Announcements

- Updated PCB Layout

Remaining Switching Losses

Switching losses:
1. Crosstalk \( \text{Cd} \)  
2. Overlap ON  
3. Overlap OFF  
4. Reverse Recovery

- 5. Gate drive
- 6. Body diode conduction
- 7. Turn-on losses
- 8. Infected gate drive distortion
Chapter 20: Resonant Switch Topologies

• Introduction

• 20.1 The zero-current-switching quasi-resonant switch cell
   20.1.1 Waveforms of the half-wave ZCS quasi-resonant switch cell
   20.1.2 The average terminal waveforms
   20.1.3 The full-wave ZCS quasi-resonant switch cell

• 20.2 Resonant switch topologies
   20.2.1 The zero-voltage-switching quasi-resonant switch
   20.2.2 The zero-voltage-switching multiresonant switch
   20.2.3 Quasi-square-wave resonant switches

• 20.3 Ac modeling of quasi-resonant converters

• 20.4 Summary of key points
The resonant switch concept

General idea:

1. PWM switch network is replaced by a resonant switch network
2. This leads to a quasi-resonant version of the original PWM converter

Example: realization of the switch cell in the buck converter

High Frequency Switch Network

Converter examples

High-frequency view of the switch network

Basic switch implementation options
- Q: single-quadrant (transistor)
- D: single-quadrant (diode)
- Q: current-bidirectional (e.g., MOSFET)
- D: current-bidirectional synchronous rectifier (e.g., MOSFET)
ZVS-QSW: Review

Converter examples

High-frequency view of the switch network

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Classification of Resonant-Switch Converters

QSw

CR
ZVS-QR Buck

- L, C, parasitics of Q, FET incorporated
- \( i_{ph} = I_c \)

Issues:
- No diode parasitics integrated
- \( V_{DS} \) << PWM case

ZVS-QR State Plane

1. \( I_c t_1 = V_g \Rightarrow \theta_1 = \frac{1}{3c} \)
2. \( J_s = \sqrt{J_s^2 - 1} \)
   \( \beta = \pi + \sin^{-1}(\frac{1}{3c}) \)
   ZVS condition: \( J_s > 1 \)
3. \( \frac{V_c}{I_c} t_3 = J_s + J_c \)
   \( \theta_3 = J_s + J_c \)
4. \( \frac{L_{in}}{P} = \theta_1 + \beta + \theta_3 + \theta_4 \)