Designing of Chebyshev Higher Order Filter using OTRA

Vivek Bhatt, Sandeep khantwal, Rahul negi , Manoj joshi

Abstract— the main feature of this paper is SISO having only one input and one output is mentioned. This recommended proposal is rely on an amplifier which is amplifier known as Operational transresistance (OTRA) also it is suggested on the feature of rising slew rate factor and bandwidth factor which is wide when compared to previous circuit of operational amplifier . This paper features structure of higher order Chebyshev filter and in PSPICE their affect is performed with the support of technology of CMOS having value 0.5µm and simulation outcomes go through the theory approach.

Keywords— OTRA, Slew rate, Chebyshev Filter, PSPICE CMOS

I. INTRODUCTION

Operational transresistance amplifier that us also known as an OTRA appeared as an alternative of analog mode of current consisting block. OTRA is also used to amplify the difference current is also known as current differencing amplifier or sometimes also known as Norton related amplifier. OTRA has some important features such as large gain current as input, voltage as a output device. Operational transresistance amplifier also features having low value of both input and output impedances. OTRA has input terminals which have internally grounded connections which helps it to in reduce parasitic capacitances available at the input. Moreover, due to the grounded connections of input there is a elimination of Input resistance. The main advantage of an OTRA is to reduce capacitance which is parasitic available at the inherent node intrnally produced and generates slew rate rises to high and also a bandwidth which is wide. No paper is mentioned till date on Chebyshev filter architecture which is based on an OTRA This recommended action concentrates on to design a filter structure which has dependency on this OTRA to produce response of Chebyshev filter.

II. CIRCUIT DESCRIPTION

The inherent building blocks related to Operational transresistance amplifier concentrates on CMOS is indicated in figure marked as number 1. The sign related to OTRA is provided in Figure indicated as 2 also the dependency of port in case of an ideal OTRA can be summarised below :

$$V_p \text{ (voltage at p terminal) } = 0$$
$$V_n \text{ (voltage at n terminal) } = 0$$
$$V_0 \text{ (output voltage) } = R_m(I_p - I_n) \qquad (1)$$

Revised Manuscript Received on January 10, 2020.
Vivek Bhatt, Department of ECE, Tula's Institute, Dehradun (Uttarakhand) India. E-mail: Vivekbhatt1987@gmail.com
Sandeep khantwal, Department of ECE Tula's Institute, Dehradun (Uttarakhand) India. E-mail: sandeep_kakma@rediffmail.com
Rahul negi, Department of ECE Tula's Institute, Dehradun (Uttarakhand) India. E-mail: rahulnegi815@gmail.com
Manoj joshi, Department of ECE, NIT Manipur, India.
E-mail: manojjoshi1506@gmail.com

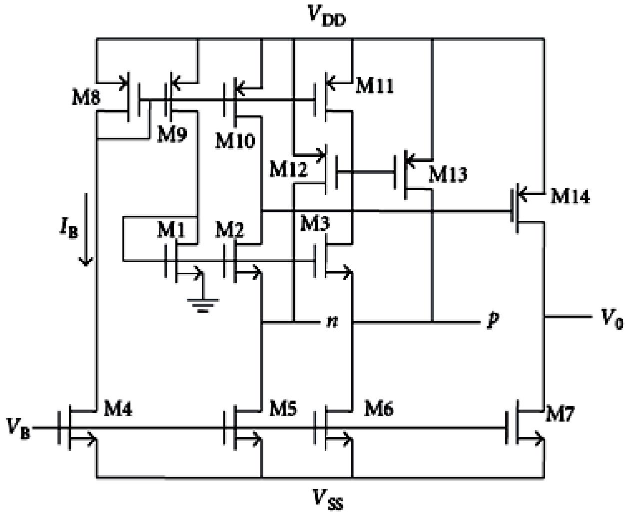


Fig.1. Internal building block of an OTRA

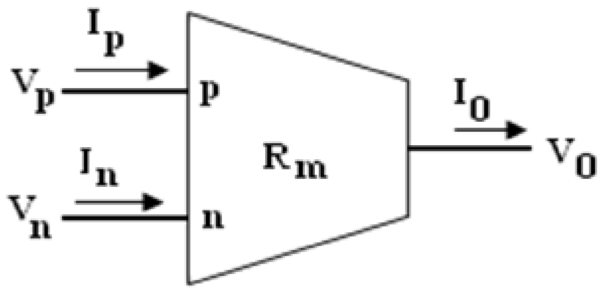


Fig.2. Representing sign related to an OTRA

In which value V_p as well as V_n is known as the inherent voltage of terminals p and n containing a gain called transresistance gain represented as R_m that rises to infinite value in case of operation of ideal mode. The filter when left the magnitude of a sound interacts hence develops shift emerges to phase. This kind of filter is known as type of filter of All Pass. Such type of filter which has the ability to pass all the elements of frequency of a signals taking as inputs with no attenuation. Moreover, it also provides shift in phase easily analysis of various signals input frequency. The reaction of variation of phase varies from 0° value to value of 360° hence frequency converts from a value of 0 to infinite. The purpose of this filter is to give equal phase basically in circuits regarding as pulse. The T(s) which is summarized of its second order is shown in equation 2:

$$T(s) = \frac{1 - A_1 s + B_1 s^2}{1 + A_1 s + B_1 s^2} \qquad (2)$$

In which the term A_1 and B_1 is referred as the coefficient of filter for Chebyshev filter whose value are mentioned in Table.1.

Published By:
Blue Eyes Intelligence Engineering & Sciences Publication

The suggested methodology utilizes structure of generalized filter having admittance value equal to eight indicated in Figure number 3. The relating transfer function is calculated with the help of the routine techniques as:

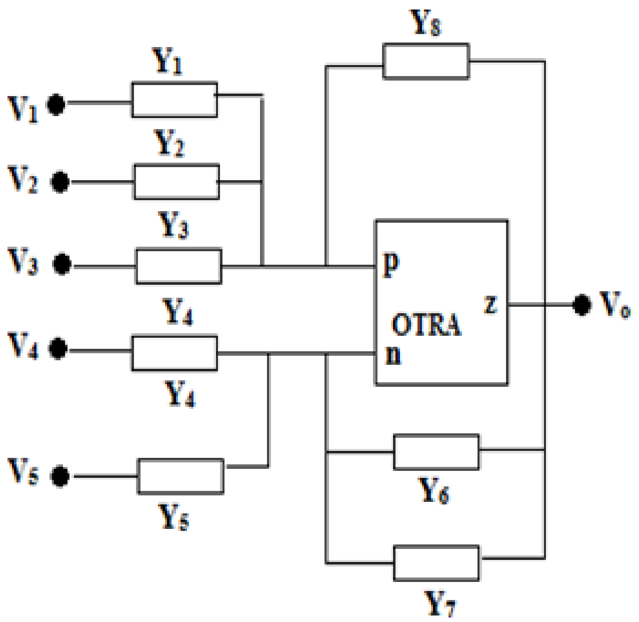


Fig.3. OTRA based second order All Pass filter structure

Table.1. Second Order Filter Coefficients

Filter name	Coefficients of filter
Chebyshev filter	$A_1 = 1.3023$ $B_1 = 1.5516$

For decomposition of RC to RC methodology the transfer function [12] for the second higher order indicated as an equation (3)

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

And the routine methodology provides output voltage given below:

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

Where,

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

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

Values of elementing components of filter Passive for Chebyshev Filter is indicated below marked as Table number 2

Table No-.2 Values of elements

Chebyshev Filter
R_a =82k Ω C_a =28.85pf
R_b =22.77k Ω C_b =74.45pf
R_c = 82k Ω C_c =28.84pf
R_d =66.04kΩ C_d =24.84pf

III.SIMULATION RESULTS

The Chebyshev filter circuit is analysed with the help of PSPICE by using CMOS that is based on an OTRA(operational transresistance amplifier) and the performance criteria of the recommended Chebyshev filter are evaluated by using implementation of CMOS of an OTRA which have power supply voltages such as $V_{ss} = -V_{ss}$ *having voltage* 1.5 and to bias the voltage such as V_B equal to -0.5 [2]. The experimental performance are performed using PSPICE which is based on constraints such as 0.5 um CMOS technology. The recommended structure for Chebyshev filters are calculated of 100 KHz frequency and to take the evaluation of the register value and capacitor ZSF termed as an impedance scale factor (ZSF) equivalent to 80×10^3 and frequency scaling factor which is known as FSF equivalent to $2\,\pi \times 100\times 10^3$ are taken. In contrast to the Chebyshev high order filter whose T(s) function achieved as (a) the elemental values of of passive parts with the utilization of admittances that is figured in Table marked as 2 and Figure number 4 shows the experimental outcome of the circuit. The simulation outcomes resemble well with the theory method. Here the recommended structure of High order Chebyshev filter is indicated in Fig. 3. The suggested high order Chebyshev filter is indicated in fig 4 and to achieve various response of filter adequate input signal is required. Table 3 shown the corresponding selection regarding V_1 , V_2 ,, V_3 ,V_4 ,V_5 to achieve different filter

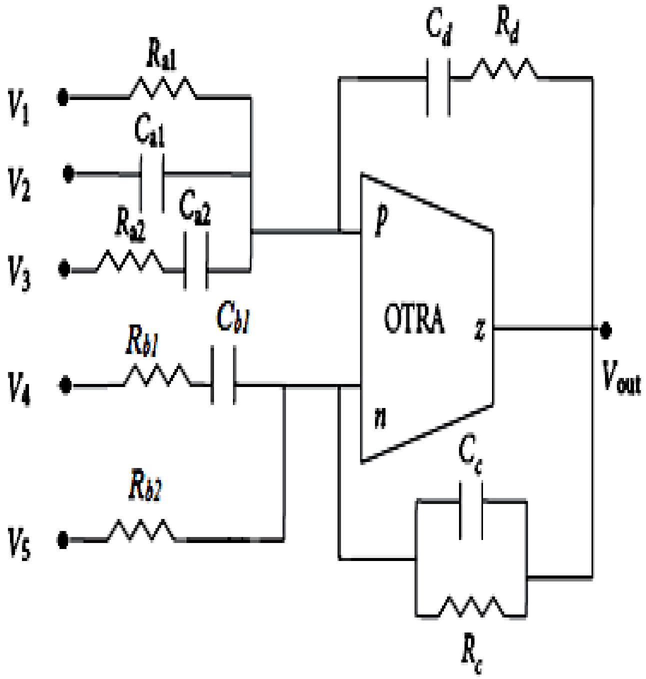


Fig.4. Suggested High order Chebyshev filter

Table 3. Values of V1, V2, V3, V4 and V5

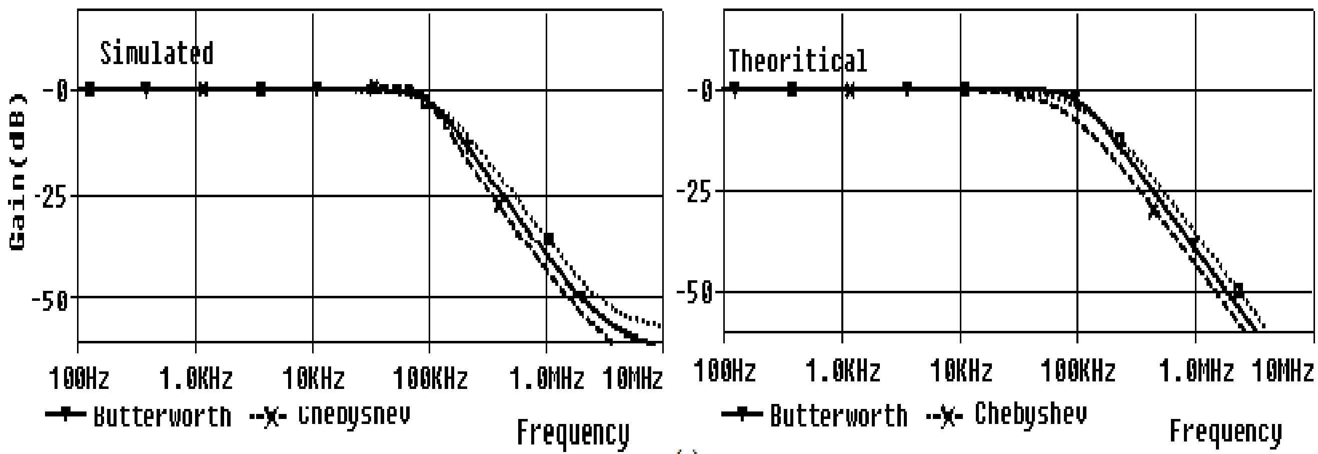
Types of f ilter	Value of v_{in}				
Vout	V_1	V_2	V_3	V_4	V_5
Low- pass	1	0	0	1	0
High pass	0	1	0	1	0
Band -pass	1	0	1	0	1
Band -reject	1	1	0	1	0
All- pass	1	1	0	1	0

Table 4. Appropriate value of elements of passive

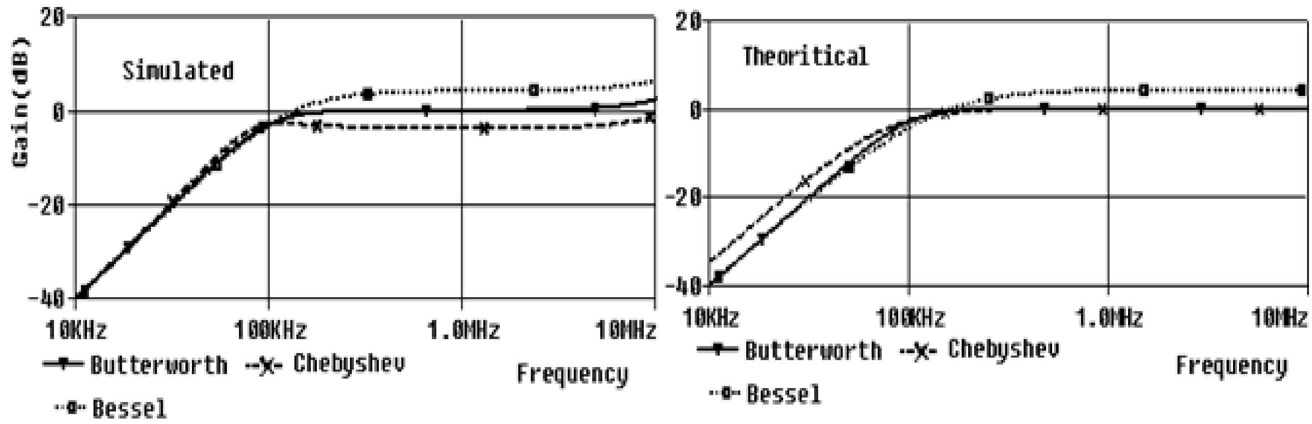
Types	R_{a1}(kΩ)	C_{a1}(pf)	R_{a2}(kΩ)	C_{a2}(pf)	R_{b1}(kΩ)	C_{b1}(pf)	R_{b2}(kΩ)
Low pass	82	-	-	-	82	20	-
High pass	-	20	-	-	82	20	-
Band pass	82	-	82	20	-	-	80
Band reject	82	20	-	-	40.76	40	-
All pass	82	32	-	-	20.76	40	-

TABLE 5: Appropriate value of elements of passive

Types	R_d (kΩ)	C_d (pf)	C_c(pf)	R_c(kΩ)
Low pass	66.038	26.86	32	82
High pass	66.038	26.86	32	82
Band pass	66.038	26.86	32	82
Band reject	66.038	26.86	32	82
All pass	66.038	26.86	32	82



(a)



(b)

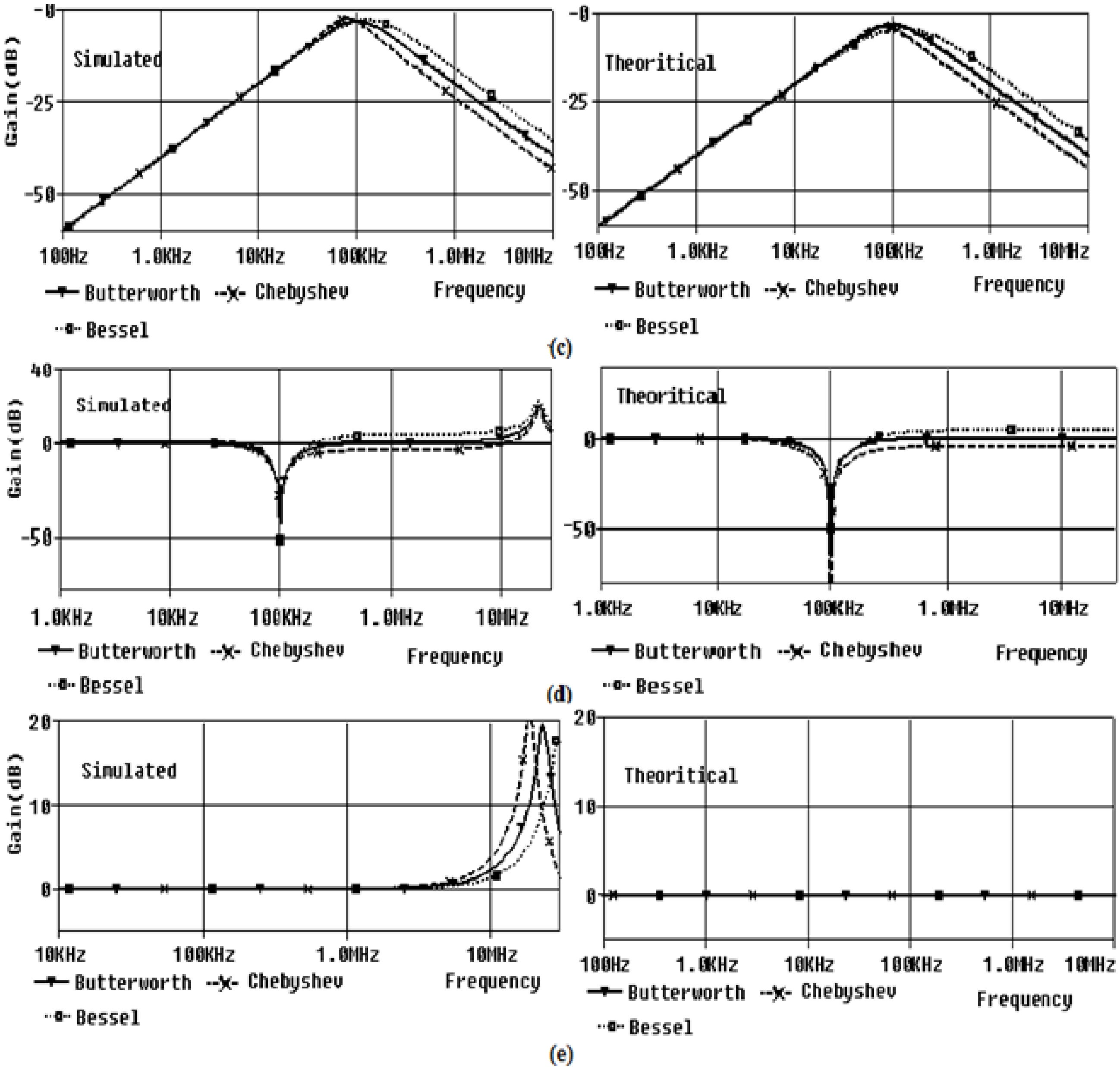


Fig no. 5 Simulation results of Chebyshev high order filter

IV. CONCLUSION

This paper features Chebyshev high order low paas and filter of high pass using an OTRA. The suggested architecture of filter utilizes the benefits of an OTRA along with some passive elements. The main use of chebyshev filter is in radio frequency applications in which there is a requirement of steep transition between paasband and stopband to neglect unnecessary elements like harmonics intermodulation. The response of the plot of phase indicates that Chebyshev filter gives a higher stepness in attenuation band. Experimental results are obtained using PSPICE simulations which is based on CMOS parameters of 0.5 um given by MOSIS.

REFERENCES

1. H. Mostafa , A. M. Soliman, "A modified CMOS realization of an operational transresstance amplifier", vol. 60, issue no 3-4, 2006, Frequenz, pp. 70–76.
2. O. Cicekoglu, U. Cam and C. Cakir,, "Novel transimpedance type first-order all-pass filter using single OTRA", Vol. 58, 2004, AEU IJEC , pp. 296-298.
3. F. Kacar, "OTRA based current-mode all-pass filter topologies", 2009, Applied Electronics, pp. 149-152.
4. J. J. Chen S. I. Liu, W. Chiu, S. I. Liu, H. W. Tsao and J. J. Chen "Parasitic capacitance- insensitive current-mode filters using OTRA", vol. 142, no. 3, 1995. IEE Proceedings: Circuits, Devices and Systems, pp. 186–192,
5. J. Petržela, R. Šotner and J. Slezák, "Current-controlled current mode universal biquad employing multi-output transconductors", vol. 18, issue no. 3, 2009. Radio engineering, pp. 285–294.
6. J. W. Horng, "High-input impedance voltage-mode universal biquadratic filter using three plus-type CCIIs," vol. 48, issue no. 10, 2001. IEEE Transactions on Circuits and Systems II, pp. 996–997.
7. S. K. Paul A. Ranjan ,, " N^{th} order voltage mode Active C- filter Employing Current Controlled Current Conveyar" vol.2, 2011. circuits and system, pp. 85-90.
8. S. K. Paul, S. B. Jain and N pandey, "A new electronical tunable current mode universal filter using MO-CCCII," vol. 58, issue no. 2, 2009. AIC and SP, pp. 171–178.

AUTHORS PROFILE

Vivek Bhatt, he obtained his B.Tech from ACE IT jaipur in year 2011 and M.Tech degree from BTKIT Uttarakhand. His areas of interest in research include analog circuits mode of current. Published six papers in reputed international journal.

Sandeep khantwal, Recieved M.Tech in (VLSI DESIGN) from UTU (Uttarakhand Technical University). Bachelor of engineering (ECE) from IGEC sagar (M. P). Fifteen pblished papers In reputed International Journal and five International Conferences attended. Best paper presentation Award entitled “Boosted CMOS differential logic and its applications” in IDSTM 2018 held at GTC (Haryana). His research interests include low power VLSI.

Rahul Negi, Awarded Degree of B.Tech in Applied E & I in year 2012 from UTU and M.Tech in Instrumentation and control in year 2014 (Graphic Era University). Published 1 paper in IJRET 2019. His research interest include Biomedical along with Instrumentation Control.