979-1986, December 1998.
[18] M. Jamal Deen, “Ultra Low-Voltage Low-Power Voltage Controlled Oscillator”, Electrical and Computer Engineering Department, CRL 226 McMaster University, Hamilton, ON, Canada L8S 4K1.
[19] M. J. Underhill, “Fundamentals of oscillator performance”, Electronics and Communication Engineering Journal, vol. 4, no. 4, pp. 185-193, 1992.

[20] M. Thamsirianunt and T. A. Kwasniewski, “CMOS VCO’s for PLL Frequency Synthesis in GHz Digital Mobile Radio Communications”, IEEE J. Solid-State Circuits, vol. 31, pp. 331-343, 1996.
[21] N. M. Nyugen and R. G. Meyer, “A 1.8 GHz Monolithic LC Voltage-Controlled Oscillator”, International Solid State Circuits Conference, pp. 158-159, 1992.
[22] Paul R. Gray and Robert G. Meyer, “Analysis and Design of Analog Integrated Circuits”, 3rd edition, John Wiley, January 1993.
[23] R. Gregorian, K. W. Martin, and G. C. Temes, “Switched-Capacitor Circuit Design”, Proceedings of the IEEE, vol. 71, no. 8, pp. 941-966, 1983.
[24] R. Jacob Baker, Harry W. Li and David E. Boyce, “CMOS Circuit Design, Layout and Simulation,” IEEE Press Series on Microelectronics Systems, pp. 355-361 and