



NPTEL ONLINE CERTIFICATION COURSES

DIGITAL CONTROL IN SMPCs AND FPGA-BASED PROTOTYPING

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Module 01: Introduction to Digital Control in SMPCs

Lecture 01: Digital Control in Switched Mode Power Converters – Course Introduction



CONCEPTS COVERED

- Examples of digital control applications in Power Electronics industries
- Why growing digital control trends in Power Electronics industries?
- Challenges in commercial digital control product development
- Need for architecture exploration and skilled manpower development
- Objectives and overview of the course introduction

Digital Control Trends in Power Electronics Industries – Examples



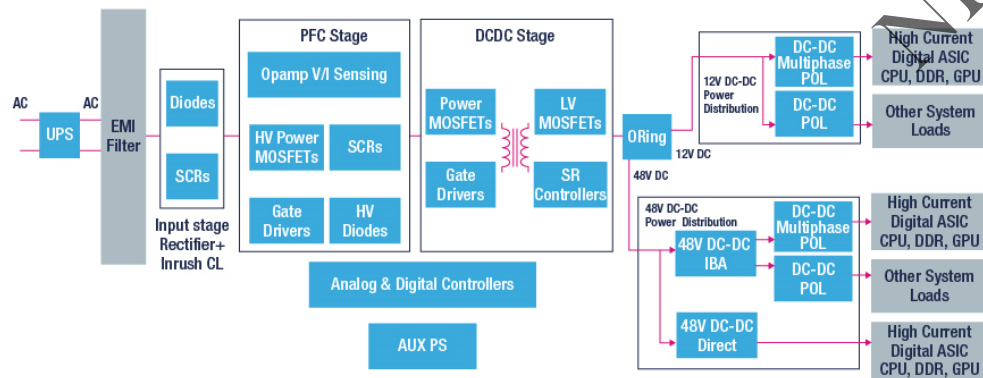
Renesas digital power for data center



TI digital power solution



Infineon digital power for LED

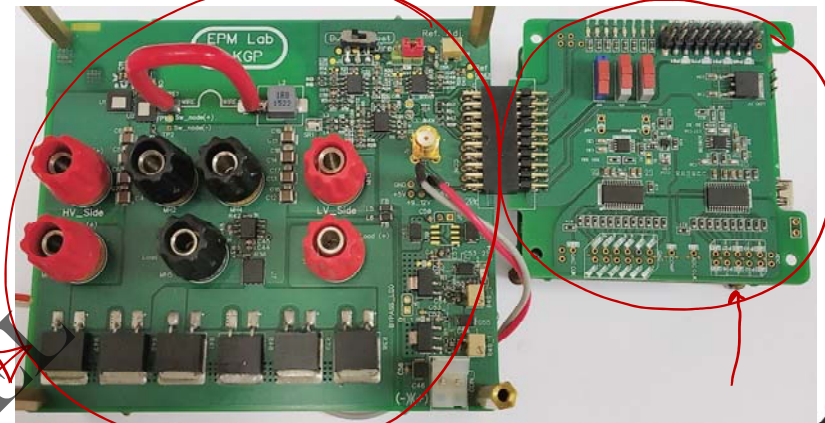
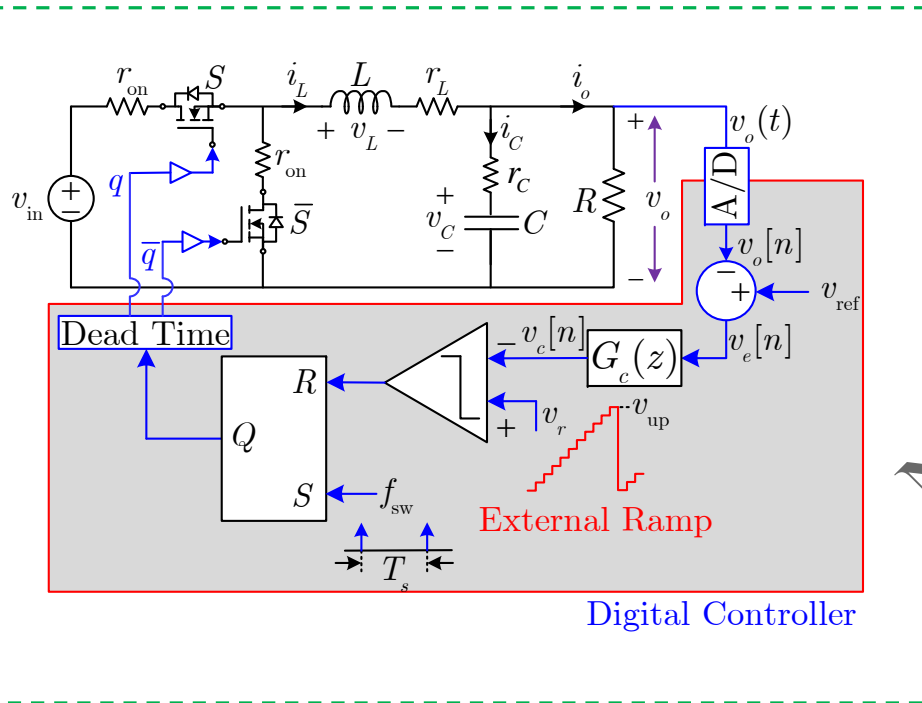


STMicroelectronics digital power solutions for servers

Why Growing Emphasis on Digital Control?

- ☐ *Flexibility, portability, reconfigurability* – varying topologies, process technology, etc.
- ☐ *Digital communication & control* – reliable, fault tolerant, smart power supply network
- ☐ *Hardware/software/firmware integration* – optimized solutions, third-party interface
- ☐ *Higher efficiency, lower component count, advanced control for faster transient*
- ☐ *Digital PMIC, digital control IC, digital control plug-and-play modules*
- ☐ *Rapid prototyping* – shorter technology & product development time

Example of Digital Control in a DC-DC Buck Converter



Complete closed-loop test set-up
for this online course

Challenges in Digital Control Commercial Products?

- ❑ *Cost* – ADC/DAC (bit size, conversion time), digital controller computation time
- ❑ *Level of digitization* – housekeeping to mixed-signal to fully digital solutions
- ❑ *Architecture* – modulation techniques, sampling methods, implementation platforms
- ❑ *Power consumption* – loop delay (sampling rate), voltage regulation (bit size)
- ❑ *Modeling, analysis and design methodology* – stability and performance
- ❑ *Mixed domain IP development* – FPGA prototyping to ASIC products

Why is this Course?

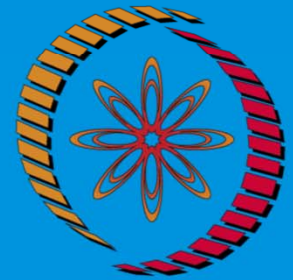
- ☐ *To familiarize digital control architectures with resource constraints, analysis/design tools*
- ☐ *To introduce Verilog HDL coding, fixed-point implementation and FPGA prototyping*
- ☐ *To demonstrate power converter hardware prototypes using Xilinx FPGA along with STM32 (from ST Microelectronics) and C2000 (from TI) microcontrollers*
- ☐ *To present MATLAB customized model development & design validation*
- ☐ *To develop skilled manpower and to enable indigenous IP development*

Summary of this 12-week Course

- ☐ *Level of digitization in closed-loop switch mode power converters*
- ☐ *Modulation and sampling methods in fixed frequency digital control*
- ☐ *Modulation and sampling methods in variable frequency digital control*
- ☐ *Custom model development using MATLAB Simulink for various architectures*
- ☐ *Overview of modeling techniques with their complexity and accuracy*
- ☐ *Modeling of closed-loop digital control and steps for model validation*

Summary of this 12-week Course

- ☐ *Design of fixed frequency digital voltage mode and current mode control*
- ☐ *Introduction to Verilog HDL and fixed-point implementation*
- ☐ *Verilog HDL-based digital control implementation and FPGA prototyping*
- ☐ *Reference design and hardware implementation with case studies*
- ☐ *Hardware demos using FPGA device, STM32 and C2000 microcontrollers*
- ☐ *Multimode digital control with opportunities and future challenges*



**THANK
YOU !**