ABSTRACT

In recent years, rapid growth in CMOS technology has made analog integrated circuits to dominate today's market in providing low cost, high performance systems. Wide band analog signal processing finds variety of applications in telecommunications, consumer and medical electronics. Since, continuous time filtering is preferred for low voltage, low power applications, an analog low pass filter forms the basic building block in all these systems. The operational transconductance based OTA-C or Gm-C filters are chosen for the realization of analog filter due to their structural simplicity, electronic tunability, high frequency capability, and monolithic integratability. The performance of this filter relies on the design of the operational transconductance amplifier (OTA), which forms the versatile building block in many analog- mixed systems. In this thesis, an approach is made towards the designing of amplifiers and filters for mobile and biomedical applications.

This research work focuses on the design and analysis of various single ended and fully differential architectures like telescopic OTA, folded cascode OTA, two stage OTA and gain boosted OTA. The comparison is made among these structures based on the performance parameters like transconductance, gain, Common Mode Rejection Ratio (CMRR), Power

Supply Rejection Ratio (PSRR), Slew rate, Total harmonic distortion (THD), Third order Harmonic Distortion (HD3) etc. The folded cascode structure performs better in both the structures. Hence, a fully differential folded cascode OTA has been proposed, which shows an improvement of 6.6 dB in DC gain, 37 dB in CMRR, 10 dB in PSRR and 40.74% reduction in power consumption when compared to the conventional folded cascode 2 OTA. The second order Gm-C Butterworth low pass filter realized using the proposed OTA, has -50.7 dB THD and 1 mW of power consumption. This filter is tunable from 50 kHz-2.5 MHz and is utilised as a channel selection filter in direct conversion receiver.

In the second work, five second order Gm-C Butterworth low pass filters have been proposed based on the design topology of the OTA. The study on the conventional OTA structures shows that the class AB pseudo differential input stage works effectively for low voltage, low power application. Hence, five different OTA structures have been proposed based on this structure for the implementation of the second order Gm-C low pass filter. The proposed OTA I perform better than the conventional OTA's with 1.45 mW of power consumption. The proposed OTA II works efficiently with 1.1 V supply voltage and attains high transconductance and less harmonic distortion compared to Conventional OTA's and Proposed OTA I. The proposed OTA III attains maximum transconductance among the Proposed OTA's and the Proposed OTA IV consumes 18.47% less power when compared to proposed OTA II. The proposed OTA V has least power among the proposed architectures with less transistor count though the transconductance is moderate. There forth, the second order low pass filters designed from the proposed OTA’s meet the specification of the multimode wireless standard of a communication receiver and are tunable from 50 kHz to 2.5 MHz.

An operational amplifier (opamp) has been proposed as the third work for biomedical signal acquisition of Electrocardiogram (ECG) signal in an analog front end system. The conventional opamp is designed with diode connected transistor at the output stage and is made programmable in low, medium and high power mode. Since, slew rate and input referred noise large in the conventional structure, four opamp structures are proposed with four different current mirrors. The proposed opamp with cascode current mirror has an improvement in gain of 2.755 dB, CMRR of 7.41 dB, slew rate of 3.3815 V/µs with 2.685 nV/√Hz reduction in noise compared to conventional opamp and performs better than the other proposed opamp structure. Hence, the proposed opamp can be employed as a bioamplifier for an analog front end bio acquisition system.

The fourth work elaborates the design of single ended folded cascode OTA and second order Gm-C Butterworth filter as a preamplifier and a low pass filter respectively for analog front end processing of ECG signal. The conventional fully differential OTA involves more design complexities and achieves less gain. Hence, a single ended folded cascode OTA is designed as a preamplifier for ECG signal acquisition, which attains a high gain of 82.15 dB, a CMRR of 131.7 dB, a PSRR of 82.5 dB with 158 μW power consumption. This OTA is utilized in the realization of Canonical and Second Order Gm-C Butterworth low pass filters. The performance comparison made among these filters show that, the second order Gm-C Butterworth filter consumes 20.06% lesser power and 12.8 dB lesser THD when compared to Canonical filter structures. Hence, the Simulink model developed for a first order low pass filter, using the folded cascode OTA shows that the filter can be used for ECG signal processing and can be extended for higher order filter implementation.

A neural signal acquisition amplifier has been proposed in the fifth work. Since, extracellular neural signals are weak in amplitude and low in frequency, amplification of these signals with less noise and low power is a must for epilepsy prediction. The conventional amplifier has large input referred noise and power consumption. Hence, a neural signal acquisition amplifier has been proposed that employs anti parallel diode connected PMOS transistors as pseudo resistors with g_m boosted LNA and Gm-C low pass filter to amplify and select the desired band of neural signals. The proposed amplifier achieves a gain 44.6 dB with 61.75% reduction in power consumption and 1 μV/√Hz less input referred noise when compared to the conventional amplifier. A bulk driven based MOSFET rectifier is used to supply adequate power as this structure can be made fully implantable. Thus, the neural signal acquisition amplifier can be used for epilepsy seizure prediction.