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Current-Mode Four-Phase Quadrature Oscillator By Means Of Current Differencing Transconductance Amplifier

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***Abstract* - In this document, a CMOS current-mode four-phase quadrature oscillator by means of current differencing transconductance amplifier (CDTA) that is based upon the pioneering first-order allpass filter is projected. The anticipated circuit configuration defines a very simple structure. It contains simply one resistor, two capacitors and three CDTAs. It is capable of affording four quadrature current outputs, and the stable affirm oscillation is also achieved subsequently to fewer than 1μs. Additionally, as the entire output impedances of the four-phase quadrature oscillator are high, the proposed oscillator circuit can be connected directly to the subsequent stage without any impedance identical necessities. PSPICE simulation results are included to substantiate the supposition.**

***IndexTerms* - Current Differencing Transconductance Amplifier,Quadrature Oscillator,Current Differencing Buffered Amplifier,Operational Transconductance Amplifier.**

I. INTRODUCTION

CDTA was firstly invented by Biolek in the year 2003 which is liberated from parasitic input capacitances and it could be applied in variety of frequency assortment because of the current mode operation ability of the element.
Oscillator is incredibly chief block in analog signal processing systems. During the past few years, in active oscillator and filter design, the current-mode approach has turned out to be more popular due to its advantages of providing larger dynamic range, wider bandwidth, lower power consumption and simpler configurations over the voltage-mode counter parts,especially for the high-frequency operation. CMOS current-mode four-phase quadrature oscillator using current differencing transconductance amplifier(CDTA)-based new first-order all pass filter is proposed. The proposed circuit has following advantages: (a) Structure is very simple that contains only one resistor,two capacitors and three CDTAs; (b) a new first-order all pass filter is projected which is worn in the oscillator; (c) Four quadrature current outputs could be supplied by it, the steady state of the oscillator are achieved less than 1μs; (d) as all the output impedances of the four-phase QO are high, the planned oscillator circuit may be associated directly to the next stage without any impedance corresponding requirements..

II. FUNDAMENTAL THEORY OF CDTA

Digital signal processing is becoming increasingly more powerful while advances in IC technology provide compact efficient implementation of its algorithms on silicon chips. Although many types of signal processing have indeed moved to digital domain, analog circuits are fundamentally necessary in many of today's complex, high performance systems. This is caused by the reality that naturally occurring signals are analog. Therefore analog circuits act as a bridge between the real world and digital systems. In the beginning, operational amplifiers were the main building blocks for analog circuit design. Unfortunately, their limited performance such as bandwidth,slew-rate etc. led the analog designer to search for other possibilities and other building blocks. Proper symbol of the element called CDTA can be seen in fig.1 with the corresponding circuit of CDTA is described in fig.2

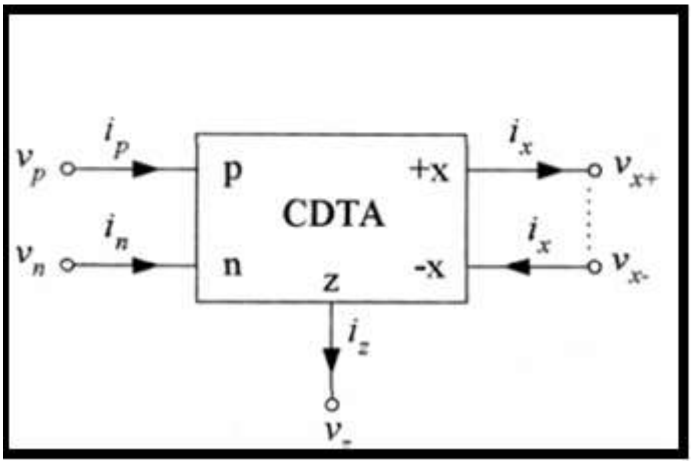

Fig.1. Symbol of CDTA[2]

The connection between the terminals of CDTA could be characterized and are explained as follows:

$$v_p = v_n = 0$$

$$i_z = i_p - i_n$$

$$i_{x+} = g_m v_z = g_m Z_z i_z, i_z - = -g_m v_z = -g_m Z_Z i_z$$

(1)

By going through the above relations between the characteristic equations it can be said that p,n will be the terminals of input and Z_Z would be the external impedance associated at the next port named as 'Z'.The difference of the current will be followed by the current source for the particular application which would be done between the two terminals p and n respectively which makes it's way from Z port to the impedance Z_Z.The terminal z suffers from the voltage drop and thus drop of voltage is given away to the x port which will have certain current in it which is denoted by i_x. from the transconductance gain denoted by g_m.This will be opportunate by electronic means subsequently to the outside bias current.CDTA is a self possessed device of unity gain source of current and there are two inputs to the current and amny outputs to the transconductance amplifier so that the modifications could be made by the means of electronics by the itinerary of the gain of transconductance offered by the device for the particular application. This has made our experiments very easy and the device proper appropriate in favor of the production of current-mode filters in the midst of electronically tenability characteristics.Additionally,this device could be used in many applications so that the whole experimental results could be found out for the production of filters made on the basis of their current mode procedure.

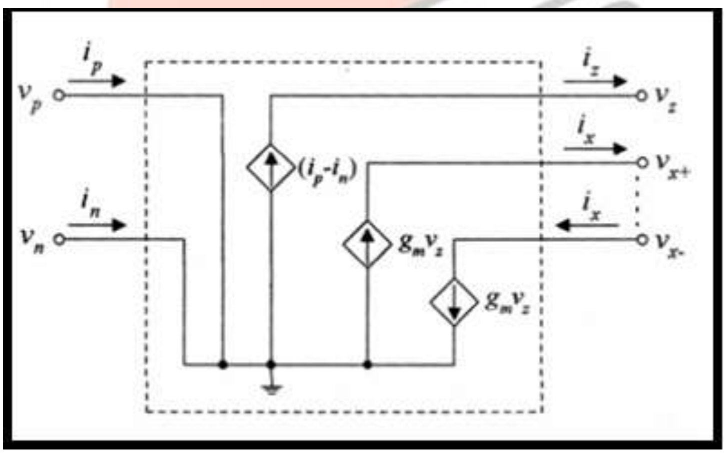

Fig.2 Equivalent model of CDTA[3]

With a rigorous quantity of acquiescent fundamentals the required block can therefore make it able to perform in that particular environment. By this way the thick and strong blocks could be achieved in variety of experiments in the practical manner.The element CDTA becomes forthcoming in many ways so as to realize the continuous processing of the signal of time repeatedly in all the equipments one after other without any disturbances.

- **Behaviour of CDTA**

Every electronics element shows ideal and practical behaviour.current differencing transconductance amplifier also shows ideal and practical behaviour.From matrix equation (1.4) and (1.5) we can get the ideal and practical behaviour of CDTA.The principle performance may be elaborated as follows:

$$I_Z = I_p - I_n,\ I_x = \pm g_m V_z$$
(2)

Practical behaviour associated with CDTA is described as follows:

$$I_z = \alpha_p I_p - \alpha_n I_n and\ I_x = + g_m V_Z$$
(3)

current gains are defined by α_p and α_n, $\alpha_p = 1 - \varepsilon p$, and $\alpha_n = 1 - \varepsilon n$. Their complete ideals which are greatly less than the unity.

III. CMOS-BASED CDTA IMPLEMENTATION

We know how to correspond to the transistor level demonstration of the projected CDTA as shown in figure 1.3.The number of transistors used in the desired circuit will be twenty seven.If we wish to find out the difference of current then the transistors named from one to seventeen would be taken into account.In greed of low impedance from the circuit the project must be offered by the voltage buffers moreover prolongs with the ports for the input values which are in very small extent by means of implicit ground.The difference of signals at input sides are exceeded by the current mirrors.By this way the outward appearance of DO OTA could be figured out eventually all this is done by the self assured inverting kinds of amplifiers .

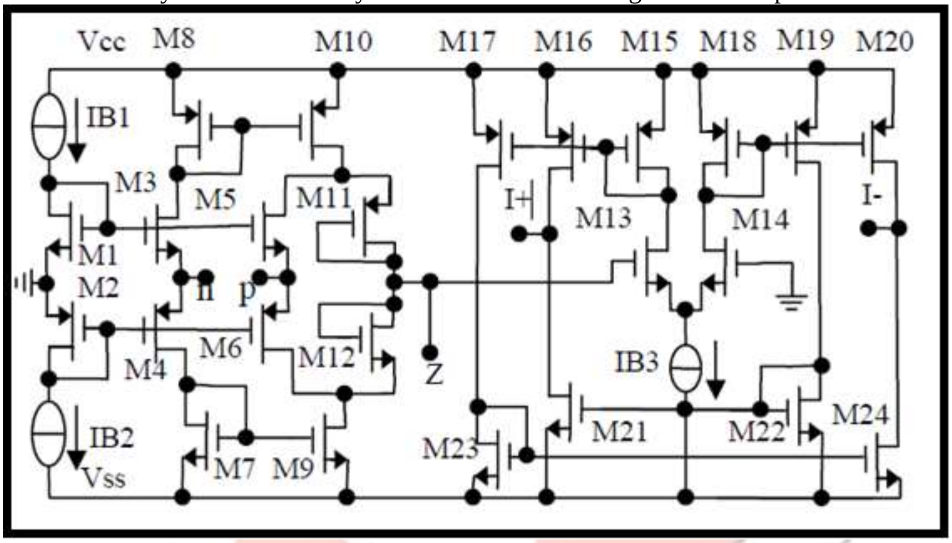

Fig.3 CMOS-based CDTA implementation

IV. CURRENT MODE FOUR PHASE OSCILLATOR USING CDTA

This defines the current mode four phase quadrature oscillators by means of CDTA based on first order all pass filter. All pass (AP) filters are extensively used within analogue signal processing so that the phase could be shifted at the same time as the amplitude is kept constant so that various types of filter characteristics could be produced at the same time and high-Q frequency selective circuits could be implemented. The new CDTA based AP filter is given in Figure.3.2 which is consisted of two CDTAs,one capacitance and one resistor.

From the routine analysis it can be shown that for the new first-order all-pass filter, the current transfer function for the all-pass filter of Figure 4 is given by the subsequent equation:

$$H(S) = \frac{I_{OUT}}{I_{IN}} = \frac{g_{m1}}{g_{m2}} \frac{(1 - SRC)}{(1 + SRC)}$$
(4)

The pole frequency (ω_0) and the phase response (φ) from the above originated transfer function can be given by the equation below:

$$\omega_O = \frac{1}{RC}$$
(5) $$\phi(\omega) = -2\arctan(\omega RC)$$
(6)

From the above equation it can be shown that the all-pass filter can provide a phase shift from 0–180° by properly by varying the values of *R* and *C*.

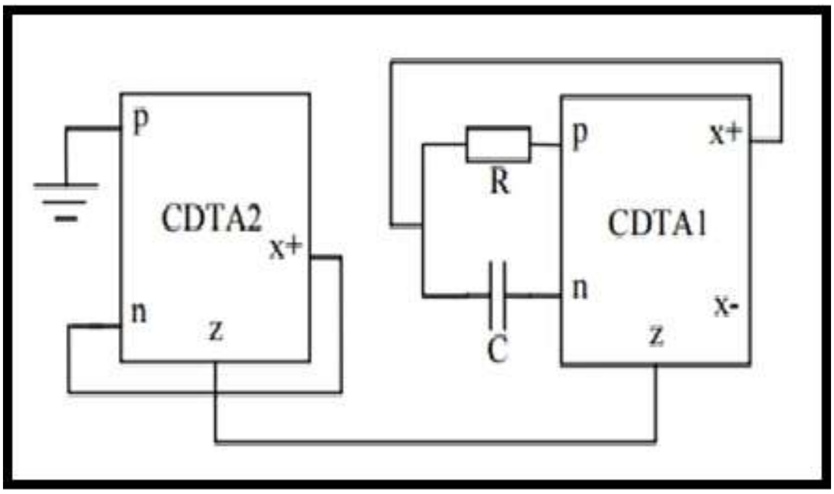

Fig. 4 Proposed First Order CDTA Based All Pass Filter Circuit

The proposed current-mode Quadrature Oscillator circuit using CDTAs is realized by cascading the proposed all-pass filter of Figure.4 and a CDTA-based lossless integrator (implemented using $CDTA_3$ and C_2); the resulting circuit is given in Figure. 5. Here,the circuit is consisted of three CDTAs, one capacitance and one resistor, and it is very undemanding.The circuit provides an inverted version of output currents i_{o1} and i_{o2} which is based lying on multiple output CDTA. Therefore, the relation of output current could be articulated as $i_{o1}= -i_{o3}$ and $i_{o2}= -i_{04}$.By this way it can be resulted that circuit is able to offer four quadrature current outputs.

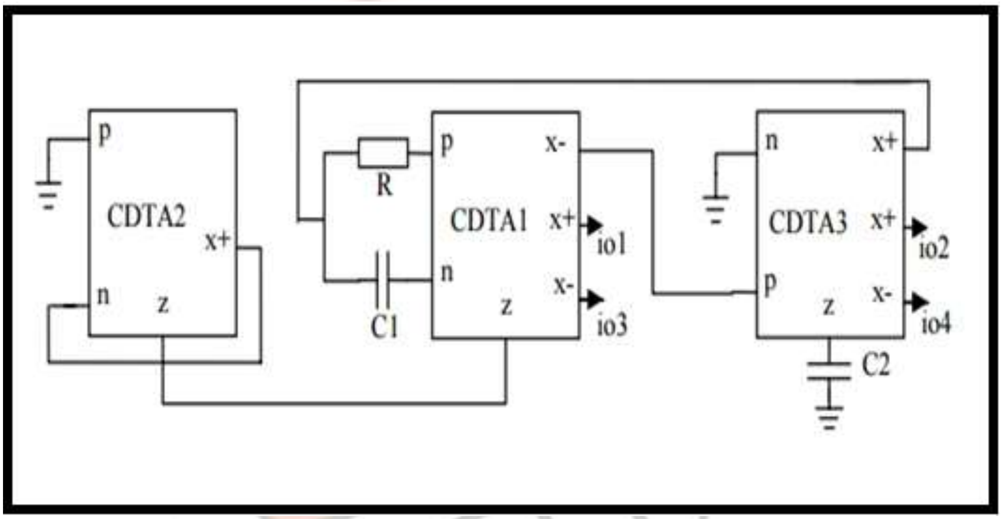

Fig. 5 Proposed Current-Mode Quadrature Oscillator implemented using first-order CDTA based all pass filter circuit

V. RESULT

A current-mode four–phase quadrature oscillator is defined and it is presented by means of a CDTA. The performance of the circuit could be verified by using PSPICE. The CMOS CDTA is presented which is used to design the four-phase quadrature oscillator. The supply voltages used were $V_{DD} = –V_{SS} = 2.5V$, and the bias currents $I_{B1} = I_{B2}= 100\mu A$. The proposed quadrature oscillator structure gives the waveforms output of Figure 5 which is revealed in Figures 6, 7and 8 respectively. The simulated frequency of the oscillation is found as 3.4 MHz, the amplitude of the output currents are also resulted which is found to be 200µA, and the steady state oscillations are achieved after less than 1µs. The total harmonic distortion (THD) of the output waveforms i_{01}, i_{02}, i_{03} and i_{04} are varying from 2% to 5%.

Carrying out the routine analysis of the quadrature oscillator circuit and using the characteristic equation of the CDTA we can obtain the characteristic equation for the proposed quadrature oscillator which could be articulated as follows:

$$S^2 + \frac{g_{m2}C_2 - g_{m1}g_{m3}C_1R}{g_{m2}RC_1C_2} + \frac{g_{m1}g_{m3}}{g_{m2}RC_1C_2} = 0$$

(7)

From the characteristic equation found above, we can find out the oscillation condition and the oscillation frequency (ω_0) which can be elaborated as follows: Condition of Oscillation (C.O.):

$$g_{m2}C_2 = g_{m1}g_{m3}C_1R$$

(8)

1) Frequency of Oscillation (F.O.):

$$\omega_o = \sqrt{\frac{g_{m1} g_{m3}}{g_{m2} R C_1 C_2}}$$

(9)

Commencing the circuit , the current transfer function between $i_{01}$and i_{02} is found to be given by the following equation:

$$i_{02} = -\left(\frac{g_{m3}}{SC_2}\right) i_{01}$$

(10)

From the above equation it can be evidently proved with the aim of the phase difference between the two output currents i_{01} and i_{02} is equal to 90° which results in two-quadrature outputs.The circuit provides an inverted version of the output currents $i_{01}$and i_{02} which is based on multiple output of CDTA .The associations of all the output currents can therefore be articulated as:

$$i_{01} = -i_{03} \ and \ i_{02} = -i_{04}$$

Therefore,by going through the relationship obtained above it can be accomplished that four-quadrature current outputs could be provided by means of the desired circuit.

The incremental sensitivity is an important performance criterion of any active network. The relative sensitivity of a parameter F to a circuit parameter x_i is defined by the equation given below:

$$S_{xi}^{F} = \frac{x_i}{F}\frac{dF}{dx_i}$$

(11)

Using the above mathematical definition of sensitivity, it can be easily shown that the sensitivities of ω_0 to the variation in active and passive element values are given by:

$$S^{\omega_0}_{g_{m1},g_{m3}} = \frac{1}{2}, S^{\omega_0}_{g_{m2}} = -\frac{1}{2}, S^{\omega_0}_{R,C_1,C_2} = -\frac{1}{2}$$

(12)

As we go through the above calculations, it can be concluded that the proposed quadrature oscillator circuit shows striking presentation in the company of active and passive sensitivities are constant and also less than unity.

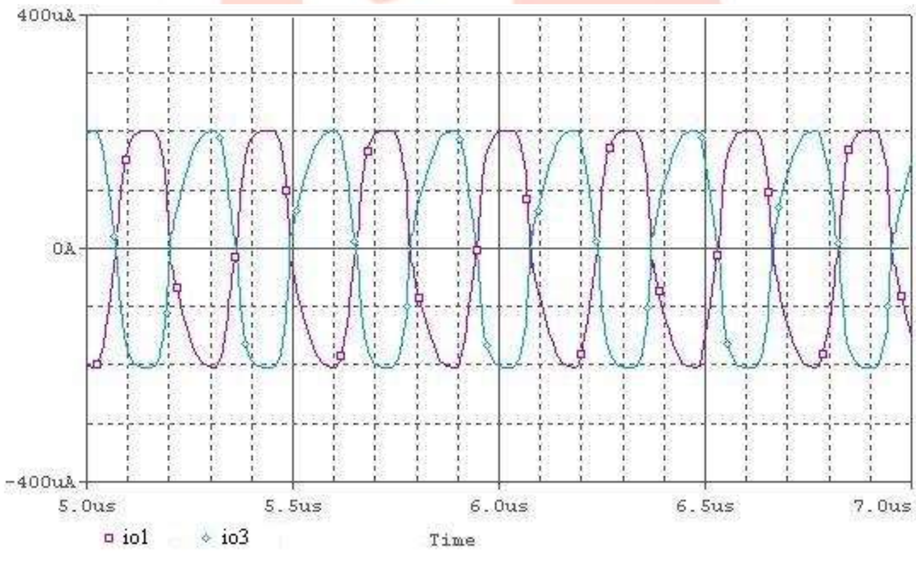

Fig. 6 – Simulation of the output waveform i_{01} and i_{03} of the oscillator circuit proposed.

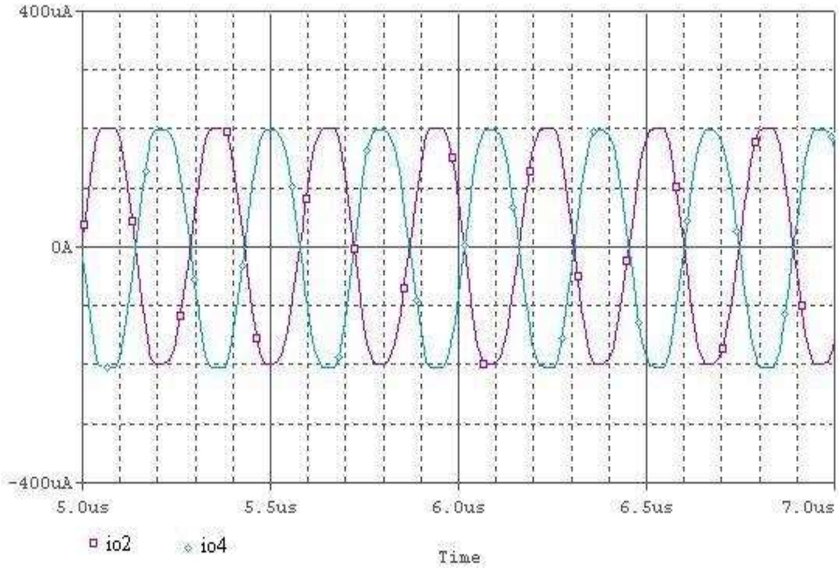

Fig.7 – Simulated output waveform i_{02} and i_{04} of the proposed oscillator circuit.

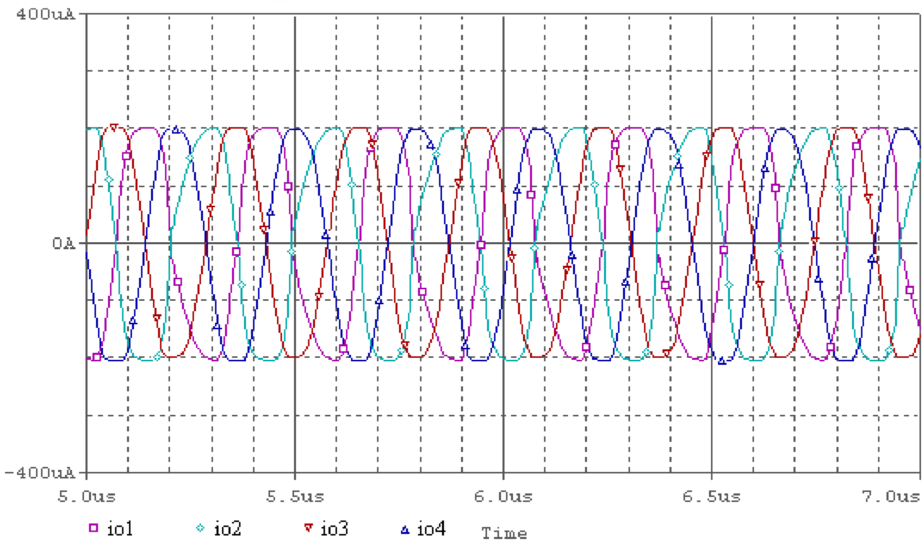

Fig. 8 Simulation of output waveform i_{01}, i_{02}, i_{03} and i_{04} of the oscillator circuit proposed.

VI. Conclusion

A CMOS current-mode four-phase QO by means of CDTA-based novel first-order all pass filter has been proposed in this dissertation. The circuit which has been projected has the subsequent compensations: (a) Simple structure of the model,Contained by only one resistor, two capacitors and three CDTAs; (bNew first-order all pass filter has been anticipated and worn in the oscillator; (c) it can provide four quadrature current outputs, the steady state of the oscillator is achieved after less than 1µs; (d) Because in this projected QO,all the output impedances are high,QO circuit be capable of getting connected unswervingly to the subsequent stage devoid of impedance matching necessities.

VII. References

[1] C. Andriesei, L. Goraş, F. Temcamani, On a RF Bandpass Filter Tuning Method, Rev. Roum. Sci. Techn. – Électrotechn. et Énerg., 55, 1, pp. 69-79, 2010.
[2]. A. Isar, S. Moga, D. Isar, Denoising Sonar Images using a Bishrink Filter with Reduced
Sensitivity, Rev. Roum. Sci. Techn. – Électrotechn. et Énerg., 55, 2, pp. 181-190, 2010.9 Current-mode four-phase oscillator 299
[3]. R. Terebes et al., A Nonel Diffusion Filter for Image Restoration and Enhancement, Rev. Roum. Sci. Techn. – Électrotechn. et Énerg., 55, 3, pp. 310-319, 2010.
[4]. A. M. Dumitrescu et al., Current Controllers Design using Naslin Olynomial Method for Active Power Filters, Rev. Roum. Sci. Techn. – Électrotechn. et Énerg., 54, 1, pp. 115-124, 2009.
[5]. Toumazou C., Lidjey F.J., Haigh D., Analog IC design: The currentmode approach, UK, Peter Peregrinus Press, 1990, 195-207.
[6]. A.T. Bekri, F. Anday, Nth order low-pass filter employing current differencing transconductance amplifiers, Proceedings of the 2005 European Conference on CircuitTheory and Design, Cork, Ireland, 2005.
[7]. F. Rezaei, S.J. Azhari, Ultra low voltage, high performance operational transconductance amplifier and its application in a tunable Gm-C filter, Microelectronics Journal, 42, 6,

pp. 827-836, 2011.
[8]. W. Chunhua, K.A. Umit, L. Yang, Minimum Configuration Insensitive Multifunctional Current- Mode Biquad Using Current Conveyors and All-Grounded Passive Components, Radioengineering, 19, 1, pp. 178-184, 2010.
[9]. W. Chunhua, Z. Yan, Z. Qiujing, A New Current Mode SIMO-Type Universal Biquad Employing Multi-Output Current Conveyors (MOCCIIs), Radioengineering, 18, 1, pp. 83-88, 2009.
[10]. K. Novacek, P. Betak, Low-Voltage Current Operational Amplifier, The 30th International Spring Seminar on Electronics Technology, Cluj-Napoca, Romania, 2007, pp. 326-329.
[11]. K. Novacek, T. Brich, A. Khateb, Current Operational Amplifier, The 29th International Spring Seminar on Electronics Technology, Marienthal, Germany, 2006, pp. 340-344.
[12]. S.A. Mehmet, Design of CDBA-based active polyphase filter for low-IF receiver applications, Turkish Journal of Electrical Engineering And Computer Sciences, 19, 4, pp. 565-574, 2011.
[13]. J. Bajer, J. Vavra, D. Biolek, A new building block for analog signal processing: current follower/inverter buffered transconductance amplifier, Research in Microelectronics and Electronics, 2009 (PRIME 2009), Ph.D, Shanghai, China, 2009, pp. 136-139.
[14]. D. Biolek, CDTA – Building block for current-mode analog signal processing, Proc. ECCTD’03, Krakow, Poland, 2003, pp. 397-400.
[15]. D. Biolek, V. Biolkova, CDTA-C current-mode universal 2nd order filter, Proceedings of the 5th WSEAS International Conference on Applied Informatics and Communications, Canary Islands, Spain, 2005, pp. 411-414.
[16]. F. Kacar, H.H. Kuntman, A new improved CMOS realization of CDTA and its filter applications, Turkish Journal Of Electrical Engineering And Computer Sciences, 19, 4, pp. 631-642, 2011.