CHAPTER I
INTRODUCTION AND BACKGROUND

1.1. Introduction

In general, Square wave generators are facing vital role in many electronic applications as a reference input for analog signal handling functions. Those are, in specifically, communication equipments, control modules, signal dispensation appliances, measurement blocks, feedback control circuits for power conversion mechanism, based on operating frequency range used in sensor interfaces, telecommunications and clock for digital structures (J.M. Jacob et al, 2000, S. Franco et al, 2002). All these prerequisites are fulfilled with the operational amplifier (OA) based classical square wave generator (J.M. Jacob et al, 2000). Conversely, OAs has the snag of lower operating frequencies as it bears from lower slew rate and flat gain bandwidth product limitation (H.C. Chien, 2012).

For the last two decades, because of the advantages of high performance and versatility all the electronic applications are being designed using current mode (B. Dalibor et al, 2008). The inevitable reasons for switching from voltage mode to current mode are high slew rate, improved dynamic range, better bandwidth, easiness in circuit realization, power reduction (K.K. Abdalla et al, 2012), (M. Akbari et al, 2015). The waveform generator proposed using Operational transconductance amplifier (OTA) in S.K. Kar et al, 2011, used more active elements in addition to that of possession of more passive components causes more power consumption and occupies even more area besides the advantages of grounded capacitor feature offered. The circuit in A.D. Marcellis et al, 2013 has used only a couple of active elements, but uses seven passive components and also not offering the grounded capacitor. Given circuits in R. Pal et al, 2015, H.C. Chien et al, 2014, S. Malik et al, 2015, A. Srinivasulu et al, 2016, S. Minaei et al, 2012 consists of same glitch of usage of higher number of passive and active devices causes the circuit usage limited to less in IC fabrication. In order to make the circuit simpler and designer’s choice by using only one active and minimum possible usage of passive components with maximum reduction of noise effects and parasitics in designing a waveform generator, a new CM current differencing device is designed.
All-pass filter is a special mode of frequency selective circuit which allows all the frequencies by maintaining the equal levels of amplitude with variation in the produced phase in accordance to the input signal. High input impedance feature is the primary requisition for making an all-pass filter used in voltage mode (VM) applications, where employed for phase compensation requirement. Additional provision of phase compensation network removes the need for voltage buffering circuit or current conveyor (CC).

1.2. Introduction to Current–Mode and Voltage–Mode Circuits


1.3. Thesis Objectives

al, 2000, W. Tangsrirat et al, 2006, C. Cakir et al, 2010), operational transresistance amplifier (OTRA) (Y.S. Hwang et al, 2009, A.K. Kafrawy et al, 2009), or second-generation differential current conveyor (DCCII) (H.O. Elwan et al, 1996, S. Ciftcioglu et al, 2005, B. Metin et al, 2012, B. Metin et al, 2012, S. Shahsavari et al, 2015). Although the DCCII element was the first active component in the open literature combining the simplicity of the conventional CCII (K.C. Smith et al, 1968) with current differencing attribute of the conventional CDBA (A.U. Keskin et al, 2005), it has not received as much attention as the CDBA yet and up to now only few integrated circuit implementations are available (H.O. Elwan et al, 1996, S. Ciftcioglu et al, 2005, B. Metin et al, 2012a, B. Metin et al, 2012b). In order to show versatility of DCCII and increase its importance for analog signal processing, recently it was used as the main sub-block in a frequency compensation scheme of three stage amplifier (S. Shahsavari et al, 2015). It is well-known in analog circuit design that reduction of unwanted parasitic terminal capacitance and resistance values increase the bandwidth of a circuit, because of the product of these two quantities form a dominant pole. In accordance with this theory, within this thesis novel CMOS implementation of a low-voltage and low-power high performance DCCII based waveform and filter circuits are proposed. Differential current conveyor (DCCII) can be defined as a second-generation current conveyor with current differencing capability. By possessing these advantages of DCCII and need for square wave generators in electronic applications, some novel circuits with two resistors and a single capacitor for square wave generation using DCCII as an active element is highlighted.

In literature, it is widely accepted that use of grounded capacitors makes the designs suitable for integrated circuit (IC) realization. Grounded IC capacitors have less parasitics compared to floating counterparts, which is important from the performance point of view and to avoid noise effects. Furthermore, the floating capacitors require an IC process with two poly layers. Integrated continuous time filters are now widely accepted in industry (R.H. Zele et al, 1993, A.M. Durham et al, 1993) where they are used in applications involving direct signal processing especially for medium dynamic range applications in cases where high speed and/or low power dissipation are needed. The DCCII is a suitable building block for the realization of current mode filters. Although current mode filters can be implemented in the voltage
mode using OAs, they usually suffer from the finite gain-bandwidth product of the op-amps which limit the frequency range. In this thesis, new all-pass filters with the Differential Current Conveyor (DCCII) as the main active device are proposed. The proposed circuits consist of two resistors and two capacitors, including one grounded capacitor, suitable for tuning. The performance evaluation of the proposed circuit vis-à-vis existing all-pass sections is carried out. The simulation of the circuit is done using SPECTRE simulation-model parameters. Experimental results of the proposed design using AD844AN ICs are included, which conform to the simulation results.

1.4. Organization of Thesis


Chapter (3) provides the background review of the existed all-pass filters, band-pass filters, multiple output filter, current comparator, inductance simulator, four quadrant multiplier and frequency comparator circuits DCCII. Three all-pass filter circuits amongst two are voltage mode and one is current mode all pass filter are discussed. One band pass filter also given. Nine inductance simulator circuits are presented. Two multiplier blocks are mentioned with inclusion of single application of frequency comparator, frequency dependent negative resistant circuit and current comparator is elaborated in this chapter. The advantages of these circuits are quoted and their drawbacks are given in this chapter.
Chapter (4) introduces some novel waveform generator circuits and all pass filter circuits. By using two resistors and a single capacitor with second generation differential current conveyor (DCCII) as an active element some new square wave generators are proposed and implemented and mathematical analysis of the proposed circuits is also given. The operations of the proposed circuits to produce oscillations are discussed in detail. The basic network laws and ideal terminal characteristics of DCCII are applied to the proposed circuits to derive the oscillation frequency and circuits realized. Similarly, the same procedure is applied to derive the mathematical equations for the all pass filter circuits.

Chapter (5) deals with the simulation results of the proposed circuits in chapter (4). All the proposed circuits are checked for waveform generation by connecting with passive components. The passive component values are calculated from the mathematical equations derived in chapter (4). All the proposed circuits are simulated using Cadence Spectre simulation model parameters. And the simulation results are presented in this chapter to validate the corresponding mathematical analysis carried out in chapter (4).

Chapter (6) presents hardware implementation of the proposed circuits on a laboratory bread board. The DCCII prototype circuit is implemented by using two AD844 AN ICs and external passive components are connected to test the waveform generation of the proposed circuits. The proposed circuits are tuned for different passive component values. Hardware results are given in this chapter to validate the simulation and theoretical analysis.

Chapter (7) presents the advantages of the proposed circuits compared to the existing circuits in the literature based on OTRA. And finally conclusions and future scope are given in this chapter.