International Conference on
"Innovative Research in Agriculture, Engineering, Technology, Applied Sciences, Humanities and Business Management for Sustainable Development"
(ETAHBS-2019)

DESIGN SIMULATION AND HARDWARE OF OTRA BASED SECOND ORDER LOW PASS FILTER

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Abstract—*In this paper, introduce single OTRA based analog filter. Analog designer got new boost in form of Operational Transresistance Amplifier (OTRA) because it is replacing the current mode analog building block. Parasitic capacitance eliminated which are internally generated at input terminals. High slew rate and bandwidth are major strength of OTRA. This work done is analysis with Electrical and Electronic simulator Proteus ISIS Professional and experimentally. Implementation of OTRA is based on AD844AN (CFOA).*

Keywords; *Operational Transresistance Amplifiers (OTRA), Second Order All Pass Filter.*

1. INTODUCTION

Operational Transresistance Amplifier (OTRA), it is preferred due to its high slew rate and wider bandwidth over the conventional operational amplifier circuit. Here Butterworth and Bessel Higher order All Pass filter structure [1]. OTRA is replace the current mode analog building block [2- 5].The OTRA is also known as Norton amplifier or current differencing amplifier. OTRA is a high current gain input, voltage output device. OTRA input and output impedance has low value. Eliminating parasitic capacitance by the grounded of input terminals of OTRA, at the input [6]. Input resistance reduced due to grounded input of OTRA. Due to it, we have some advantage over the current mode analog building blocks like operational Transconductance Amplifier OTA [7], DVCC [8], current conveyer (CC) [9-12], CDBA [13]. In this simulation and experimental work, design a second order low Pass filter structure with an OTRA.

2. CIRCUIT DESCEPTION

Generalized structure of filter using admittance term shown in figure 1

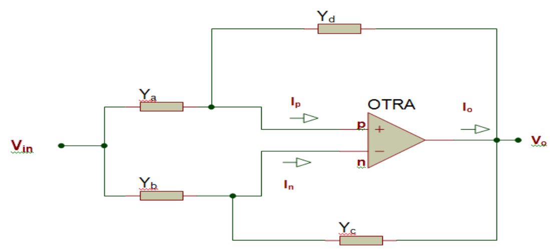

Fig. 1. Generalized circuit of OTRA based filter

Transfer function of proposed circuit is derived as current at positive terminal ip calculated with help of figure 1 as

$$ip = V_{in} + V_o Y_d \qquad (1)$$

Current at negative terminal in calculated with help of figure 1 as

$$i_n = V_{in} Y_b + V_o Y_c \qquad (2)$$

Let's assuming that in ideal condition of OTRA, the amplifier voltage gain can by calculate by equating the current of positive (p) and negative (n) terminal, that is

$$i_p = i_n \qquad (3)$$

$$V_{in} Y_a + V_o Y_d = V_{in} Y_b + V_o Y_c \qquad (4)$$

Transfer function of OTRA based filter given by

$$T(s) = \frac{V_o(s)}{V_{in}(s)} = \frac{Y_a - Y_b}{Y_c - Y_d} \qquad (5)$$

There is Y_a, Y_b, Y_c and Y_d are admittance function of passive elements.

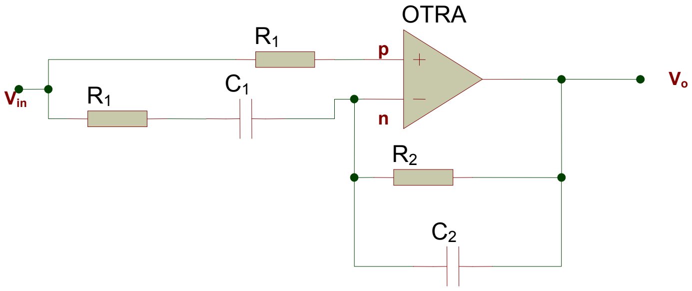

Fig. 2. filter circuit

By using equation (5) we derived transfer function of circuit given in figure 2

$$Y_a = \frac{1}{R_3} \qquad (6)$$

$$Y_b = \frac{sC_1}{1 + sR_1C_1} \qquad (7)$$

$$Y_c = \frac{1 + sR_2C_2}{R_2} \qquad (8)$$

$$Y_d = 0 \qquad (9)$$

$$T(s) = \frac{1 + sR_1R_2C_1 - sR_2R_3C_1}{s^2R_1R_2C_1C_2 + s(R_1R_3C_1 + R_2R_3C_2) + R_3} \qquad (9)$$

Rearranged equation after putting $R_1=R_2=R_3=R$ and $C_1=C_2=C$

$$T(s) = \frac{\frac{1}{R^2C^2}}{s^2 + \frac{2s}{CR} + \frac{1}{R^2C^2}} \qquad (10)$$

3. SIMULATION AND HARDWARE RESULTS

OTRA based second order filter could be design with help of AD844AP (CFOA), and its performance can be analysis using Proteus ISIS Professional simulation software.

Simulation verified by practically also. Details of used element in hardware and simulation given in table 1.

Table 1: List of used elements for OTRA based filter designing

Quantity	Part – Name	Value
 3 1	Resistance R4 - R6 R7	 2KΩ 1MΩ
 2	Capacitor C1, C2	 1uF
 2	Integrated Circuits U1,U2	 AD844AP
 2	Miscellaneous B1,B2	 15V
1	Function Generator	0 – 1MHz
1	CRO	

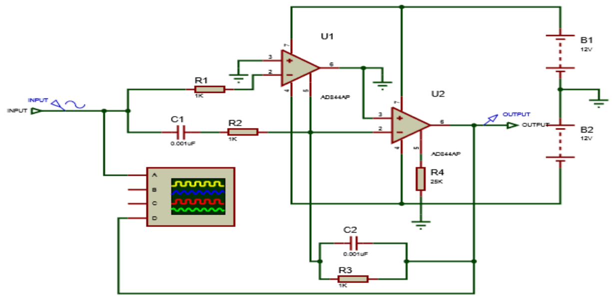

Fig. 3. Simulation circuit of OTRA based second order filter

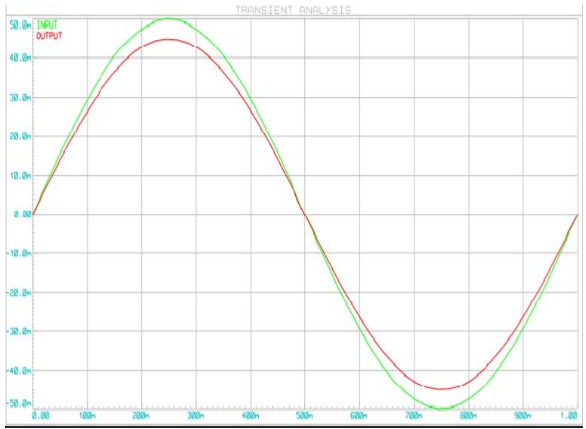

Fig. 4. Input – Output response of OTRA based filter

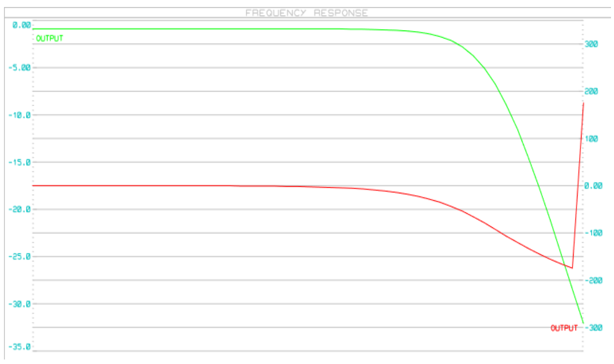

Fig. 5. Frequency and Phase response of OTRA based filter

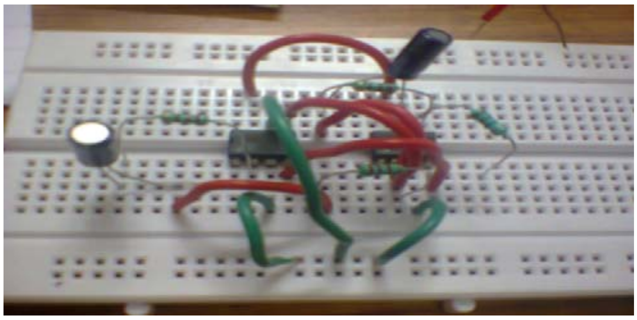

Fig. 6. Practical circuit of OTRA based second order filter

ISBN-978-93-85822-96-4

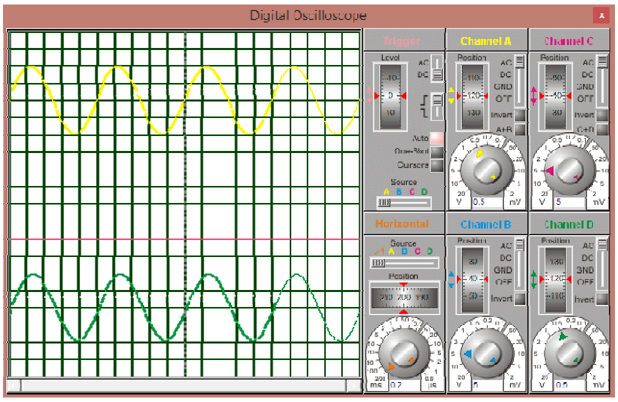

Fig. 7. Input – Output response

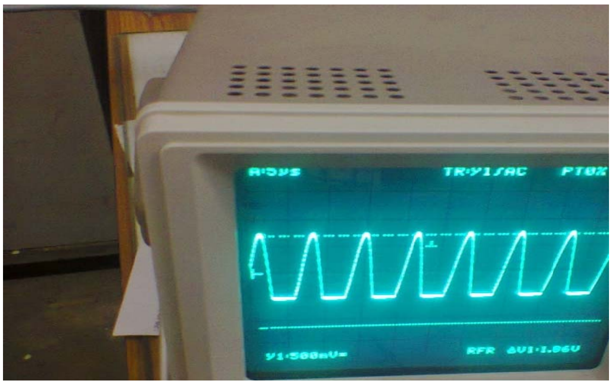

Fig. 8. Experimental result

Figure 4, 5, 7 and 8 shows the result of simulation and experiment respectively of this circuit. The simulated results agree quite well with the theoretical and each other.

4. CONCLUSION

In this paper, OTRA Based Second Order low pass filter structure is presented. The design filter structure uses an OTRA and some active passive components. From the phase response plot it is clearly show the response of filter.

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ISBN-978-93-85822-96-4