Prototypage rapide du contrôle d'un convertisseur de puissance DC-DC à haut rendement

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Agenda

→ Supergrid origins and SuperGrid Institute SAS

→ Power converter DC-DC 100kW

→ Model based design and rapid control prototyping

→ Conclusions and perspectives
What is a supergrid?
Why supergrid?

➤ Strong increase of renewable energy share in the global energy mix: from 19% in 2008 to 32% in 2035

➤ Sharing renewable energies over a large territory, smoothing generation variations

➤ Complementarity of consumption profiles (time offset seasonal peaks and daily peaks)

➤ Connecting major reserves of renewable energy (unpopulated areas)

➤ Designed to reduce emissions of greenhouse gases
SuperGrid Institute SAS

**Mission**

Collaborative research leading to industrial and commercial applications

**Objectives**

- To develop new technologies for the construction of supergrids
- To generate intellectual property rights
- To federate the French industry around supergrids’ challenges
- To develop education programs
A Collaborative Research Center

- Involving private industry and public laboratories
- Owning equipment for simulation and testing
- With research staff mostly provided by partners and gathered in one location

“OPEN INNOVATION”
Budget: 225 M€ over 10 ans 2014 - 2024

10 years expenses (M€)

- Investment: 19.7%
- Staff: 66.0%
- Programmes Expenses: 35.3%
- ITE Expenses (building, IP, Gen. Expenses): 81.9%

86.6 M€ Public Grant
Power converters in supergrids
What is a power converter?

- You use them to charge your phone, laptop, etc.
- Over the last decade they have become much smaller and much more energy efficient

- For supergrids it is the same ...

5 W
What is a power converter?

→ ... but bigger, much bigger

500 000 000 W
SGI’s power converter DC-DC 100kW

- Isolated Dual Active Bridge topology

- Nominal power 100kW
- Nominal voltage 1200V input / 600V output
- High frequency switching at 20kHz
- High efficiency >98%
- Compact size with simple cooling

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Power converter model based design

From a Simulink control and plant model design to a real-time software implementation and testing
Power converter control prototyping

MATLAB Simulink and Speedgoat real-time target
Power converter control prototyping

**Mother board**
- Intel Core i7 3.5GHz CPU 4 cores
- Control up to 20 kHz

**SSD**
- 250Gb (540Mb/s read / 520 Mb/s write)
- Allow logging of data at high sample rate

**Rack 4U**
- Power supply 400 W
- 2 x Gigabits ethernet

**IO 204**
- 16 24V inputs
- 16 24V/0.5A outputs

**FPGA board with digital I/O + mezzanine ADC**
Power converter control prototyping

Speedgoat Real Time Target

1 ms
Supervision

100 µs
Control

10 ns
FPGA

20 kHz
DC-DC
100kW
Power converter control prototyping

- Simulink
- MATLAB
- SimPowerSystems
- etc.

- .c
- .h
- .vhdl
- HDL Coder
- Simulink Coder

- Simulink Real-Time

MathWorks

SuperGrid Institute
SGI’s DC-DC 100kW: 1 kV 100 kW in one year!
Conclusions

- SuperGrid Institute’s power converter DC-DC 100kW is a step towards the supergrids

- Preindustrial control development for a high frequency switching power converter using Simulink Coder and HDL Coder

- Very fast transition from a design model to a real-time software thanks to the complete compatibility between MATLAB-Simulink and Speedgoat

- Convenient testing tools allowing a complete control of a test bench with Simulink Real-Time
Perspectives

→ SuperGrid Institute continues the research on high voltage and high power converters

→ The focus is put on multilevel converters using the distributed control with fibre optics network

→ Our adventure making the supergrids a reality continues with MATLAB Simulink and Speedgoat
SuperGrid Institute

Penser les réseaux électriques du futur

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