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| Sigma Delta Analog to Digital Converter for Audio Applications |
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Sigma Delta Analog to Digital Converter for Audio Applications

Dr.Ahmed Nader

**Abstract:**

Delta Sigma modulations are widely used within analog-to-digital conversion interfaces in modern VLSI design, such as digital audio system and wideband communication.

In high audio applications, a large dynamic range (i.e. 16 ~ 20 bits) at 20 KHz bandwidth is essential. We can easily achieve a high resolution converter using sigma-delta architecture, and this approach is relatively insensitive to imperfections in circuit specifications than others.

In particular, over-sampling architecture is less in complexity of analog circuits compared with Nyquist-rate converters. And this is due to less component circuit requirement, and relying more on digital Signal processing to perform the A/D conversion with the advantage of much relaxed matching requirement on analog components, while still achieving the high required resolution

For a delta sigma converter, the performance is often determined in the front-end of the modulator. However, when a switched-capacitor circuit is adapted, there is often some non-ideal affection which will make the performance degrade. So we have studied lots of non-ideal affection.

One can depress the affection as low as possible after the model simulation and find out the corresponding circuit specification to meet the system performance. The models in system-level and the simulation results are included while the circuits are implemented according to them using two different approaches.

[1] Discrete time approach (D.T): using switching capacitor circuit techniques.

[2] Continuous time approach (C.T): using OPAMP RC circuit techniques

For The continuous time approach,

 The Analog part (Δ Σ modulator) is assembled on PCB using suitable COTS components (Commercial Off The Shelf) which satisfy the system

requirements.

 The Digital part (Digital Decimation Filter) is implemented over suitable FPGA kit.

For the Discrete time approach, it is simulated on EDA tools (Electronic Design Automation) to simulate transistor, and layout level for the mixed signal system; using TSMC 130um standard technology

The signal-to-noise ratio of the modulator is 95 dB in maximum, which can be used effectively in digital audio system within 20Kh bandwidth.

**CONCLUSION:**

Over the recent years Sigma Delta has been more and more popular and widely

used in the implementing high resolution low and intermediate bandwidth analog-to digital conversion. This Project has focused on the performance impact of circuit nonidealities effect and design flow of both CT and DT fourth-order sigma-delta modulator and corresponding decimation filter.

The related fundamental principles of delta sigma technology are introduced,

including quantization noise, over-sampled technique, and the architectures of delta sigma modulators.

Fourth-order feed-forward modulator is adapted and its corresponding Coefficients are synthesized, then a behavioral model of non-idealities was built and simulated. The simulation results provided corresponding circuit specifications, which were used and implemented on PCB and ASIC Design as well, Eventually the overall simulation model was built to evaluate and measure the total performance. An experimental modulator is designed according to the circuit specification which is obtained from behavior model simulation.

In order to demonstrate the analysis, the DT delta sigma ADC was implemented in TSMC 0.13μm CMOS technology, and the CT one was implemented on PCB and FPGA Kit.

**Future Work**

 ASIC Implementation for the CT  Modulator.

 More enhancements for stability design

 IC padding

 Parasitic extraction for DT  ADC

 Post layout Simulation for DT  ADC

 Virtuoso mixed signal simulation