NPTEL ONLINE CERTIFICATION COURSES

DIGITAL CONTROL IN SMPCs AND FPGA-BASED PROTOTYPING

Dr. Santanu Kapat
Electrical Engineering Department, IIT KHARAGPUR

Module 01: Introduction to Digital Control in SMPCs

Lecture 03: Examples of Some Commercial Digital Control Solutions

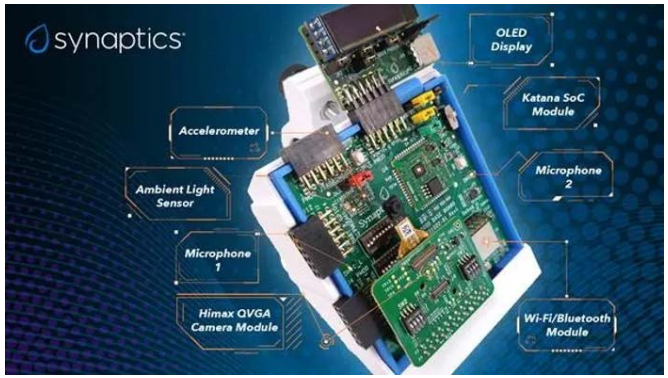
CONCEPTS COVERED

- Examples of digital power control integrated circuits
- Examples of digital control system solutions
- Benefits of digital power solutions
- Important aspects in this course

Some Important Applications of Power Management

Automotive *[Source AVNET]*

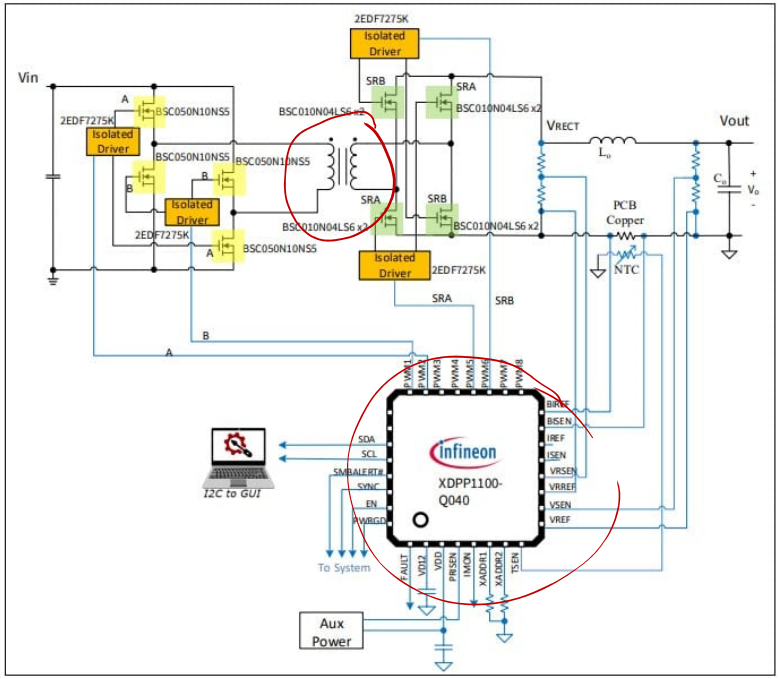
Data center *[Source ABB]*



Consumer Electronics *[Source EDN]*

5G Communication *[Source EE Times]*

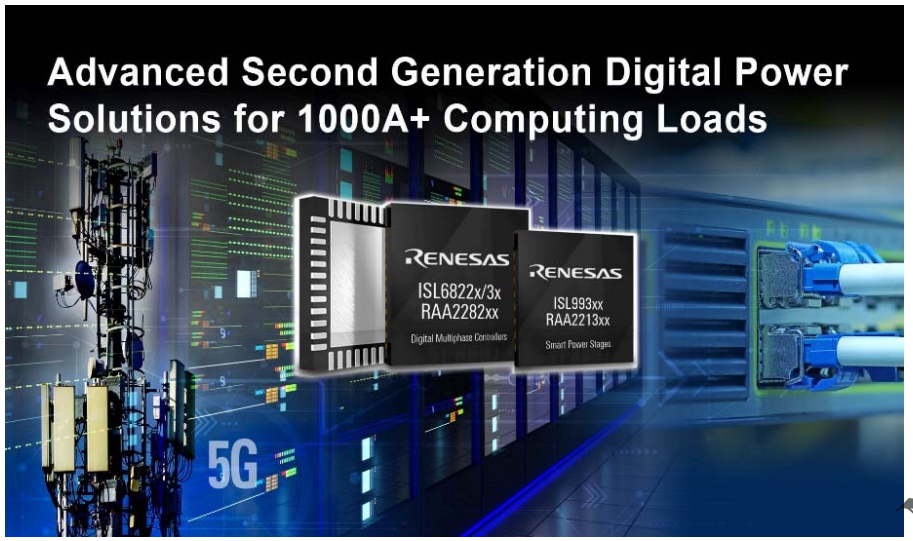
Digital Power Control IC for 48-to12 V Server Supply



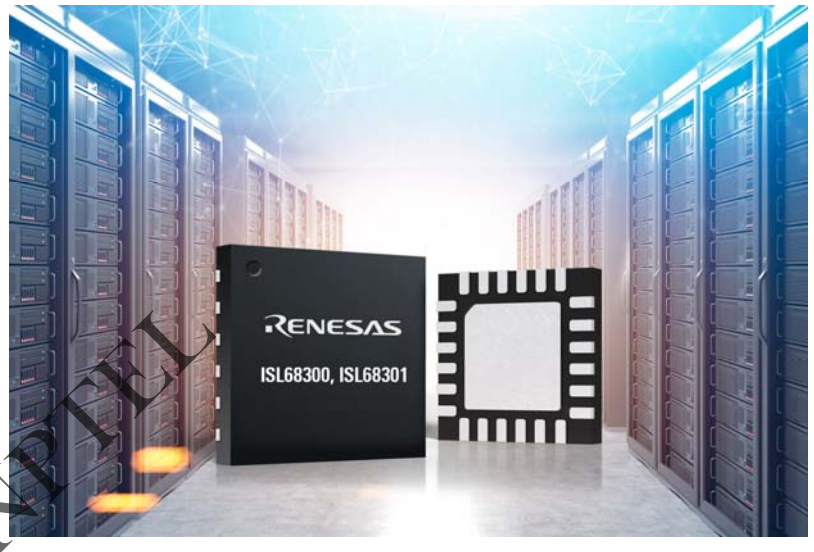
Infineon digital power

- Digital control of isolated brick converter
- Active current sharing among multiple modules
- Voltage mode digital control with flux balance
- Configurable GUI support
- High power density

Digital Power Control ICs



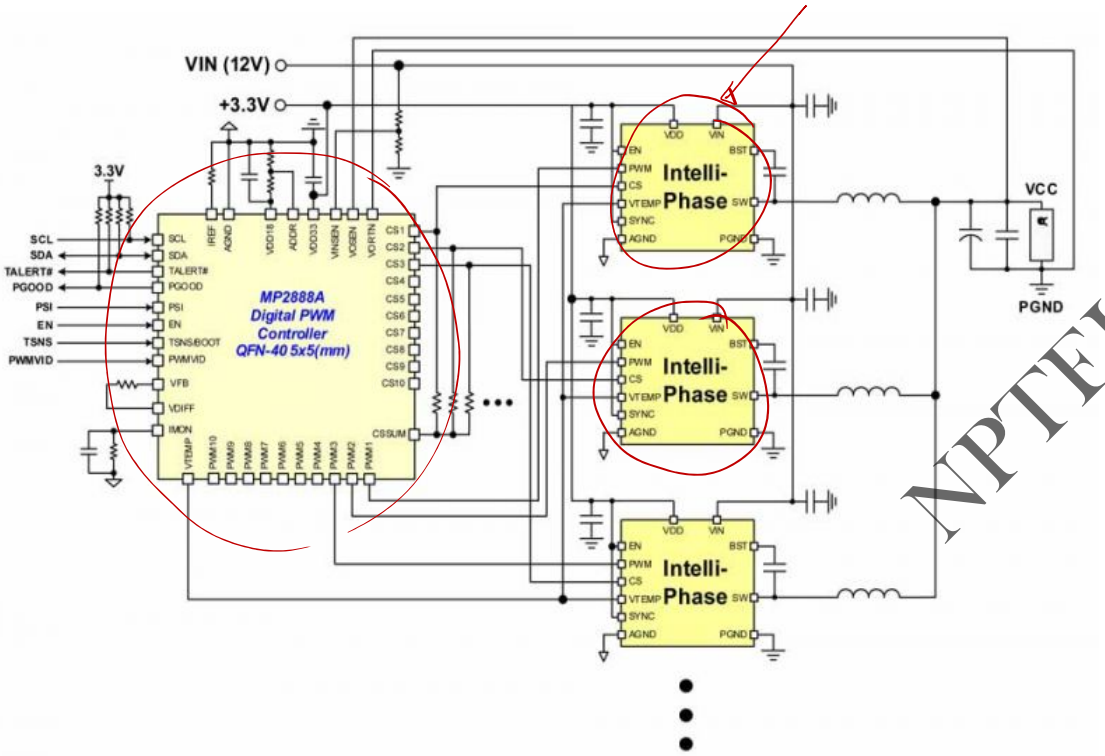
Renesas digital power for data center



Renesas digital power for cloud server

- *ChargeMode Control for Fast Transient Performance*
- *Inherently stable current loop without external ramp compensation*

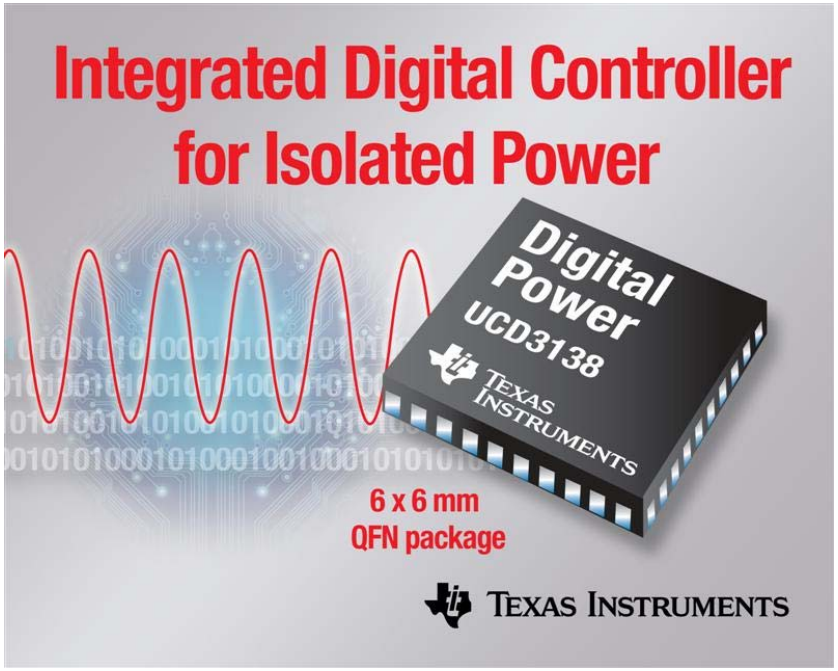
Digital Power Control ICs



Monolithic Power Systems

- Nonlinear digital control for very fast transient performance
- Automatic loop compensation
- Flexible phase management
- Fewer component count

Digital Power Control ICs



TI digital power solution

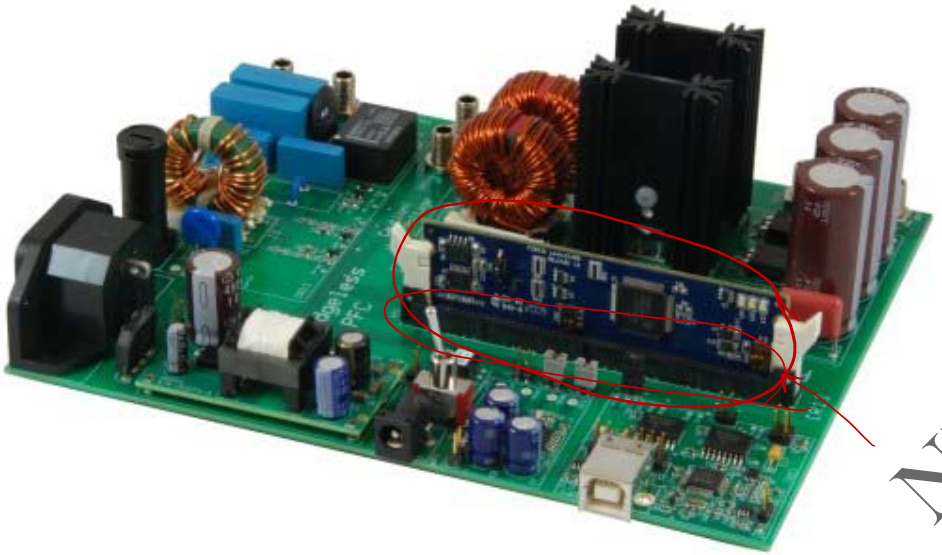
- Smart features for high peak/light load efficiency, soft on-off control, etc.
- Support various isolated converters
- All protection circuits included

Digital Power Control IC for PFC-LLC

Infineon digital power

- Integrated start-up logic with low standby power
- Digital multi-mode PFC-LLC combo solution
- Multi-mode PFC for optimized efficiency curve
- Reduced component count – smaller size
- Parameter configurations

Digital Control System Solutions for PFC



TI C2000 microcontroller based digitally controlled PFC

- Fully digital control solution
- High efficiency
- Hardware/software/firmware

Digital Control System Solutions for PFC

STMicroelectronics STM32 microcontroller based digitally controlled interleaved PFC

- Fully digital control solution
- Mixed-signal average CMC
- Input voltage, load feed-forward
- Hardware/software/firmware

Benefits of 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

Important Aspects in 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

CONCLUSION

- Examples of digital power control integrated circuits
- Examples of digital control system solutions
- Benefits of digital power solutions
- Important aspects in this course

THANK YOU !