Abstract:

Circuit design greatly depends on the ability to control and reproduce transistor and process parameters. Variation in processing was in the past countered by defining process corners: boundaries in parameter variation that accounted for process tolerances. With the improved control over processing, this batch-to-batch variation is largely under control. However, now a new class of phenomena has appeared: statistical variations.

In analog circuits with a differential operation such as analog-to-digital converters, the performance is directly affected by this random parameter spread. The variation between otherwise identical components is generally described by “mis-match” parameters. Next to these static random phenomena, time-dependent variations also play an increasingly important role: variations in supply voltages and temperature and interference (supply and substrate noise, cross-talk, etc.) are of major importance to optimize circuit performance. Understanding and mitigating these effects requires more and more statistical means.

Analog-to-digital converters have led for many years the progress in expanding digital signal processing to more application domains. Power, resolution and bandwidth are the main parameters from a system point of view. Especially the need for achieving more resolution at high bandwidth has become a major objective for e.g. mobile phone base stations and medical imaging. This objective is severely constraint by variability effects and especially mismatch.

Where micron feature size process allowed for compensation of larger mismatch with larger voltages, the nanometer era requires careful search for alternative means to avoid loss of conversion performance. In a global review, some of the deterministic and statistical effects in nanometer processes are presented and the various techniques that analog designers use to mitigate statistical issues are reviewed.

An overview of mismatch theory is also presented, with a short side step to the more fundamental aspects. Based on this knowledge, some examples and exercises will be used to turn theory into operational skills. This statistical background knowledge will be applied to the design of a comparator and a band-gap reference circuit. Design options and choices are also presented. A ladder structure under mismatch and stress conditions are discussed. The example of comparator will be expanded to yield calculations on the level of a flash converter.

Not all analog-to-digital converters show a similar behavior under mismatch conditions. The mismatch sensitivity of various ADC topologies will be addressed and some consequences for multiplexed conversion topologies will be reviewed. Component mismatch, interference issues and various considerations for designing high-performance converter shall be discussed.

The applicable technological scope ranges from 1 micro-meter to the 45 nano-meter node. Many topics covered in the short course can be found in the reference book: Analog-to-Digital Converter by Dr. Marcel Pelgrom.
About the Instructor:

Dr. Marcel Pelgrom received his B.EE, M.Sc and PhD from Twente University, Enschede The Netherlands. In 1979 he joined Philips Research Laboratories, where his research has covered topics as Charge Coupled Devices, MOS matching properties, analog-to-digital conversion, digital image correlation, and various analog building block techniques.

He has headed several project teams and was a team leader for high-speed analog-to-digital conversion.

From 1996 till 2003 he was a Department Head for mixed-signal electronics. Next to various activities concerning industry-academic relations, he is involved as a research fellow in research on the cutting edge of design and technology. In 2003 he spent a sabbatical in Stanford University where he was appointed a consulting professor. Since 2007 he is a Member of the Technical Staff of NXP Semiconductors.

Dr. Pelgrom is an IEEE Distinguished Lecturer and has written over 40 publications, five book chapters and holds 30 US patents. He is lecturing at Twente and Delft Universities, and for MEAD Inc. In August 2010, Springer published Dr. Pelgrom’s lecture notes as a book: “Analog-to-Digital Conversion”.

Dr. Pelgrom is a pioneering expert on transistor variability. His JSSC Classic Paper published in October 1989, “Matching properties of MOS transistors” has been cited more than 150 times according the Journal Citation Report.

Benefits of this Course

To learn from the industry expert & distinguished lecturer

• Statistical variations of transistor and process parameters
• Mismatch and variability effects on data converters
• Design examples to turn theory into operational skills
• Practical converter designs using nanometer technologies

Who Should Attend?

This course is designed for engineers, technical staff and students who are involved in high performance analog and data converter IC designs using deep submicron process technologies.

Reference Book:
Analog-To-Digital Conversion
Author: Marcel Pelgrom
Publishing Date: Aug 2010
Publisher: Springer
Number of Pages: 455

Book Summary of Analog-To-Digital Conversion

The design of an analog-to-digital converter or digital-to-analog converter is one of the most fascinating tasks in micro-electronics. In a converter the analog world with all its intricacies meets the realm of the formal digital abstraction. Both disciplines must be understood for an optimum conversion solution. In a converter also system challenges meet technology opportunities. Modern systems rely on analog-to-digital converters as an essential part of the complex chain to access the physical world. And processors need the ultimate performance of digital-to-analog converters to present the results of their complex algorithms.

The same progress in CMOS technology that enables these VLSI digital systems creates new challenges for analog-to-digital converters: lower signal swings, less power and variability issues. Last but not least, the analog-to-digital converter must follow the cost reduction trend. These changing boundary conditions require micro-electronics engineers to consider their design choices for every new design.

Analog-to-Digital Conversion discusses the different analog-to-digital conversion principles: sampling, quantization, reference generation, nyquist architectures and sigma-delta modulation. Analog-To-Digital Conversion presents an overview of the state-of-the-art in this field and focuses on issues of optimizing accuracy and speed while reducing the power level. A lot of background knowledge and practical tips complement the discussion of basic principles, which makes Analog-to-Digital Conversion also a reference for the experienced engineer.
Singapore Polytechnic
500 Dover Road
Singapore 139651
http://www.sp.edu.sg

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One-Day Short Course on

“Practical Data Converter Design in Nanometer Technologies”

Organized by IEEE
Singapore Solid-State Circuits Chapter

Date: Monday, 11th October 2010, Time: 0900hrs – 1730hrs (Registration starts at 08:30hrs)
Venue: LT12A/T12A, Singapore Polytechnic, 500 Dover Road, Singapore 139651

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