Abstract

The present thesis aims at developing OTA based signal conditioning circuit for MEMS capacitive sensors. The major challenges normally encountered in the design of such circuits are enhancement of linearity and introduction of tunability to compensate the variations of sensors after fabrication. An ASIC containing these features has been fabricated and successfully tested with a MEMS capacitive sensor.

The circuit configurations proposed in the thesis are on (i) linearity improvement of Operational Transconductance Amplifier (OTA), (ii) square-wave and clock generator with tuning options of both amplitude and frequency and (iii) a signal conditioning circuit for capacitance measurement particularly MEMS capacitive accelerometer. All the circuits have been designed and fabricated in UMC $0.18\mu m$ CMOS process technology and their performances have been tested and compared with similar configurations reported earlier.

First, a linear transconductance amplifier is proposed combining non-linear signal attenuation and conventional source degeneration techniques. Theoretical analysis shows that the mobility degradation makes the attenuation non-linear in a differential attenuator. This non-linear attenuation along with source degeneration reduces and as well as partially cancels out the harmonic distortion components. This improves the linear range significantly. The proposed linear transconductor achieves third order intermodulation distortion of less than $-60dB$ for $500mVpp$ input differential voltage at $5MHz$ signal frequency whereas for 2% transconductance variation the linear range is $1.2Vpp$ approximately.

Next, a fully on-chip tunable square-wave and clock generator is implemeted based on the linear transconductance amplifier. The tunable generator provides amplitude tuning range of $720mVpp$ and frequency tuning range of $780KHz$ within non-linearity less than 5% for both the cases.

Finally, a generic signal conditioning ASIC for capacitance measurement is developed with various programmability and tuning options. This ASIC is integrated with a MEMS capacitive accelerometer structure to form an integrated sensor system. The complete system is tested with electro-static actuation by applying actuation voltage

to the actuation fingers and also with a vibrating shaker for dynamic measurement. The performance of the integrated sensing system has been found to be superior in some features when compared with similar commercially available devices.

Keywords: *OTA, Linearization, Harmonic distortion, Square-wave generator, Tunability, Capacitive accelerometer, Signal conditioning ASIC, MEMS, Integration.*