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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

- researchers and educators (VIP)
- in support functions
- PhD fellows*

*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

Capacitive
Inductive
Capacitive

Impedance (log)
Phase
Frequency (log)

Resistive
Resistive
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!