A Novel Tunable High Frequency Sinusoidal Oscillator Based on the Second Generation Current Controlled Conveyor (CCCII)

Nupur Mittal[1], Piyush Charan[2], Firdaus Majeed[3]

[1,2,3]ECE Department, Integral University, Lucknow-226026

Abstract- The field of analog VLSI design current mode devices has significantly gained importance. Current mode devices such as current conveyors have established their identity as the most demanding devices in the signal processing area due to their high bandwidth, greater linearity, larger dynamic range, low power consumption, simple circuitry and occupy less chip area. In this paper we have proposed a Tunable High Frequency Oscillator that employs the use of only Current Controlled Conveyors and Capacitors. Various simulations have been carried out to obtain the desired results. The outcomes show that by varying Bias Current and capacitor value we get oscillations of different frequencies.

Index Terms- Current controlled conveyor, High Frequency Sinusoidal Oscillator, CCCII.

I. INTRODUCTION

The second generation current controlled conveyor (CCCII) has the advantage of electronic adjustability over the CCII i.e. in CCCII; adjustment of the X-terminal intrinsic resistance via a bias current is possible. The CCCII has been designed to work as a Tunable Oscillator for high frequencies. An oscillator enjoys the same status in the domain of electrical and electronics engineering as do wheels in the mechanical engineering. Sinusoidal Oscillators of variable frequency find wide range of applications in instrumentation & measuring systems, communication, control systems and signal processing.

In this paper second generation positive (CCCII+), negative (CCCII-) and dual output current controlled current conveyor (DOCCCII) is simulated by using 350nm CMOS technology and its various applications are simulated which are beneficial in the field of analog signal processing like high frequency tunable sinusoidal oscillator.

II. BACKGROUND

Current conveyors and current mode circuits have reasonably established their identity as an important circuit design element. The second generation current controlled conveyor (CCCII) has proven the most promising candidate over the CCII because of its advantage of electronic tunability therefore it is most frequently used in the world of current mode to design different analog circuits. The proposed oscillator realization is shown in Figure 1 where CCCII± elements are considered having ideal terminal properties. This circuit enjoys the circuit simplicity, as it utilizes a CCCII+, a CCCII- and just two capacitors. A CCCII- is different from a CCCII+ only in its output stage; otherwise, their principle architecture remains the same.

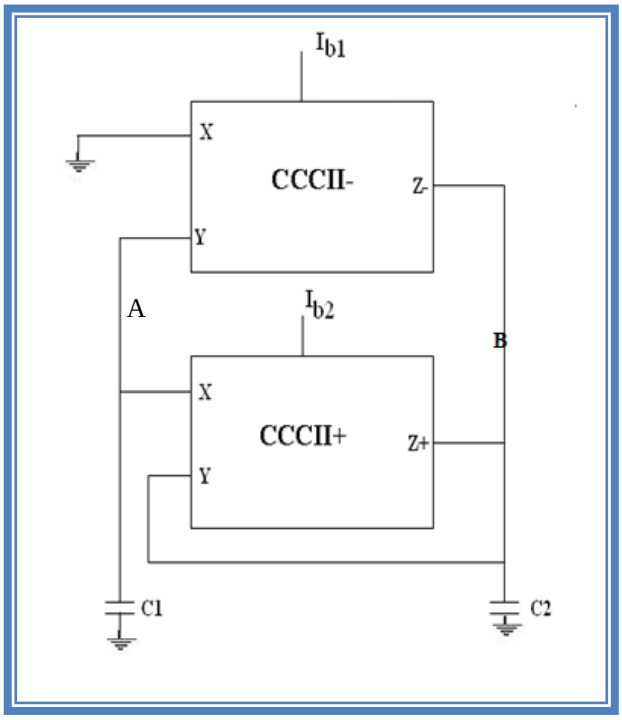

Figure 1: Block diagram of Sinusoidal Oscillator using CCCII±

The analysis of the oscillator circuit is given below

Applying KCL at the node A

$$V_1 sC_1 = (V_2 - V_1)/Rx_2 \quad (2.1)$$

$$V_2 = V_1 (1 + sC_1 Rx_2) \quad (2.2)$$

Applying KCL at the node B

$$V_2 sC_1 + V_1/Rx_1 = (V_2 - V_1)/Rx_2 \quad (2.3)$$

Putting value of V_2 in the above equation we get

$$V_1 \times ((1 + sC_1Rx_2)\, sC_2Rx_1 + 1) = V_1 \times (1 + sC_1Rx_2 - 1)\, Rx_1/Rx_2 \quad (2.4)$$

i.e.

$$sC_2Rx_1 + s^2C_1C_2Rx_1Rx_2 + 1 = sC_1Rx_1 \quad (2.5)$$

Finally we get

$$s^2C_1C_2Rx_1Rx_2 + sRx_1(C_2 - C_1) + 1 = 0 \quad (2.6)$$

So at C_1=C_2

$$\omega_0^2 = 1/(Rx_1Rx_2C_1C_2) \quad (2.7)$$

Where Rx_1 and Rx_2 depends on biasing currents I_{b1} and I_{b2}. Applying the choice of equal components,

$C_1 = C_2 = C$; $Rx_1 = Rx_2 = R$, the frequency of oscillations is simplified to

$$\omega_0 = 1/RC$$

Here we have taken values as C_1=C_2=3pF, I_{b1}=70µA and I_{b2}=70 µA. An impulse has been applied at node A and we get sinusoidal output at node B.

For realizations, of the above Sinusoidal Oscillator, CMOS design of CCCII± is adopted, and the oscillator of figure 1 is simulated on HSPICE. The simulation results of the oscillator are presented in fig 2 and fig3. Figure 2 shows the oscillations generated by the oscillator and figure 3 shows the expanded view of oscillations.

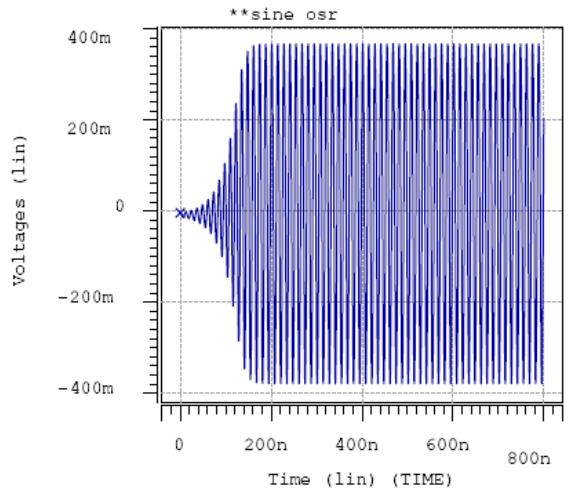

Figure 2: Output of the oscillator

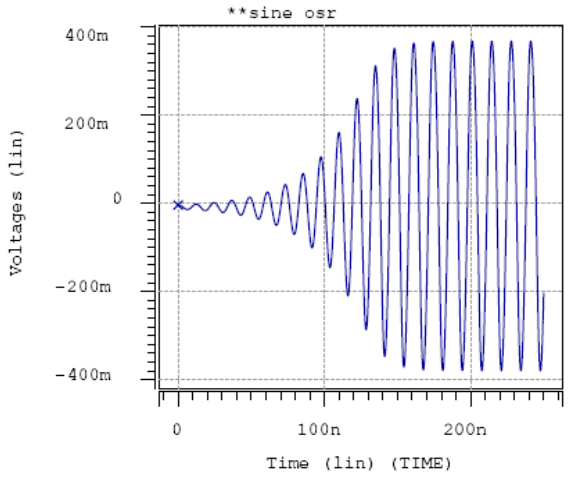

Figure 3: Expanded view of the Oscillations

Fourier analysis, with respect to the principal frequency (75MHz), is performed on the signal to ascertain the quality of the oscillations. Result of this analysis is presented in figure 4.

III. SIMULATION RESULTS

Peaks in figure 4 correspond to the principal frequency of the oscillator and its harmonic frequencies. Estimates of the total harmonic distortion (THD) and the DC component of the signal are important quality matrices for the sinusoidal wave shape of the output signal. Both these parameters are found reasonably very low. The simulation results are summarized in Table 1.

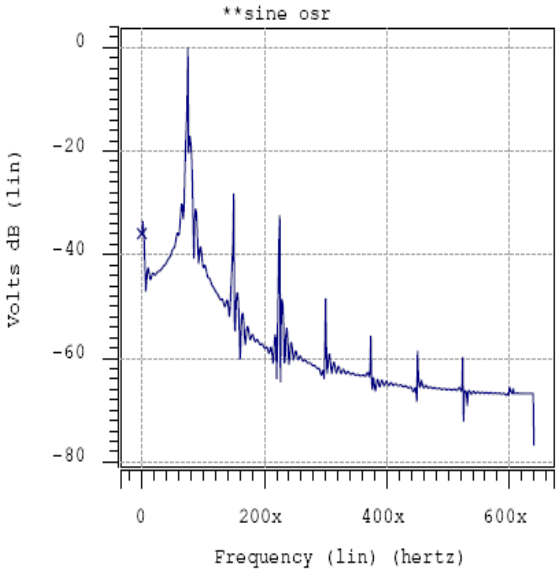

Figure 4: Fourier Response of the Oscillator

Table 1: Performance Results of the Proposed Oscillator

[1] **Performance Parameters**	[2] **Details**
[3] **Frequency**	[4] 75MHz
[5] **I_{BIAS}**	[6] 70µA
[7] **C_P**	[8] 3pF
[9] **THD**	[10] 4.67%
[11] **DC Component**	[12] 8.29mV
[13] **Peak Amplitude**	[14] 368mV
[15] **Avg. Power**	[16] 4.37mW

The graph shown below in figure 5 is plotted across the frequency of output signal in MHz to the device bias current in µA. HSPICE tool is used for extensive simulations and for these analysis capacitances are fixed at 3pF. We see that there is a significant increase in the frequency of the output signal of the oscillator when the Bias Current is increased.

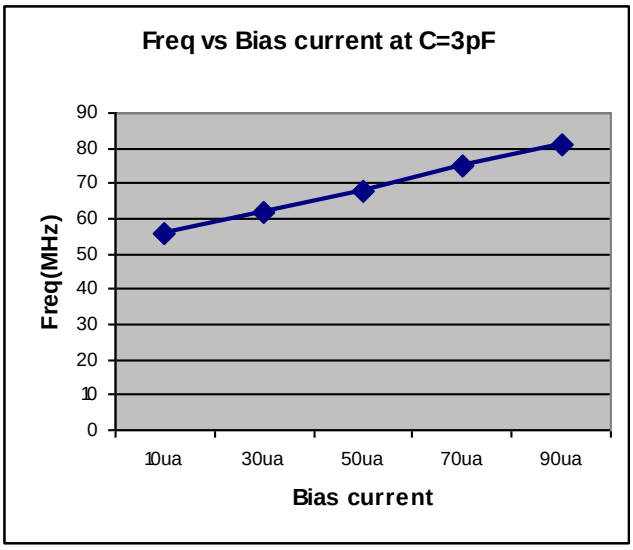

Figure 5: Graph of frequency of output signal against the device bias current (when C=3pF is constant).

Figure 6 is the response plotted when device bias current is kept constant at 70µA and the capacitances are changed from 1pF to 7pF.It has been observed from the graph that there is a significant decrease in frequency with increase in capacitances.

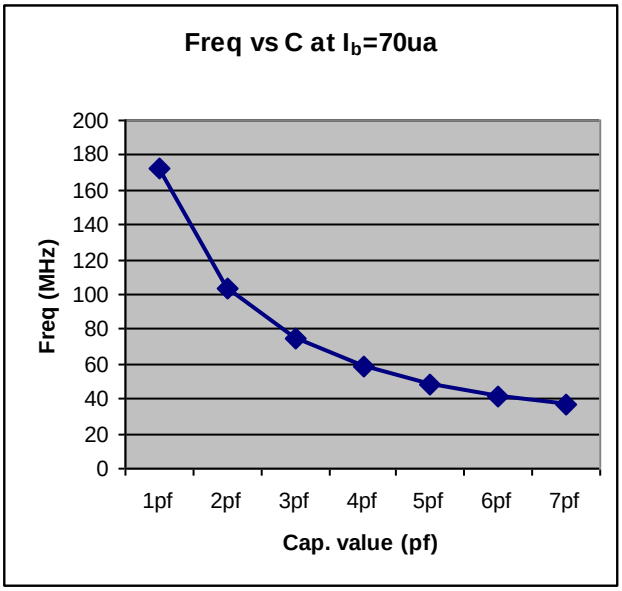

Figure 6: Graph of frequency of output signal against the value of Capacitance (when I_b=70µA is constant).

IV. CONCLUSION

The simulation results show that by varying Bias Current and capacitor value we get oscillations of different frequencies. So it works as tunable oscillator of Higher Frequency range as it is of the order of few MHz.

REFERENCES

[1] Kramer Liu "Analog VLSI: circuits and principles", a Bradford book, the MIT press Cambridge, London , 2004.

[2] Sedra. S, Smith K. C "A second generation current conveyor and its applications," IEEE Trans. Circuit Theory, vol. CT-17, pp. 132-134, Feb.1970.

[3] Kumar, U., Shukla, S.K., "Recent developments in current conveyors and their applications", Microelectronics. J., 16, pp. 47-52, 1985.

[4] Minaei Shahram "Dual Input Current Mode Integrator and Differentiator Using Single DVCC and Grounded Passive Elements", IEEE MELECON 2004,may 12-15, 2004 Dubrovnik, Croatia.

[5] Grigorescu. L "Amplifiers built with current conveyor", sept 2006 Dunarea of Romania.

[6] Pandey Neeta , Paul. Sajal K. and Bhattacharya Asok "Sinusoidal Oscillator – A New Configuration Based on Current Conveyor" University of Patras Department of Physics Section of Electronics & Computers Electronics Laboratory.

[7] Shah N. A · M. F. Rather · S. Z. Iqbal "SITO electronically tunable high output impedance current-mode universal filter" April 2006 Springer Science + Business Media, LLC 2006.

AUTHORS

First Author – **Nupur Mittal** is currently working as Assistant Professor in the Department of Electronics and Communication Engineering of Integral University, Lucknow. She received her B.Tech. Degree in Electronics & Communication Engineering in 2007 from UPTU, Lucknow, India and her M.Tech. Degree in Electronics & Communication Engineering in 2012 from Integral University, Lucknow. Her research is focused on Embedded VLSI and Current Mode VLSI.
E-mail: mittalnupur2004@gmail.com

Second Author – **Piyush Charan** is currently working as Assistant Professor in the Department of Electronics and Communication Engineering of Integral University, Lucknow. He received his B.Tech. Degree in Electronics & Communication Engineering in 2010 from Integral University, Lucknow, India and received his M.Tech. Degree in Wireless Communication Engineering from the Department of Electronics & Communication Engineering in 2012 from Sam Higginbottom Institute of Agriculture, Technology and Sciences-Deemed University (SHIATS-DU), Allahabad, India. He is a Member of IEEE, USA and Life Member of ISTE, India. His research is focused on Embedded VLSI, Current Mode VLSI, Wireless Sensors, Mobile Ad-Hoc Networks and VANETs.
E-mail: mr.piyush.c@ieee.org

Third Author – **Firdaus Majeed** is currently working as Assistant Professor in the Department of Electronics and Communication Engineering of Integral University, Lucknow. She received her B.Tech. Degree in Electronics & Communication Engineering in 2007 from UPTU, Lucknow, India and received her M.Tech. Degree in Electronics & Communication Engineering in 2011 from Integral University, Lucknow. She is a Member of IEEE, USA. Her area of research is focused on Embedded VLSI and Current Mode VLSI.
E-mail: firdausmajeed11@gmail.com