

Technical University of Catalunya
Department of Electronics Engineering

Seminar announcement

Digital Control of Switched-Mode Power Supplies

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Abstract

Digital control of high-frequency DC-DC converters is gaining attention and importance. Potentials for significant improvements in flexibility, scalability, performance gains and advanced power management features, combined with advances in practical implementation techniques in relatively low-cost fine-geometry digital CMOS processes open the doors for a new generation of controllers for switched-mode power supplies (SMPS). Applications range from low-power DC-DC converters for portable electronics, to point-of-load DC-DC converters and microprocessor power supplies, to off-line power conversion. The objective of the seminar is to introduce digital controller architectures, as well as analysis, modeling, design, and implementation techniques behind the emerging SMPS digital control technology. In addition, we discuss a selection of recent advances in the area, including nonlinear control, multi-phase, efficiency optimization, on-line identification, and auto-tuning methods. Simulation and experimental examples of high-frequency digitally controlled converters based on custom digital CMOS prototype chips or FPGA development platforms illustrate the discussions.

Outline: Day 1

1. Introduction
 - Review of switched-mode power converters
 - Review of standard analog voltage-mode PWM control
 - Introduction to digital PWM control architecture and building blocks
 - A/D conversion
 - Discrete-time compensator
 - Digital pulse-width modulator (DPWM)
2. Introduction to dynamic modeling and discrete-time compensator design
 - Review of averaged small-signal converter models
 - Review of standard analog compensator design
 - Review of discrete-time systems
 - Discrete-time compensator design based on emulation
 - Averaged small-signal model with delay
 - Continuous-time to discrete-time mapping
 - Design examples
3. Quantization effects
 - Modeling of quantization effects and limit cycling
 - Static model
 - Dynamic model: describing functions
 - No-limit-cycling conditions
4. Implementation of digital control building blocks
 - A/D conversion
 - Window-flash A/D
 - Delay-line A/D
 - Discrete-time compensators
 - Standard fixed-point realizations
 - Look-up table-based realization
 - DPWM realizations
 - DPWM Classification
 - Counter-based DPWM
 - Delay-line-based DPWM
 - Feed-forward DPWM
 - Hybrid DPWM
 - Hybrid DPWM with Digital DLL
 - DPWM resolution enhancement techniques
 - Dither
 - Sigma-delta
 - Examples of complete high-frequency digital PWM controllers

Outline: Day 2

5. Discrete-time converter modeling and direct-digital compensator design
 - Discrete-time small-signal models with delay
 - Direct-digital compensator design
 - Design examples
6. Section of recent research results in digital SMPS control
 - Digital current-mode control and overload protection
 - Digital control of power-factor correctors
 - Nonlinear control for improved transient responses
 - Wide-bandwidth multi-phase control
 - Sensorless dead-time optimization
 - On-line identification of converter frequency responses
 - Automated direct digital compensator design
 - Auto-tuning techniques

Location: Aula de Teleensenyament, 1st floor, B3 building, Campus Nord UPC, Barcelona

Dates: *Monday* July 3rd 10h – 13:30 h , 15:30h – 19:00h and *Tuesday* July 4th 10h-13h

There is no fee for the course. Please notify Eduard Alarcón (elalarcon@eel.upc.edu) so as to organize course materials