MANTECH Publications

Journal of Research in Electrical Circuits and Systems
Volume 4, Issue 1, January-April 2019

Capacitor Controlled Oscillator with the Help of Operational Transresistance Amplifier

Sumanta Karmakar[1], Khushi Banerjee[2], Lipika Mondal[3], Ashmi Chakraborty[4], Pratik Dey[5]

Department of Electronics and Communication

Asansol Engineering College, Asansol, India

Corresponding Author: *sumanta.karmakar@gmail.com*

Abstract

This research paper introduces a fully controllable Oscillator and Operational Trans Resistance Amplifier (OTRA) and six passive components consist of three Resistors and three Capacitors. Workability of all the simulators are tested by 0.5µm CMOS Technology.

Keywords: *Operational Trans Resistance Amplifier, Oscillator*

INTRODUCTION

The operational Transresistance amplifier (OTRA) plays a very important role as an active element in analog integrated circuits due to their low input and output impedances which eliminates limitations of response time due to capacitive time constants. Both input terminals are internally grounded, thereby purge parasitic capacitances of the input. OTRA has the benefits of a high slew rate &extensive bandwidth. The OTRA is generally a three port analog building block besides the power terminals.

In this paper, the capacitance controlled oscillator is planned using one OTRA and six passive components consisting of three resistors and three capacitors.

CIRCUIT DESCRIPTION

The symbol of OTRA and its corresponding CMOS circuit is given respectively in Fig.1 and Fig.2. Its port relations are shown below:

$$\begin{pmatrix} V+ \\ V- \\ Vo \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ Rm & -Rm & 0 \end{pmatrix} \begin{pmatrix} I+ \\ I- \\ Io \end{pmatrix}$$

$$V = V\text{-} = 0$$

Page 15-20 © MANTECH PUBLICATIONS 2019. All Rights Reserved

And Rm→∞ therefore,1/Rm=0

V0 = Rm(I+ – I-)

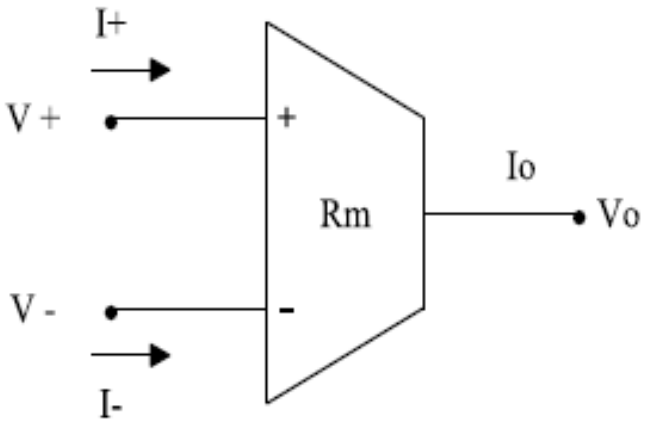


Fig1: Block Diagram of OTRA

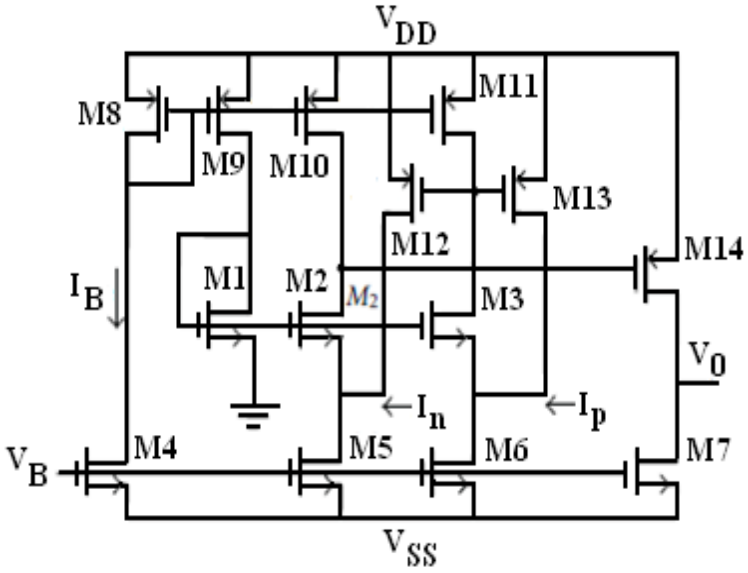


Fig 2:Internal Circuit of OTRA Using CMOS

The proposed capacitance controlled oscillator using OTRA is shown in Fig 3

The routine analysis results an expression of input current In asIn=VC1S+V0/R1

and that of input current Ip is given by

Ip=V/R3+V0/R2

and that of output voltage V0 is given by

V0 =Rm(V/R3+V0 /R2-V0 /R1-VC1S)

Which is obtain by putting the values of Inand Ip in the equation V0 = Rm(Ip – In)

Page 15-20 © MANTECH PUBLICATIONS 2019. All Rights Reserved

And (VZ-V) C2S=VC1S+V/R3+VC3S **See figure 3.**

Now solving the three equations we obtain the characteristic equation of the oscillator which is given by:

$R1R2R3C1C2S^2$+(R2R3C1+R2R3C2+R2 R3C3-R1R3C1-R3R1C2-R1R3C3-R1R2C2)S+(R2-R1)=0

And the condition of the oscillation can be obtain by making the S=0 which is given by:

R2R3C1+R2R3C2+R2R3C3-R1R3C1-R3R1C2-R1R3C3-R1R2C2=0

And the frequency of the oscillation is given by:

Frequency=1/2π(√(R2-R1)/R1R2R3C1C2)

[where, R1,R2,R3 are the resistors and C1,C2,C3 are the capacitors]

SIMULATION RESULT

The PSPICE simulations given in this paper are performed using OTRA based on CMOS given in Fig.3. Model parameters, supply voltages and L and W of transistors are obtained from MIETEC 0.5 μm CMOS process. To implement 1KHzfrequency the passive elements of C1=150pF, C2=100pF, C3=120pF, R1=3kΩ and R2 = 10kΩ, R3=20kΩ are used.

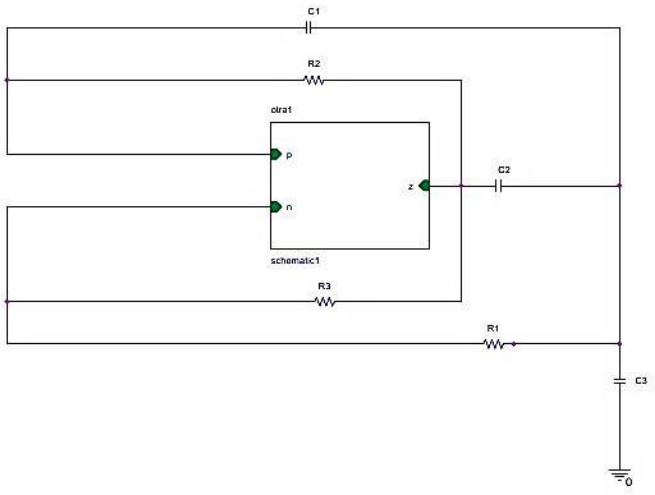


Fig 3 OTRA based proposed oscillator structure

Page 15-20 © MANTECH PUBLICATIONS 2019. All Rights Reserved

Table 1 MOS Dimensions Used In This Circuit

TRANSISTORS	W (μm)	L (μm)
M1-M3	100	2.5
M4	10	2.5
M5,M6	30	2.5
M7	10	2.5
M8-M11	50	2.5
M12,M13	100	2.5
M14	50	2.5

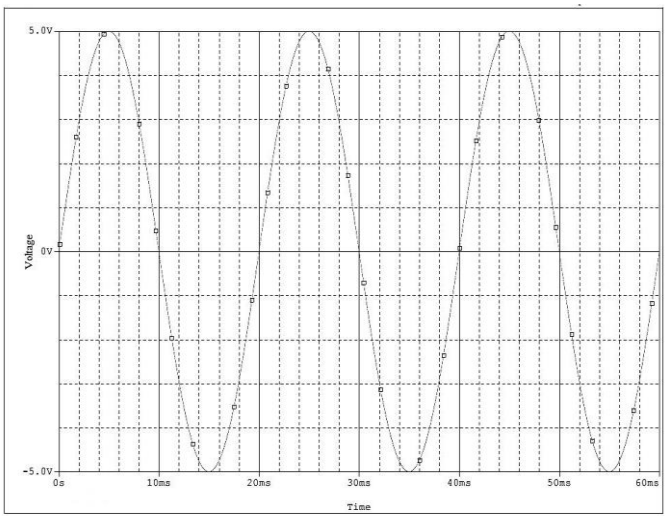


Fig 4 Simulation of proposed oscillator

CONCLUSION

In this paper the proposed circuit use only one OTRA and a few passive components, and the proposed circuit is simpler than the voltage-mode (op-amp based) waveform generators. Both the simulated and experimental output waveforms are given in Fig. 4. The main advantage of the proposed circuit is less number of passive components, grounded capacitor which is useful for integrated realization. The percentage of Total Harmonic Distortion (THD) for the proposed circuit is within the acceptable limit. Taking these advantages into consideration, the proposed circuit can have wider

Page 15-20 © MANTECH PUBLICATIONS 2019. All Rights Reserved

applications in many fields of electronics, signal processing and for instrumentation applications.

REFERENCES

1. FıratKacar,AbdullahYesil., " New CMOS Realization of Voltage Differencing Buffered Amplifier and Its Biquad Filter Applications," Radioengineering, VOL. 21, NO. 1, APRIL 2012.

2. Alperduru, HakanKuntman, "CMOS Differential OTRA Design for the Low Voltage Power Supplies in the Sub- Micron Technologies," Turk J Elec Engin,VOL.13, NO.1 2005.

3. Khaled N. Salamaa, Ahmed M. Soliman, "CMOS operational Transresistance," Microelectronics Journal 30 (1999) pp.235–245.

4. Ahmed M.Soliman., "modified CMOS differential operational Transresistance amplifier (OTRA)," Int. J. Electron. Commun. (AEÜ) 63 (2009) pp.1067–1071,24 August 2008.

5. K.N. Salamaa, A.M. Soliman,"Novel oscillator using the operational Transresistance amplifier," Microelectronics Journal 30 (1999) pp.235–24

6. K.N. Salama and A.M. Soliman, Mostafa H, Soliman A. "A modified CMOS realization of the operational transresistance amplifier". Frequenz 2006;60:70–6.

7. Cheng J, Tsao H, Chen C. "Operational transresistance amplifier using CMOS technology". Electron Lett 1992;28:2087–8

8. S. Kılın, c, U. C, am, "A new biquadratic filter configuration employing a single operational transresistance amplifier", European Conference on Circuit Theory and Design, Vol. 1, pp. 275-278, 2003.

9. U. Cam, C. Cakir, O. Cicekoglu, "Novel transimpedance type first-order all-pass filter using single OTRA", AEUInternational Journal of Electronics and Communications, Vol. 58, pp. 296-298, 2004.

Page 15-20 © MANTECH PUBLICATIONS 2019. All Rights Reserved

10. F. Kacar, "Operational transresistance amplifier based current-mode all-pass filter topologies", Applied Electronics, pp. 149-152, 2009.

11. Y.S. Hwang, D.S. Wu, J.J. Chen, C.C. Shih, W.S. Chou, "Realization of high order OTRA MOSFET-C active filters", Circuits Systems Signal Processing, Vol. 26, pp. 281-291, 2007.

12. Y.S. Hwang, D.S.Wu, J.J. Chen, C.C. Shih, W.S. Chou, "Design of current mode MOSFET-C filters using OTRAs", International Journal of Circuit Theory and Applications, Vol. 37, pp. 397-411, 2009.

Page 15-20 © MANTECH PUBLICATIONS 2019. All Rights Reserved