



Design of Bessel High Order All Pass Filter Based on AN OTRA

Vivek Bhatt, Sandeep Khantwal, Rahul Negi

Abstract— This paper features a single-input single-output (SISO). The suggested circuit is depend on OTRA which is referred as operational transresistance amplifier. and OTRA recommended on the parameters of its increasing slew rate and large bandwidth as compared to conventional circuit containing operational amplifier. In this paper Bessel Higher order All Pass filter structure are described and their simulation is carried out in PSPICE with the help of 0.5µm CMOS technology and simulation result follows the theoretical approach.

Keywords— OTRA, Higher Order All Pass Filter, SISO, Bessel, PSPICE, slew rate

I. INTRODUCTION

Operational transresistance amplifier (OTRA) evolved as a solution of current mode analog consisting block. The operational transresistance amplifier is referred as amplifier of current difference or an amplifier of Norton. OTRA has features like high gain current input, voltage output device[1-3]. OTRA has both input and output impedance having low value. Due to internally grounded connections of input terminals of OTRA helps in reducing parasitic capacitances at the input[4-6]. Input resistance is also eliminated due to the grounded connection of input. It gives some merits over the building blocks of analog current mode like operational transconductance amplifier OTA, DVCC[5], (CC) known as current conveyor[6] and CDBA etc. Reduction of the parasitic capacitance at the input terminal which is internally generated is the main factor of an OTRA and produces high slew rate along with wider bandwidth. Several analog filters based on OTRA are represented and reference cited there in all involved large than single OTRA [7]. No papers are described on Bessel second order all pass filter architecture depend on Operational transresistance amplifier [8-10].

The suggested work focuses on to develop a second order All Pass filter structure based on an OTRA that provides Bessel filter response.

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II. CIRCUIT DESCRIPTION

The inherent architecture of CMOS depend OTRA is shown in figure number 1[2]. The symbolic representation of an OTRA is given in Figure number 2 and the relative port-dependency for an ideal OTRA are summarised as:

$$\begin{aligned} V_p &= 0 \\ V_n &= 0 \\ V_o &= R_m(I_p - I_n) \end{aligned} \tag{1}$$

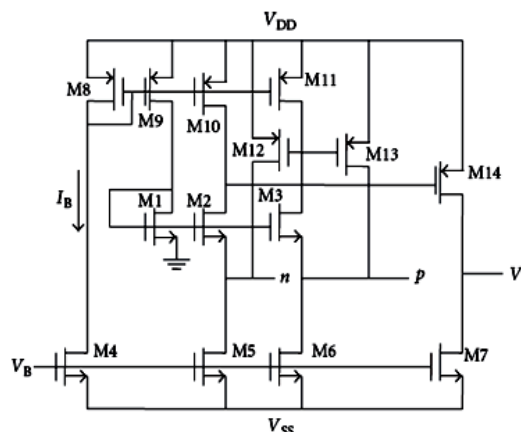


Fig.1. Inherent architecture of OTRA[2]

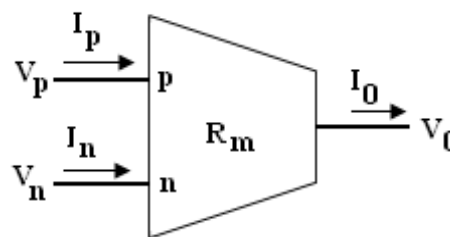


Fig.2. symbolic representation of an OTRA

Where, the V_p and V_n referred as the input terminals voltage of p and n having a transresistance gain denoted as R_m , which rises to infinity for the ideal circuit operation. After leaving the magnitude of a signal filter contacts but produces a change in phase. Such type of filter is considered as All Pass filter. An All-Pass filter which passes all the components of frequency of the input signals without attenuation. However, it gives phase shift which is predictable for different frequencies of the input signals. The response of phase changed from 0° to 360° since the frequency is changes from 0 values to infinite. An all pass filter objective is to give equalization of phase in p circuits containing pulse. The transfer function which is generalised of second order All-Pass filter is shown in equation 2:



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$$T(s) = \frac{1 - A_1s + B_1s^2}{1 + A_1s + B_1s^2} \quad (2)$$

In which A_1 and B_1 are known as the filter coefficient for All-Pass Bessel Filter which value are indicated in Table.1. The architecture obtained for the OTRA depend second order Bessel Filter are given in figure 3.

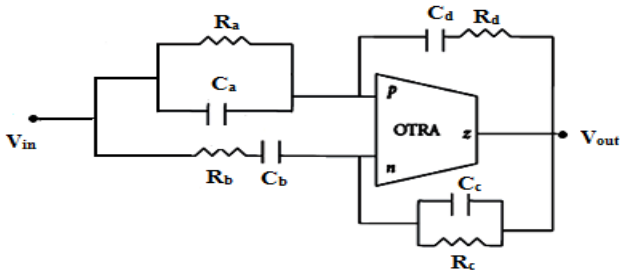


Fig.3. OTRA based second order All Pass filter structure

TABLE.1 SECOND ORDER FILTER COEFFICIENTS

Name of Filter	Coefficients of filter
Bessel Filter	$A_1 = 1.3617$ $B_1 = 0.6180$

The Bessel filter considered as accurate alternative between two constraints taken as attenuation and phase response. It has feature of no ripple carried out in pass band and moderate flat stop band filter. The transfer function for its RC-RC decomposition methodology [8] for the second order transfer function shown by equation (3)

$$T(s) = \frac{N(s)}{D(s)} = \frac{(s+1)}{D(s)} \quad (3)$$

And the routine analysis gives output voltage as

$$V_{out} = \frac{N(s)}{D(s)} V_{in}$$

where,

$$N(s) = \frac{1}{R_{a1}} + \frac{C_{a2}s}{R_{a2}C_{a2}s+1} - \frac{C_{b}s}{R_bC_b s+1}$$

$$D(s) = \frac{1}{R_c} + C_c s - \frac{C_d s}{R_d C_d s+1} \quad (4)$$

The Element Values of filter Passive Components for Bessel Filter is shown in Table.2

TABLE.2 Element Values of Passive Components.

Bessel	
$R_a = 80k \Omega$	$C_a = 12.29pf$
$R_b = 26.85k \Omega$	$C_b = 59.26pf$
$R_c = 80k \Omega$	$C_c = 12.29pf$
$R_d = 312.13k$	$C_d = 5.098pf$

III.SIMULATION RESULTS

The second order All Pass Bessel filter circuit is evaluated with PSPICE using CMOS depend OTRA and the performance index of the suggested second order All-Pass

filters are calculated with the help of CMOS implementation of OTRA having power supply voltages $V_{ss} = -V_{ss} = 1.5$ Vdc and biasing voltage taken as $V_B = -0.5$ Vdc [2]. The experimental results are introduced through PSPICE depending upon parameters 0.5mCMOS technology. The suggested circuits for various filters are evaluated for frequency of 100KHz and for the calculation of the values of the register and capacitor in which ZSF considered as impedance scaling factor $= 80 \times 10^3$ and FSF considered as frequency scaling factor $(FSF) = 2\pi \times 100 \times 10^3$ are taken. In case of the Butterworth All pass second order whose transfer function obtained as (1) the element values of passive components using the admittances are shown in Table.2 and Figure 4 indicates the simulation results of this circuit. The experimental results satisfy quite well with the theoretical approach.

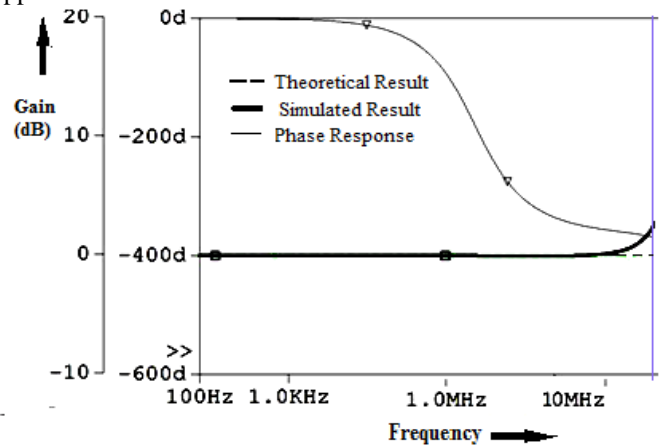


Fig.4.All Pass second order Bessel filter response

IV. CONCLUSION

In this paper OTRA depend Second Order all-pass Bessel filter structure is described. The suggested filter architecture uses an OTRA along with some passive components. The phase response plot clearly indicates that Bessel filters provides a linear phase response over a wide range of frequency. Theoretical results are proved with the help of simulation in PSPICE depend on parameter of 0.5 μ m CMOS through MOSIS.

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