Introduction

The subject of this master thesis is the design of the first stage of a second-order Sigma-Delta converter developed at Microchip. This stage is developed according to specifications defined in a first internship.

Theory/Method/Hypothesis

A second order Sigma-Delta converter has 2 filter stages. The first stage is a critical part of the design: noise at this stage is directly part of the signal. The noise coming from following stages is divided by the gain of the first stage when referred to the input.

The first stage is a switched-capacitor integrator. The amplifier was designed in order to have a sufficient gain and to be low power. Capacitors were sized in order to have a low thermal noise. Switches must have a low on resistance so that the system has a short settling time. Bootstrapped switches were developed. Bootstrapped switches are needed because the input goes up to VDD, and a CMOS switch would also work but would have a larger on resistance.

Sizing of the bootstrapped switches was done with the goal of minimizing current spikes and leakage currents. Leakage currents include input to output leakage and internal leakage. Bootstrapped switches were tested and included in the first stage top-level. The integrator was tested with all the blocks designed.

Results

The different parts of the first stage were tested separately and together in the integrator top level in all corners.

The amplifier DC gain and gain-bandwidth product were sufficient for the system. The bootstrapped switches utilization is confirmed as they have a on resistance much lower than Nmos transistors. Their leakage was measured and was low enough not to kill the performances of the system.

The first stage has a settling time fast enough for the specified sampling rate. Its power consumption is lower than specified, thus there is still room for improvement in terms of noise and speed.

Capacitor sizes can be increased to reduce the thermal noise. Circuit speed can also be increased so that the maximum input bandwidth can be larger.

To conclude the characterization of the system, noise simulations must be made.

Conclusion/Perspectives

During this project I discovered different steps of design, from the choice of a converter topology to transistor-level design.

I learned how a project evolves in industry.

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