Abstract

The low-voltage and low-power mixed mode circuit design has gained importance with the advent of the portable electronic and mobile communication systems. More and more mixed mode circuit blocks, are being integrated onto a single chip in an effort to reduce overall cost and space and to improve system performance. This requires the scaling of CMOS technology. The reliability and density factors associated with technology scaling demand for downsized supply voltages. This trend of continuous reduction of the supply voltage poses serious challenges to the analog designers. To circumvent this conflict instead of using costly CMOS technologies with lower thresholds, it is desirable to use low voltage circuit techniques that are compatible with standard CMOS processes.

In last few decades the current-mode processing has emerged as an alternative design technique. Ever shrinking feature size of devices on ICs and consequential reduction of power supply voltage can be handled by operating in the current domain, as current mode circuits are designed for lower voltage swings. While fundamentally any design techniques is limited by device characteristics there may be specific applications where current-mode circuits provide one or more of the following advantages: higher bandwidth, better signal linearity, higher slew rates, lower power consumption, and better accuracy. Additionally, current-mode circuits are often less complex than the voltage-mode circuits, which may lead to significant chip area savings.

Emergence of various current-mode analog building blocks is outcome of the considerable progress in current-mode analog signal processing. Operational transresistance amplifier (OTRA) among those is of relatively recent origin. It is a high gain current input voltage
output device which provides advantages of current mode design techniques and can readily be used for voltage-mode applications.

A wide variety of OTRA based system applications, ranging from filters, oscillators, multivibrators through general analog interfacing, are available in literature. In this research work design and development of signal generating and processing circuits using OTRA as building block is presented. The prime concern of the designs is to provide better quality response, introduce versatility and modularity, and to develop circuits which could be better implemented in integrated circuit form.

Exploring the important research topic of active inductance simulation, OTRA based five inductance simulation topologies have been proposed. A single OTRA based lossy inductance topology and two topologies of lossless inductance using two OTTRAs are presented. Further an important contribution is development of single OTRA based lossless grounded inductance, as, no such topology exists in the literature.

Single OTRA based two; biquadratic multifunction structures, development of single- input multiple output (SIMO) biquadratic universal filter and wave method based realization of higher order resistively terminated LC ladder filters is the research contribution in the field of filter design.

Single OTRA based designs are single- input single-output (SISO) configurations and can realize low pass (LP), high pass (HP), and band pass (BP) filter functions. The proposed circuits do not impose any component constraints in contrast to the similar class of existing circuits.
Single amplifier based biquad (SAB) is a useful choice for power efficient design. However, SABs are less versatile and more sensitive to parameter changes as compared to multiamplifier filters. As an improvement over presented SISO structures a SIMO biquadratic universal filter is proposed which provides all standard responses simultaneously. Concept of electronic tunability of filter parameters has also been introduced.

Multiamplifier filters can be used for design of biquads and higher order filters. Higher order filters using doubly terminated lossless ladders have low sensitivity to component tolerances. However, these use inductors, which are difficult to realize in an IC form. Wave method can be used for realizing higher order resistively terminated LC ladder filters which does not require use of inductors. In this work, OTRA based electronically tunable wave active filter structures are presented which are highly modular and can readily be used.

Signal generators are an important class of electronic circuits. A number of sinusoidal oscillator circuits are proposed which include a sinusoidal oscillator; a third order quadrature oscillator and three multiphase sinusoidal oscillators. The proposed sinusoidal oscillator and third order quadrature oscillator are MOS-C implemented and can be tuned electronically.

An important contribution is development of few OTRA based linear and nonlinear applications. Under linear class of applications, a transimpedance instrumentation amplifier and feedback controllers are proposed whereas a voltage controlled multivibrator, a pulse width modulator and an analog multiplier have been proposed as nonlinear applications.

Practical design issues pertaining to nonidealities associated with OTRA have been addressed for all the proposed structures. The proposed designs are verified either through SPICE simulations or combination of SPICE simulations and experimental evaluations.