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TITLE: REALIZATION OF ANALOG SIGNAL PROCESSING CIRCUITS USING DIGITALLY PROGRAMMABLE CURRENT CONVEYORS

ABSTRACT

Analog circuits are irreplaceable components of systems on chip. They are required to perform a variety of critical tasks such as amplification, filtering, demodulation, signal conditioning etc. Programmable/tunable characteristic of analog block is essential in many engineering applications such as in widely tunable filters, adaptive filters, variable gain amplifiers, music synthesizers, formant speech synthesizers etc. Apart from this, programmability/tunability is required for compensating the undesired parameter variation caused by temperature and process. One of the most critical issues in integrated circuits is large deviation of RC time constant due to the variations in process and temperature. Both resistor and capacitor values may vary as much by 25% in integrated circuits and thus, results in 50% variation in time constant. Thus, in order to suppress the undesired time constant variation programmability feature is needed.

Literature reports ample signal processing/ generation circuits based over analog tuning techniques. However, the work is limited over its digital counterpart. Digital programming techniques exhibits better performance especially in low voltage applications where the analog technique suffers from limited tuning range. The digital control provides higher resolution capability and complete reconfiguration to the continuous time analog systems. Digital programming techniques not only yields better accuracy in avoiding parameter race, but also offers additional advantages such as better noise immunity, power saving option and most importantly the direct compatibility to modern mixed mode (analog/digital) systems.

Second generation current conveyor (CCII) is widely used analog building block for the realization of signal processing/generation circuits since its inception in 1970. Compared to the classical voltage mode operational amplifier, which mainly suffers from gain bandwidth product limitation; CCII exhibits higher signal bandwidth, very high slew rate, good linearity, wider

dynamic range and low power consumption. Furthermore, current mode processing of CCII results in simplified circuit structures. In last one decade, introduction of digital control has further boosted the functional flexibilities and versatility of CCII. However, as mentioned before, limited work is available over digitally programmable CCII.

Inherent advantages of CCII and the scarcity of digitally programmable signal processing/generation circuits based over it have been the major source of motivation for the work presented in this thesis. Current feedback Amplifier, which is well known extension of CCII is also used in thesis for the realization of various circuits.

Thesis presents several current/voltage/mixed mode digitally programmable universal filters and quadrature/multiphase sinusoidal oscillators using digitally programmable CCII as main building block. Filters presented in the thesis are realized with goal to include independently programmable parameter set, low component count, realization of all filter functions, operation in all the modes and cascadability. Similarly, digitally programmable oscillators are designed to have independently programmable condition of oscillation and frequency of oscillation.

Detailed analysis comprising sensitivity and parasitic analysis of all the modules provides better insight of the presented circuit configurations and provides way for realization of more efficient circuits. Workability of all the presented circuits is proved by presenting vast SPICE simulation results. Apart from this, the systematic comparison carried throughout the thesis further shows the potentiality of presented structures.