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Piezoelectric transformers: Control

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Technical University of Denmark - DTU

DTU will develop and create value using the natural sciences and the technical sciences to benefit society.

H.C. Ørsted, founder of DTU in 1829
Technical University of Denmark - DTU
Technical University of Denmark - DTU

5,895
human resources (FTEs)

11,031
full-time students

21%
researchers and educators (VIP)

43%
in support functions

36%
PhD fellows*

28%
BEng

32%
MSc

40%
BSc

*Employees only
DTU Electrical Engineering

Power engineering
Automation, control, and robotics
Biomedical engineering, CMR, ultrasound
Antennas & microwave tech.
Acoustics
Hearing systems
Power electronics & IC design
Electronics group
Electronics group

• Is research leader within:
  – Switch-mode (class D) Audio power amplifiers
    • 3 spin-off’s: B&O ICEpower & TI Denmark & Merus Audio
    • Highest output power IC class-D amplifier chip ever
  – High efficiency fuel cell power converters
    • Has the highest efficiency (> 98%) fuel-cell power converter ever
  – VHF power converters

• Provides unique solutions to the collaborating companies
• One of the most innovative groups at DTU:
  – 46 inventions
  – Start-up companies:
    • ICEpower (former Bang & Olufsen ICEpower)
    • Texas Instruments DK (former Toccata)
    • Upcon Technology
    • Merus Audio
    • Nordic Power Converters
    • Senserna
    • Nordic Firefly
Electrical behaviour of piezos

- Capacitive behavior
- Inductive behavior
- Resistive behavior
Inductive behaviour of piezos

• Intro
• Capacitive behavior
• **Inductive behavior**
• Resistive behavior
• Conclusions
Piezoelectric transformers
Self-oscillating PT-based SMPS
Control block
SO Principle

- Voltage
- Current
- Zero crossing
- Edge detect
- Delay
- High – side
- Low – side

Impedance (log)

Phase

Capacitive
Inductive
Capacitive

Resistive
Resistive

Frequency (log)

$f_c$

$\omega_r$
Bidirectional operation
Modular design
Why inductorless?
MRI testing
MRI testing

SNR degradation of 10dB
Conclusions

*PT-based SMPS control method:*

- Simple method for minimizing hard-switching losses
- Fast control to track and maintain self-oscillation
Thank you for your attention!