International Conference on Recent Trends in engineering & Technology - 2013(ICRTET'2013)
Special Issue of International Journal of Electronics, Communication & Soft Computing Science & Engineering, ISSN: 2277-9477

Designing of Different oscillators for ISM and WI-FI Band Applications

B.V.Gavali **S.K.Rode** **M.S.Shinde** **S.K.Shelke**

Abstract—**The last decade of this century has seen an explosive growth in the communications industry. People want to be connected all the time using wireless communication devices. In addition, the demand for high bandwidth communication channels has exploded with the advent of the internet. Thanks to the high density available on integrated circuits, sophisticated digital modulation schemes can be employed to maximize the capacity of these channels. This has changed the design of wireless and wire line transceivers. We focus on the design of a critical sub-block: the voltage controlled oscillator (VCO, Ring oscillator, LC oscillator). We review the requirements for VCOs and evaluate the advantages and disadvantages of VCO.**

Keywords— Ring oscillator, LC oscillator, Voltage controlled oscillator, Microwind3.5

I. INTRODUCTION

We have decided to study oscillators, because we were interested in this type of Structure as it is useful in many different types of electronic equipment. Their role is to create a periodic logic or analog signal (sinusoidal or not) with a stable and predictable frequency. They are used in different fields and especially in radio-frequency transmission in order to generate the carrying signals. We also need this structure to generate the main clock of processors. Moreover, there are many different types of oscillators. We chose to study four of them :

Ring oscillators,
LC oscillators,
Voltage Controlled Oscillators

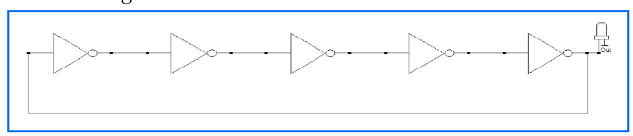
Here we will particularly focus on the frequency's study.[1][2]

The ring oscillator made from five inverters has the property of oscillating naturally. The output oscillating frequency is equal to the inverse of the propagation delay of all inverters It is a device composed of an odd number of inverters attached in a chain, with the output of the last inverter fed back into the first. The output oscillates between two voltage levels, representing true and false. The oscillations are due to the switching delay existing between the input and the output of each inverter. The fastest oscillation is obtained with the minimum number of inverters which is 3, because it doesn't oscillate with only one. Here is the implementation layout where it is easy to recognize the five gates. On this layout, we can notice that there is no clock as the oscillation appears naturally. We just need to connect the last inverter on the left to the output with a metal bridge, in order to obtain the ring shape.[1]

Truth Table:

Enable	Out
0	1
1	toggle
X	X

Circuit Diagram:



Here is the implementation layout where it is easy to recognize the five gates. On this layout, we can notice that there is no clock as the oscillation appears naturally. We Just need to connect the last inverter on the left to the output with a metal bridge, in order to Obtain the ring shape. The below figure is the transient analysis for voltage curve which provides you the free oscillation. Note that we are not providing any input at the input node.

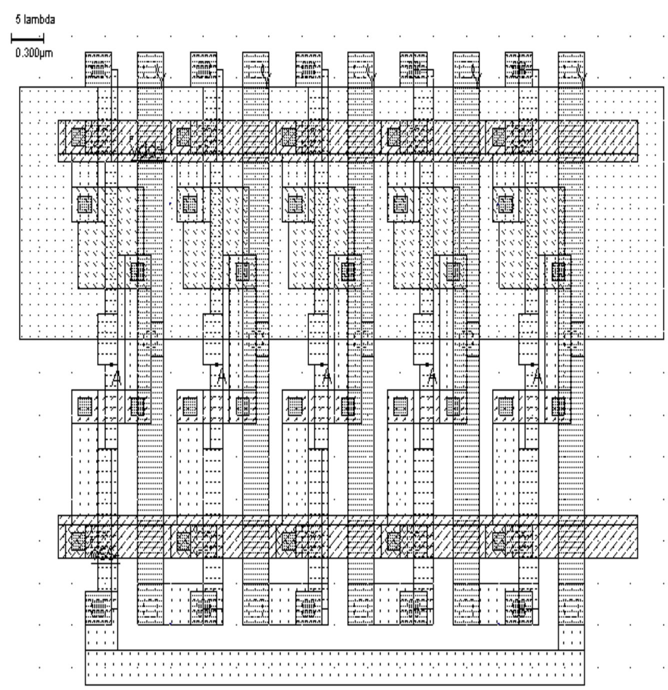


Figure 2: Implementation of a 5-inverter oscillator

With the simulation, we obtained a stable frequency oscillation (except at the beginning of the simulation because it is the transitory mode)

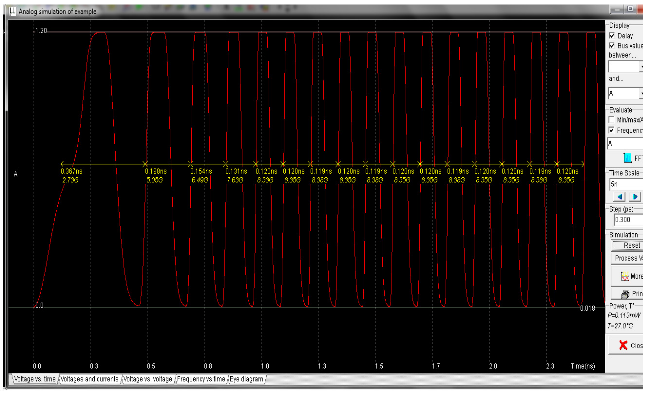


Figure3 : Oscillator voltage variation

A simulation mode displays the frequency variations versus time together with the voltage variations. We can notice on Figure 4 that the frequency is stable around 08.35 GHz.

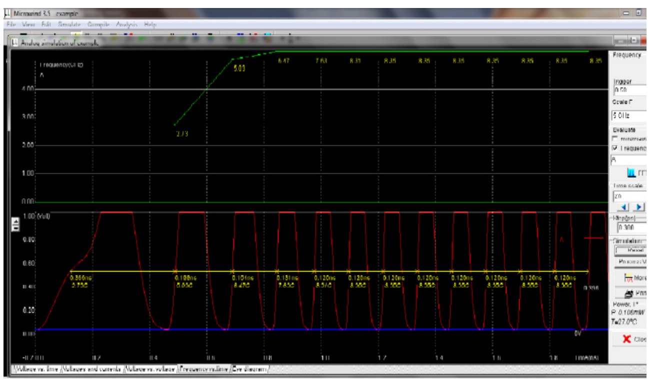


Figure 4: Oscillator frequency and voltage variation

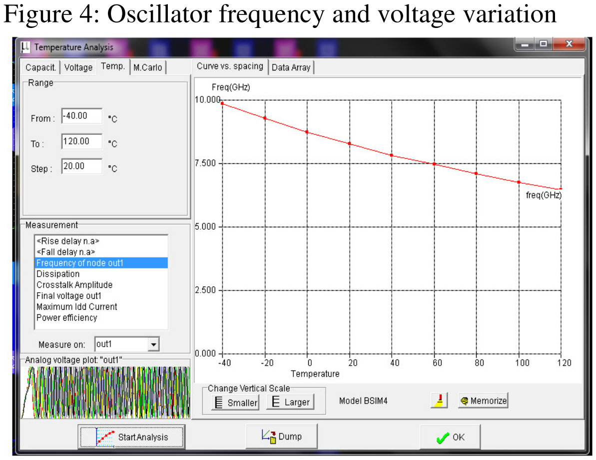


Figure 5: frequency variation with Temperature.

Besides, with this type of oscillator, operating conditions and parameters have an Influence on the oscillating frequency. For example, we studied the influence of the power Supply voltage Vdd.

Figure 6 represents several simulations with Vdd varying from 0.5 to 1.2V. We can notice a significant raise of frequency when V_{dd} increases

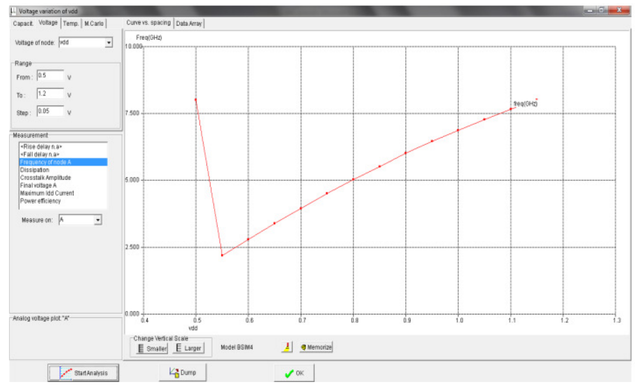


Figure 6: frequency variation with V_{dd}

Figure 7represents a Monte Carlo Simulation, which consists in studying frequency variation when Vdd is varying in a random way. We can easily conclude that any supply fluctuation has a significant impact on theoscillator frequency.[2][3]

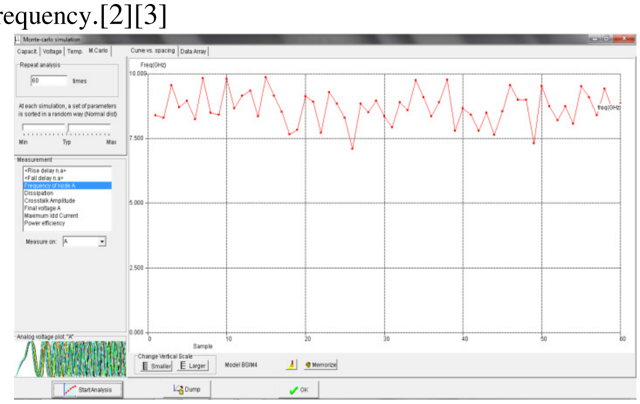


Figure 7: Monte Carlo Simulation

We obtain a frequency varying from around 08 to10 GHz.

II. RING OSCILLATOR WITH 11 INVERTERS

The more inverters you have, the smaller frequency you obtain. Another advantage is that the output signal looks better, it is more rectangular like a logic signal.[4]

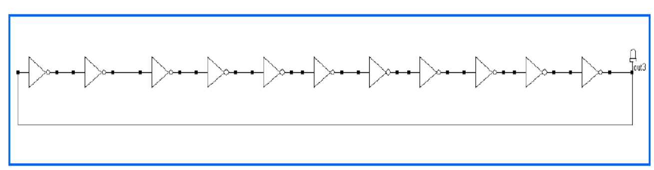


Figure 8: Ring oscillator with 11 inverters

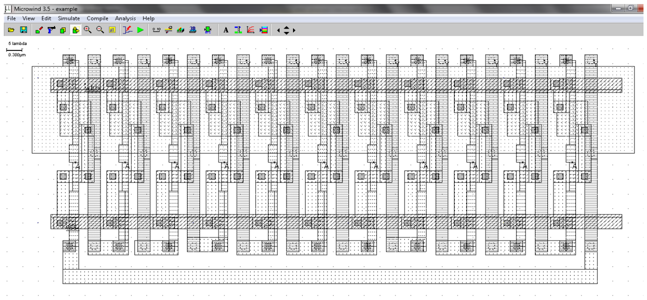


Figure 9: Implementation of 11-inverter oscillator

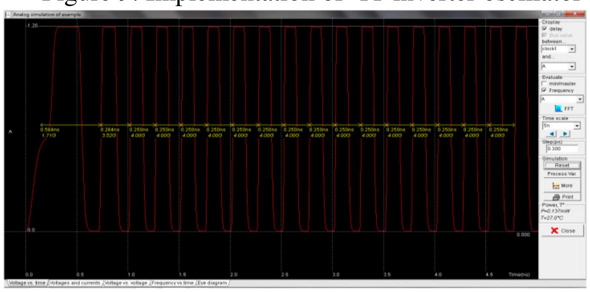


Figure 10: Oscillator voltage variation

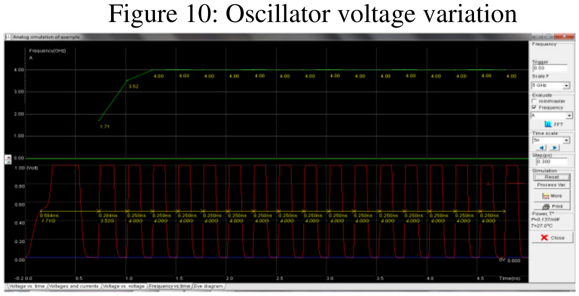


Figure 11: Oscillator frequency and voltage variation

The simulation gives an oscillating frequency around 4 GHz, which is in an ISM band, that is what we were looking for. Unfortunately, when we use more inverters, consumption increases also the area of the layout increases. But in the CMOS layout designing we have to follow the area optimization. So here we can say it will be the drawback of the implementation of Ring oscillator.

Now the second oscillator comes in the picture,

III. Differential LC Oscillator

The circuit will be like this.

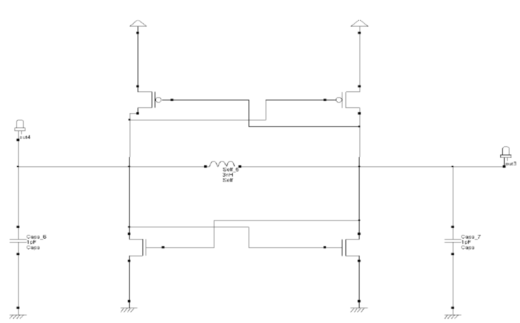


Figure 12: LC oscillator structure

On our implementation layout on the figure12 we added some virtual capacities and inductor because their values are easy to change during the simulation. Once the good values of the capacities and inductor were known, we could implement these components but we didn't have enough time to do it.[9]

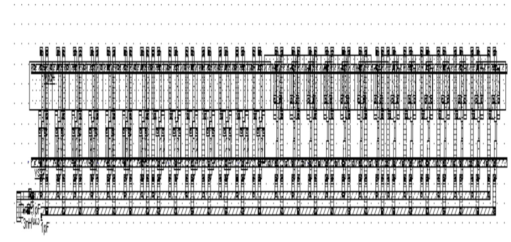
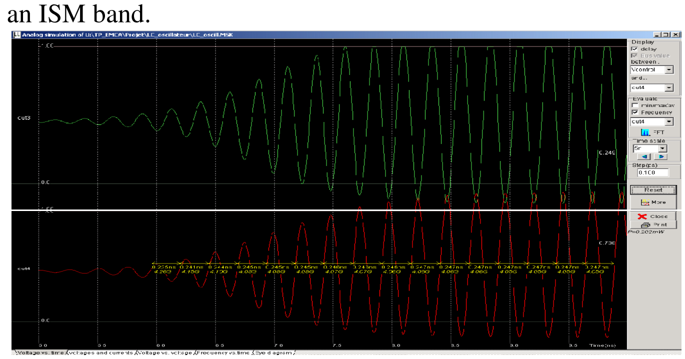


Figure 13: Implementation of LC oscillator

The result of the simulation is on figure13. Both outputs oscillate and a permanentregime is reached after some eight nano-seconds. A simulation mode displays the frequency variations versus time together with the voltage variations. We can notice on Figure 14 that the frequency is stable around 4.05 GHz. This is an ISM band.



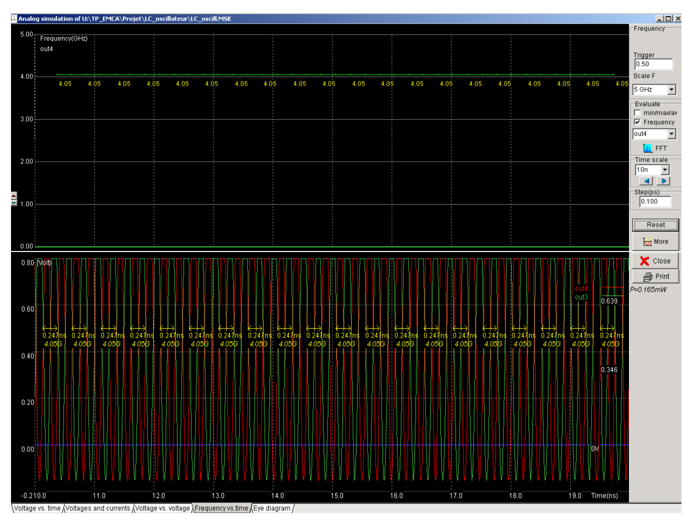


Figure 14: Oscillator frequency and voltage variation

III. VOLTAGE CONTROLLED OSCILLATOR

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". Here in Figure 15, we studied a current-starved VCO. Vcontrol is used to fix the current in N1, N2, N3, N4 and P1, P2, P3, P4. A change on Vcontrol will modify the currents in the inverters and act directly on the delay.[6][7][8]

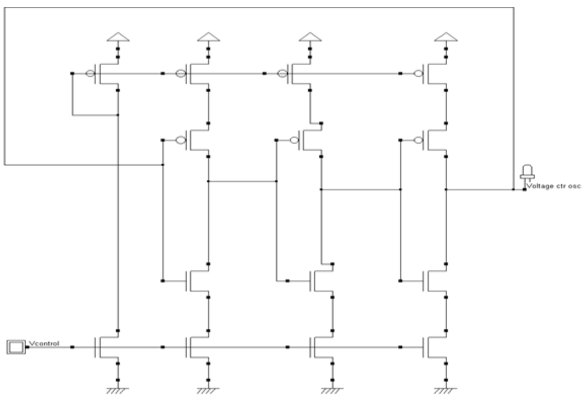


Figure 15: current-starved VCO

Here we have three inverters in the loop but it is possible to put more, it depends on the oscillating frequency required. The voltage variations of "Vcontrol" and "Voltage ctrosc" are given in Figure 17. We chose to modify Vcontrol very slowly, in order to see the influence on the oscillations. We put Control higher than 0.5 V, because there are not any oscillation under that value.

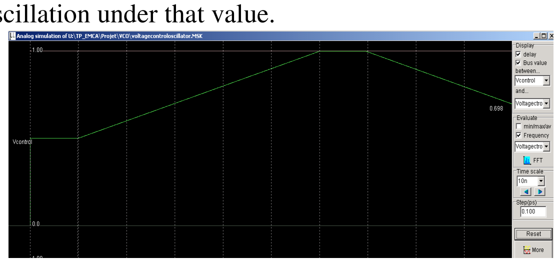


Figure 16: voltage variations of "Vcontrol

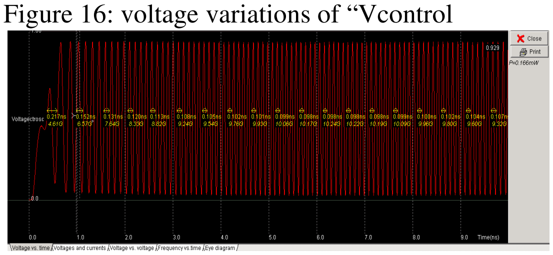


Figure 17: voltage variations of"Voltage ctrosc"

As we can notice on Figure 18, the oscillation frequency's variation is not linear. The maximum value: 8.67 GHz is obtained when Vcontrol is maximal. It is possible to modify these values by implementing more inverters.

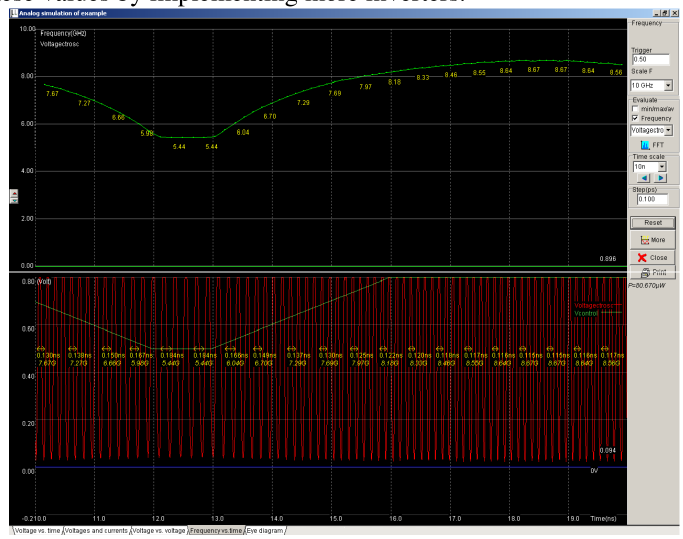


Figure 18: Oscillator frequency and voltage variation

CONCLUSION

In this paper we simulated oscillators using Microwind3.1

However, for our paper, we decided to use the ISM radio bands of frequency (Industrial, Scientific and Medical radio bands), which are not controlled by national regulations. Their use is free and we don't need any authorization for Industrial Scientific or Medical use. For example, we selected the 2.400 – 2.483 GHz band of frequency which is used by Bluetooth applications, and the 5.725 – 5.875 GHz band for WI-FI applications.

Here, we obtained an oscillation frequency around 8.35 GHz, that is why weimplemented a new ring oscillator with more inverters in order to get a frequency in an ISMradio band. However, it is necessary to put an odd number of inverters to get oscillations thatis why we chose to study a ring oscillator with 11 inverters.With the advent of higher communication data rates and digital clock rates andthe proliferation of wireless terminals the demand for integrated GHz oscillators

is growing. Whereas for digital and data applications fully integrated ringoscillators are being widely used, the use of fully integrated tuned oscillatorsis only emerging in wireless products. Performance concerns as well as largearea still inhibit the widespread acceptance of integrated tuned oscillators.

REFERENCES

[1] B. Razavi, “Design of Integrated Circuits for Optical Communications”, McGraw-Hill, 2003
[2] N. M. Nguyen and R. G. Meyer, “Start-up and Frequency Stability in High- Frequency Oscillators,” IEEE Journal of Solid State Circuits, vol. 27, pp. 810-820, May 1992.
[3] K. O. Kenneth, N. Park, and D. J. Yang, “1/f noise of NMOS and PMOS transistors and their implications to design of voltage controlled oscillators,” IEEERadio Frequency Integrated Circuit Symp., Jun. 2002, pp. 59-62.
[4] M. Danesh et al., “A Q-Factor Enhancement Technique for MMIC Inductors,” Proc. IEEE Radio Frequency Integrated Circuits Symp., pp. 217-220, April 1998.
[5] D. Baek, T. Song, E. Yoon, and S. Hong, “8-GHz CMOS Quadrature VCO Using Transformer-Based LC Letters, vol. 13, pp. 446-448, Oct. 2003
[6] M. Tsai, Y. Cho, and H. Wang, “A 5-GHz Low Phase Noise Differential Colpitts CMOS VCO,” IEEE Microwave and Wireless Components Letters, vol. 15, pp. [7] Y. Eo, K. Kim, and B. Oh, “Low Noise 5 GHz Differential VCO Using InGaP/GaAs HBT Technology,” IEEE Microwave and Wireless ComponentsLetters, vol. 13, pp. 259-261, Jul. 2003
[8] J. Yuan and C. Svensson, “High Speed CMOS Circuit Technique,” IEEE J. Solid-State Circuits, vol. 24, pp. 62-70, Feb. 1989.
[9] J. N. Soares, Jr. and W. A. M. Van Noije, “A 1.6 GHz Dual Modulus Prescaler Using the Extended True Single Phase Clock CMOS Circuit Technique (E-TSPC),” IEEE J. Solid-State Circuits, vol. 34, pp. 97-102, Jan. 1999.327-329, May2005.

AUTHOR’S PROFILE

Mr.B.V.Gavali.
Receive B.E. Instrumentation from S.R.T.M.U.Nanded
M.E.in Instrumentation from S.R.T.M.U.Nanded
Currently working as H.O.D at K.K.W.Polytechnic Nashik
Email ID : bhausaheb.gavali@gmail.com
Mob No. +919822491729

Mr.Rode S.K.
Receive B.E. Electronics from S.R.T.M.U.Nanded.Now Pursuing M.E.in VLSI& EMBEDDED SYSTEM at SITRC from UOP .Currently working as Lecturer at K.K.W.Polytechnic Nashik
Email ID: suresh.rode@gmail.com
Mob No. +9198890728472

Mr.Shelke S.K.
Receive B.E.E&Tc from University of Pune. Now Pursuing M.E. in VLSI & EMBEDDED SYSTEM at SITRC from UOP.
currently working as Lecturer at Shatabdi College of Engineering Nashik
Email ID : sandeep.shelke@gmail.com
Mob No. +919823468084

Mr.M.S.Shinde.
Receive B.E.E&Tc from University of Pune. Now Pursuing M.E. in Coommunication at SGDCOE from NMU..
currently working as Lecturer at K.K.W.PolytechnicNashik
Email ID : mahenshinde88@gmail.com
Mob No. +919975650094