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Title: Investigations into Analog Signal Processing/Signal Generation circuits using New Generation Current-Mode Active Elements

ABSTRACT

This thesis dealt with "Investigations into Analog Signal Processing/Signal Generation circuits using New Generation Current-Mode Active Elements". The thesis has presented the results of an investigation for the design and synthesis of signal processing/signal generation circuits in voltage-mode (VM), current-mode (CM) and Transadmittance-mode (TAM) employing two modern analog active building blocks (ABB) namely voltage differencing transconductance amplifier (VDTA) and voltage differencing current conveyor (VDCC) with a focus on achieving advantageous features not available simultaneously in circuit configurations known earlier.

The thesis begins by presenting a brief introduction and an overview of the recent developments in the area of analog signal processing/signal generation circuits and review some sample hardware implementation of selected number of analog ABBs such as Op-amp, Operational transconductance amplifier (OTA), current conveyors (CC), current feedback operational amplifier (CFOA), operational transresistance amplifiers (OTRA), current differencing buffered amplifiers (CDBA), current differencing transconductance amplifiers (CDTA), four-terminal floating nullor (FTFN), differential difference current conveyors (DDCC), dual output second generation current conveyors (DOCCII), multiple output second generation current conveyors (MOCCII), differential voltage current conveyors (DVCC), inverting second generation current conveyors (ICCII), fully differential second generation current conveyors (FDCCII), voltage differencing transconductance amplifiers (VDTA), current follower transconductance amplifiers (CFTA), current backward transconductance amplifiers (CBTA). In the end, an outline of the research work reported in this thesis has been given.

Chapter 2 of the thesis deals with the realization of universal biquad filter employing VDTA(s). The contribution of this chapter is to propose current-mode (CM), voltage-mode (VM) and transadmittance-mode (TAM) universal filter configurations employing minimum number of active and passive elements. All the configuration use only grounded passive elements. The proposed filter structures yield standard second order low pass (LP), high pass (HP), band pass (BP), band reject (BR)

and all pass (AP) filter responses without altering the circuit topology. Two of the proposed universal biquad filter structures employ a single VDTA while the third structure uses two VDTAs. The first and third proposed biquad filter circuits although realizes all the basic second order filter functions but does not provide all explicit CM outputs. All three proposed configurations offer the following advantageous features (i) use of all grounded passive elements, (ii) independent tuning of natural angular frequency (ω_0) and bandwidth (BW) (iii) no requirement of any element matching condition or inversion of input signal(s) and (iv) low active and passive sensitivities. Simulation results using 0.18μm TSMC, CMOS technology have been used to establish the workability of these new biquad filters.

Chapter 3 of the thesis deals with the realization of quadrature oscillators employing VDTA(s) and VDCC. After a brief review on CM/VM quadrature oscillator circuits using different active elements/devices, three new quadrature oscillator configurations have been presented. All the proposed oscillator circuits enjoy the feature of independent tunability of CO and FO. The first proposition employs single VDTA and offers electronic control of FO. The next oscillator is single VDCC based quadrature SRCO. Finally a fully uncoupled electronically controllable sinusoidal oscillator employing two VDTAs has been presented. All the presented circuits have been investigated for their non-ideal effects and the validity of the proposed circuits was verified by SPICE simulations using TSMC CMOS 0.18μm process parameters.

After this, a brief review of development in the area of losssy/losses grounded inductor simulation employing various analog ABBs/active elements has been presented in chapter 4. Realizations of grounded inductors which are useful in realizing filters by replacing the passive inductors by active ones and also find application in realizing oscillators. New VTAD-based lossy/lossless grounded inductors have been introduced. The proposed new grounded inductor configurations are important new additions to the existing repertoire of various ABBs/active elements based inductor simulations. The SPICE simulations have confirmed the workability of the proposed configurations using CMOS VDTAs.

Finally, conclusions of this thesis are made in Chapter 5, which also suggests some ideas for future research work.