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A Research Paper on Fully Capacitor Controllable Oscillator Constructed By The Assistance Of Operational Trans Resistance Amplifier

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ABSTRACT: Operational Trans resistance Amplifier is important on the go element in Analog integrated circuits and system. The OTRA is receiving increasing attention as a basic building block in analog circuit design. It is relatively a new building block functioning from low voltage supplies and overcomes the finite gain bandwidth product associated with traditional op-amp. The basic principle behind the design of OTRA is to provide amplification of high frequency signals with the using standard operational amplifier. In this paper, effort is made to study the role of OTRA as an active building block in analog circuits. Various CMOS realization of OTRA present in the literatures are studied and these circuits are used to realize various signal processing and generating circuits. Based upon component sensitivity tendency and variation amount, just properly adjusting one capacitance by a small difference, or giving approximate component values for achieving precise output responses is investigated and developed different OTRA realization. In many applications high speed and efficient power consumption is required is preferred. For this purpose conventional transistor technique are usually chosen, but this results in lower power efficiency. The main objective behind the use of this amplifier is to make the analog and digital system as compact as possible and more power efficient with the required functionality of OTRA. The Low Power is the key contribution of the main processing blocks in OTRA system. This paper represents, a fully capacitor controlled oscillator constructed by the assistance of Operational Trans resistance Amplifier (OTRA). The proposed circuit requires single OTRA and a few passive components to generate oscillations. The condition of oscillation and frequency of oscillation of the proposed circuit is controlled by a single grounded capacitor. The performance of the proposed circuit is examined using ORCAD software. The proposed circuit has been build using ORCAD and the circuit has been implemented using PSpice. Theoretical analyses of the proposed circuits are carried out by the help of PSpice simulator.Workability of all the simulators are tested by 0.5μm CMOS Technology

KEYWORDS: Operational Trans Resistance Amplifier, Oscillator, Capacitance, Resistance

I.INTRODUCTION

Ever since its development the operational amplifier (op-amp) is an integral part of analog signal processing and generating circuits. It is intended to implement closed loop voltage processing circuits which are known as voltage-mode (VM) circuits. However high frequency performance of these circuits is limited due to constant gain-bandwidth product and low slew rate of the op-amps. The attempt to overcome this problem has led to the development of current-mode (CM) signal processing. In CM signal processing, current is used as the active variable in preference to voltage, either throughout the circuit or only in certain critical areas. CM techniques can achieve a considerable improvement in system performance in terms of bandwidth, signal linearity, slew rate and power consumption. Consequently CM signal processing has progressed considerably in past few decades and has resulted in emergence of various CM analog building blocks and OTRA among those is of relatively recent origin. The OTRA is a high gain current input voltage

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output device. Both input and output terminals of the OTRA are characterized by low impedance resulting in circuits that are insensitive to stray capacitances making OTRA appropriate for high frequency applications. In order to maintain compatibility with existing voltage processing circuits, it is necessary to convert the input and output signals of current-mode circuits to voltage, using Trans conductors and trans resistors respectively. This has the disadvantage of increasing both the chip area and power dissipation. However circuits using OTRA as the active element benefit from the current processing capabilities at the input terminals, and can directly drive the existing VM signal processing circuits thus eliminating the requirement of additional circuitry and associated power consumption, at the output. The ideal OTRA is introduced first which is followed by its null or based model. This model can be used in CAD tools to compute fully-symbolic small-signal characteristics of OTRA-based analog circuits. The existing OTRA realizations have been taken up later. Few basic applications of the OTRA such as voltage amplifiers, adder, subtracter, and integrator circuits are also described. The operational Trans resistance amplifier (OTRA) plays a very important role as an active element in analog integrated circuits due to its 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 Differential Operational Trans resistance Amplifier (OTRA) is a four terminal analog building block, besides the power terminals.

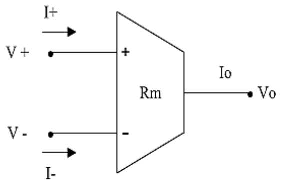

Fig 1: Block diagram of OTRA

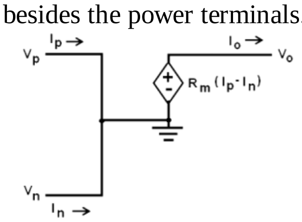

Fig 2: Equivalent Circuit of OTRA

The port relationship of OTRA may be characterized by the following matrix form:

$$\begin{bmatrix} V_p \\ V_n \\ V_0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ R_m & -R_m & 0 \end{bmatrix} \begin{bmatrix} I_p \\ I_n \\ I_0 \end{bmatrix}$$

Therefore, $V_p=V_n=0$

$V_O=R_m(I_p-I_n)$

Where R_m is the Trans resistance of the OTRA, since input terminals of this element are internally grounded, most effects of parasitic capacitances at the input disappear. For ideal operation, the Trans resistance (R_m) approaches infinity, forcing the input currents to be one and the same. Thus, OTRA must be used in a feedback configuration in a way that is similar classical operational amplifier.

II. SIGNIFICANCE OF THE SYSTEM

This paper aims at designing the OTRA based Capacitor controlled Oscillator and introducing basic features of OTRA which provide user level priority. The main focus of this work is to present the implementation of OTRA instead of widely used OPamp and comparison between those two amplifiers. The implementation of capacitor controlled OTRA based Oscillator has been implemented in ORCAD using PSpice tool and simulation results are discussed. The scope of this work is limited to use of minimum number of passive components.

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III. LITERATURE SURVEY

A novel operational Trans resistance amplifier (OTRA)-based single resistance controlled sinusoidal oscillator (SCRO) is proposed.

[UGUR CAM]

Fully integrated universal biquads using operational Trans resistance amplifiers with MOS-C Realization

[AHMET GÖKÇEN & UGUR CAM]

IV. METHODOLOGY

A. COMPONENTS USED

- Operational Trans Resistance Amplifier
- Resistors
- Capacitors

B. SOFTWARE USED

- **ORCAD (Pspice)**

C. PROPOSED OSCILLATOR

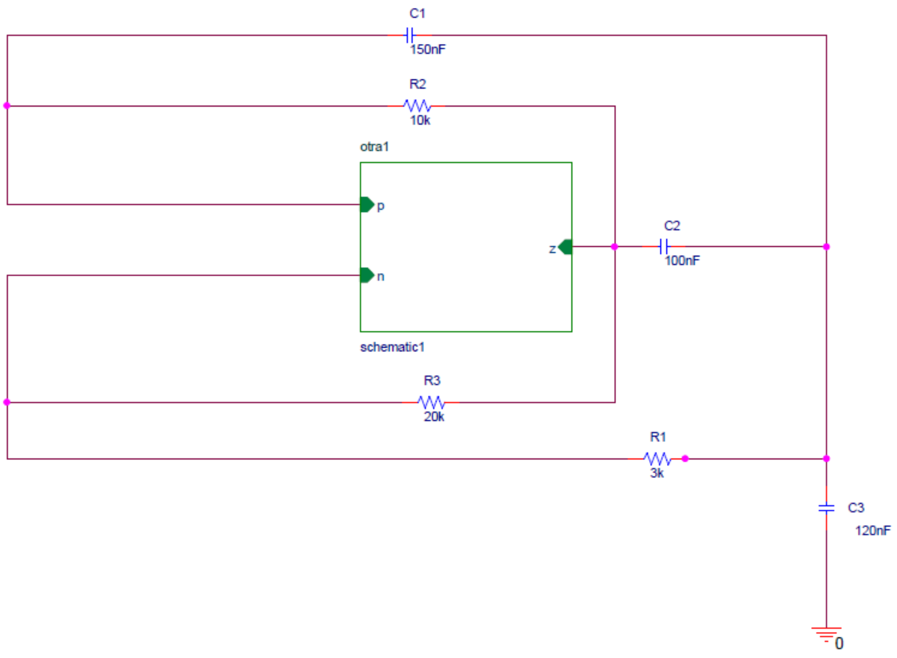

Fig 3: OTRA based proposed oscillator structure

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D. MATHEMATICAL CALCULATION

By applying KVL and KCL on the above circuit as discussed above we get,
$I_n = VC_1S+V_Z/R_1$
$I_p = V/R_3+V_Z/R_2$
Putting The Value of In and Ip in equation $V_Z = R_M (I_p-I_n)$
[Where, R_M is the Trans resistance and I_p and I_n are the input ports and $V_Z$is the output Port.]
$V_Z = R_M (V/R_3+V_Z /R_2-V_Z /R_1-VC_1S)$
$V_Z (R_M/R_2-R_M/R_1) = R_M (1/R_3-C_1S) V$
$V_Z (1-R_M (1/R_2-1/R_1)) = R_M (1/R_3-C_1S) V$
$V_Z R_M (1/R_M-(1/R_2-1/R_1))= R_M (1/R_3-C_1S)V$
We know that $R_M \rightarrow \infty$
Therefore, $1/R_M = 0$
So $V_ZR_M (-(1/R_2-1/R_1)) = R_M (1/R_3-C_1S)V$
So $V_Z (1/R_1-1/R_2) = (1/R_3-C_1S) V$
$V_Z= V((1-R_3C_1S)/R_3) ((R_1R_2)/(R_1-R_2))$
And $(V_Z-V) C_2S = VC_1S+V/R_3+VC_3S$
Putting the value of V_Z in above equation we get,
$R_1R_2R_3C_1C_2S^2+(R_2 R_3C_1+R_2R_3C_2+R_2R_3C_3-R_1R_3C_1-R_3R_1C_2-R_1R_3C_3-R_1R_2C_2)S+(R_2 -R_1) = 0$
Frequency of Oscillator$=1/2\pi (\sqrt{} (R_2 -R_1)/ R_1R_2R_3C_1C_2)$
Condition of Oscillation: $R_2R_3C_1+R_2R_3C_2+R_2R_3C_3-R_1R_3C_1-R_3R_1C_2-R_1R_3C_3-R_1R_2C_2 = 0$

V. EXPERIMENTAL RESULTS

A. SIMULATION

For simulating the above circuit the values of the passive components taken as shown below
$R_1 = 3k\Omega$
$R_2 = 10k\Omega$
$R_3 = 20k\Omega$
$C_1 = 150nF$
$C_2 = 100nF$
$C_3 = 120nF$

Table 1: MOS Dimensions

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

After simulating the circuit in PSpice simulator we get the following output using MOS dimensions and Simulation Parameters in the Proposed Oscillator Fig 3.

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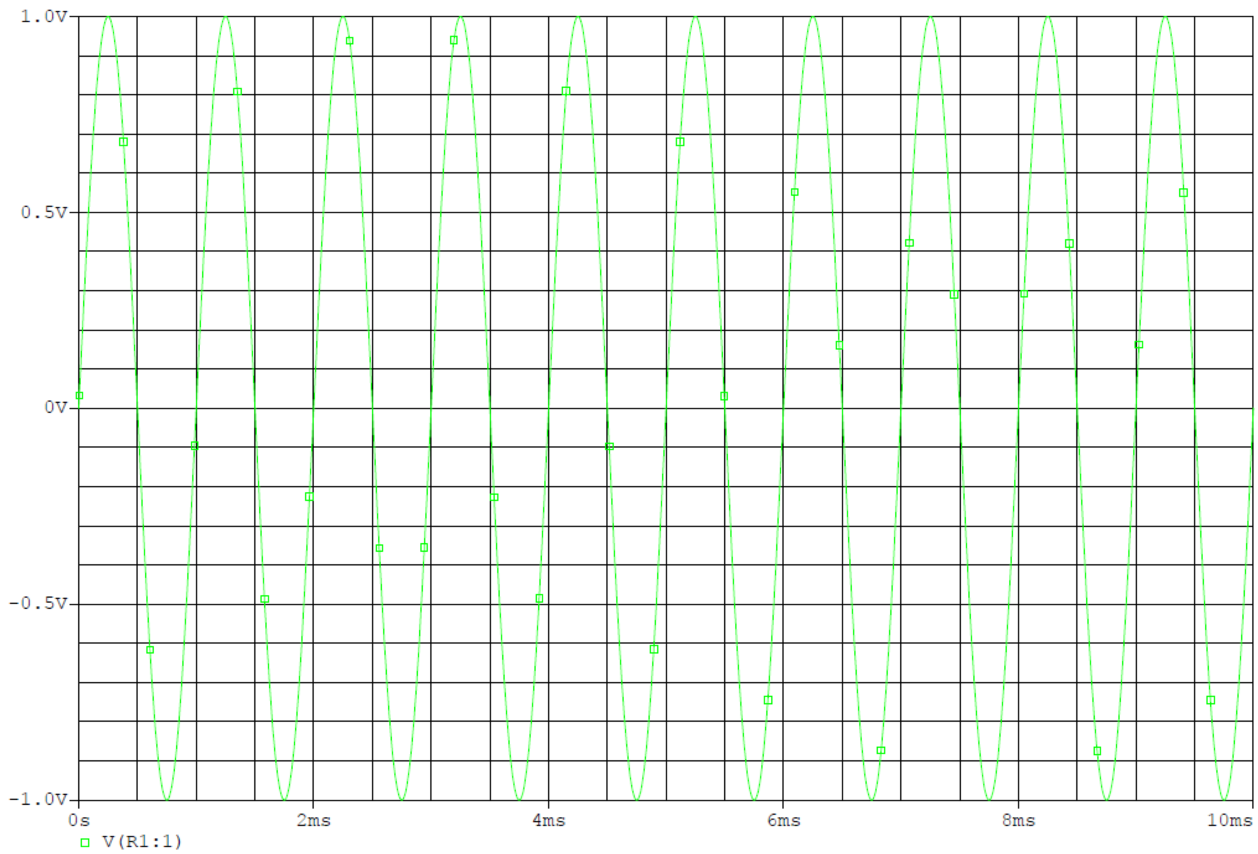

Fig 4: Output Of The Proposed OTRA

VI.CONCLUSION AND FUTURE WORK

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 advantages of the proposed circuit is less number of passive components, grounded resistor which is useful for integrated realization and the later can be replaced with a grounded capacitor. The percentage of Total Harmonic Distortion (THD) for all the proposed circuits is within the acceptable limit. Taking these advantages into consideration, the proposed circuits can have wider applications in many fields of electronics, signal processing and for instrumentation applications. Thus the operational Trans resistance 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.

A. Future Scope

- A oscillator can be design whose frequency and condition of oscillation can be independently controlled with minimum number of components.
- OTRA can be used in realizing voltage amplifiers, multipliers, integrators, continuous time filters and quadrature oscillator, universal filters, single-resistance-controlled oscillators, admittance simulators, and all-pass filters.

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