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Electronics & Comm. Dept.

جامعة القاهرة

Post Graduate, Fall'12
Final Project
December 8th 2012
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ELC609: Data Converters

Time Allowed: 70 days

Due Date: February 16th, 2013

General Rules:

In the final project, choose one of the following options. For all options, assume the following:

1- $V_{DD} = 1.2V$ and $V_{SS} = 0V$.
2- Use TSMC 130nm technology (you are free to use any available device in the design kit).
3- Assume an input current source of $I_{source} = 50\mu A$ coming to your circuit going to an NMOS diode connected device to generate any other bias current or voltage you might need in your design.
4- To check mismatch between transistors, you can do one of the following:
   a. Use Monte Carlo simulations to check the exact offset numbers.
   b. Hand analysis: Assume for a high-voltage devices (3V) $A_{vt}(3\sigma) = 20mV$ and for low-voltage devices (1V) $A_{vt}(3\sigma) = 10mV$ (Not Recommended: to be used only in specific cases that we can discuss together)
5- All AC, TRAN, NOISE, DC, Stability … etc requirements should be checked using simulations.
6- You can use any circuit simulator in the design.
7- We can have a one-to-one meeting before starting to:
   a. Fix the project
   b. (Optional) Have a jump start discussion

Delivery of the project:

Project Delivery will be done on three steps:

1- (20% of the grade) A one-to-one meeting after 40 days to check the progress and refine the specifications and requirements. A small presentation is needed in this step. I expect the project to be 50% done, or at least to have a solid idea of what the issues are and what the potential solutions are with some preliminary simulations. You should be ready to present the state of the art papers/results related to your task.
2- (30% of the grade) A presentation to the whole class (if possible) 1 week after the delivery of the project (Saturday Feb 23rd, 2013).
3- (50% of the grade) A 10 page report in IEEE format as described later in the report Section. The report should include all the hand analysis and calculations, derivations, simulations, results and comparison with state of the art, proper figures, and references.

Project Options:

Option 1: 12-bit, 3GSps Digital-to-Analog Converter
Design a DAC to meet to following specifications:

1- Sampling Frequency = 3 GHz
2- Load Resistance = 50 Ω
3- Differential Outputs
4- Output Swing = $400\ mV_{pp}$
5- SFDR > 70dB for input frequencies < 300MHz
6- SFDR > 50dB for input frequencies > 300MHz up to 1.5GHz
7- Ensure by design INL < 2 LSB and DNL< 0.5 LSB

Option 2: High-Speed, Rail-to-Rail 500MSps 12-bit Sample-and-hold Circuit
Design a sample-and-hold circuit to achieve the following requirements:

1- Differential Output
2- Input swing = 80% of the supply voltage
3- Sampling frequency = 500 MHz
4- Total harmonic distortion < -80dB
5- Input referred noise < quantization noise level of a 12-bit ADC following this SHA
6- Load capacitance = 1pF

Option 3: 6-bit 4GSps Flash ADC
Design a 6-bit Flash type ADC with the following specifications:

1- Fully differential design
2- Reference input range from 0.3V to 0.9V
3- Sampling frequency = 4 GHz
4- Input capacitance < 0.3pF
5- Effective number of bits > 5.5 bits (Use FFT to check that)
6- Design the clock buffers used (include its power consumption in the design)
7- Power Consumption < 20mW (including clock buffers)

Option 4: 12-bit, 1GSps Pipeline ADC using digital calibration (2 people)
Design a 12-bit pipeline ADC with the following specifications:

1- Fully differential design
2- Input range = 50% of the supply
3- Sampling Frequency = 1GHz
4- Avoid using high-gain hihly-linear opamps by using background digital calibration
5- Design the digital calibration algorithm and discuss the circuit implementation (use matlab digital calibration)
6- Use circuit simulators to give you the digital samples, store them in a file and give them to Matlab to calibrate.
7- Required INL < 2LSB and DNL < 0.5 LSB
8- Do FFT on Matlab

Option 5:
Come up with your own idea, come talk to me before you start to approve the specifications.

Final Report:

As a final output of this project, you are required to prepare a report in the style and format of an IEEE journal paper. Use the "Template for Transactions" at http://www.ieee.org/publications_standards/publications/authors/author_templates.html to prepare your write-up. The (fictitious) target audience for your report consists of circuit designers that are generally familiar with ELC609 material, but are assumed to know nothing about your particular circuits and design task.

Your write-up should roughly consist of the following:

Abstract. See IEEE Journal papers for good examples. Briefly explain what your paper is about, and what you accomplished. The abstract should end with quantitative data. Be as clear, concise and specific as possible.

Introduction. Explain from a high level perspective what you have done, and roughly outline the rest of your paper. Define metrics and objectives, discuss the general architecture and point the reader to important references. Do not elaborate any circuit details in the introduction! It is usually OK, however, to mention the key idea that you leveraged in your design.

Core Section(s). Explain the details of your work in any format and number of sections you prefer. The key objective is to explain your design and the involved trade-offs in a concise, but yet comprehensive manner. A good paper makes it crystal clear to the reader how and why you achieved your specs. Writing good papers is not about hiding information and bragging about results; it is about clearly explaining where these results come from.

Conclusion. "Tell them what you are going to say, say it, and conclude by concisely summarizing what you just said…" In that spirit, end you paper with a brief conclusion that should ideally be only a few sentences long.

References. A list of papers that you deem relevant for your design or used result/circuit ideas from. Be sure to follow the IEEE citation format.

Figures. Make sure the figures are clearly labeled and ***readable***. If you have trouble integrating readable figures into the text section, it is better to attach larger versions at the end of the paper/report.