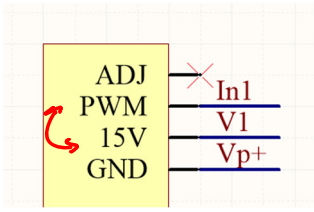
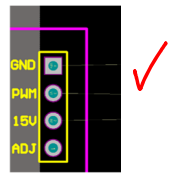
Announcements

- Updated PCB Layout

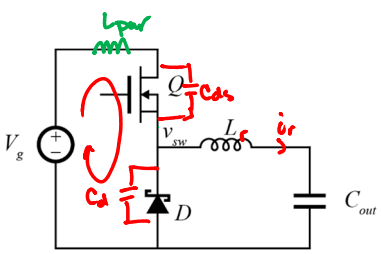


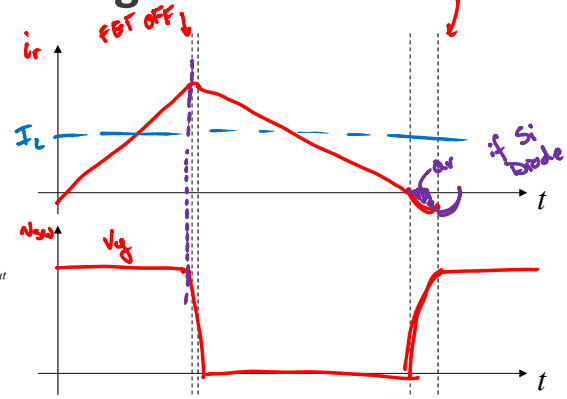


Remaining Switching Losses

FET ON

$\int VS - QSW$

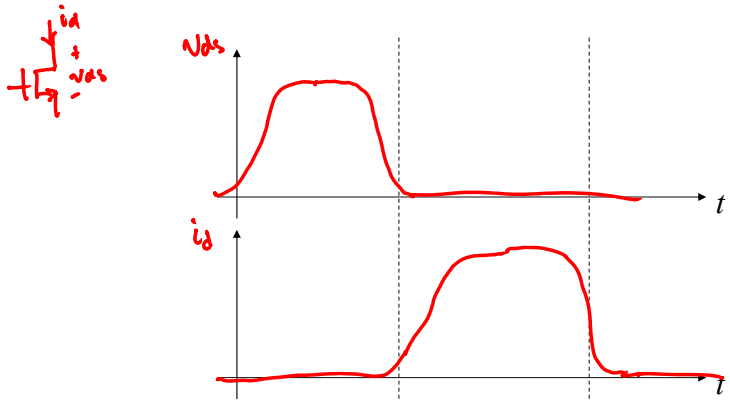




Switching losses

1. Coss / Cd ✓
2. Overlap ON ✓
3. Overlap OFF ↓
4. Reverse Recovery ↓
5. Qg - from Gate Driver —
6. → Body Diode conduction —
7. Lpar losses —
8. $\frac{dV}{dt}$ induced gate drive distortion

Idealized Switching Waveforms



1. Trapezoidal – limit stresses for a given average value
2. No overlap v-i
& small slopes of v & i @ switching transitions

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

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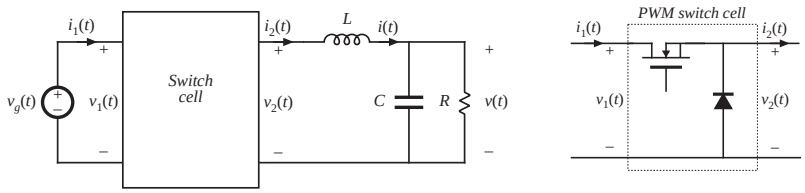
The resonant switch concept

General idea:

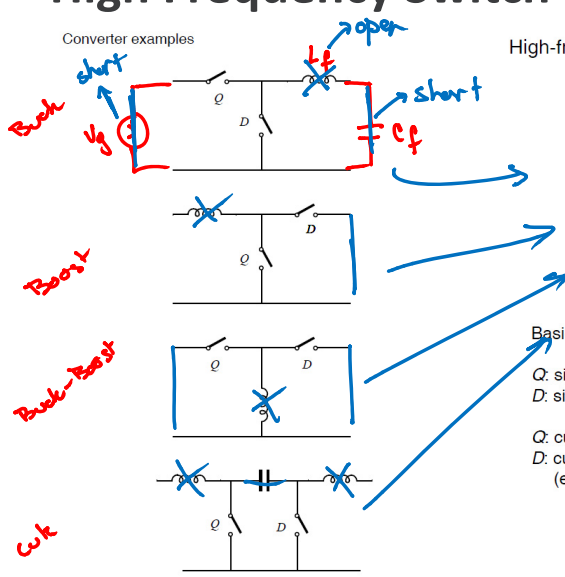
- 1. PWM switch network is replaced by a resonant switch network
- 2. This leads to a quasi-resonant version of the original PWM converter



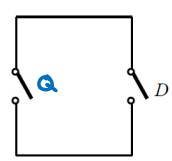
Example: realization of the switch cell in the buck converter

High Frequency Switch Network

Converter examples



High-frequency view of the switch network



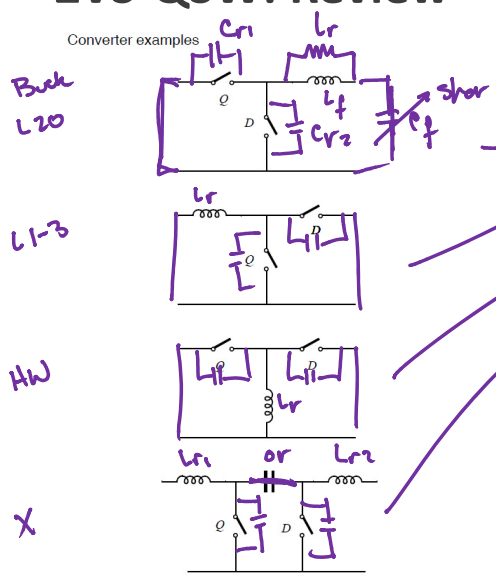
Basic switch implementation options

Q: single-quadrant (transistor)
D: single-quadrant (diode)

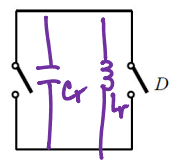
Q: current-bidirectional (e.g. MOSFET)
D: current-bidirectional synchronous rectifier (e.g. MOSFET)

ZVS-QSW: Review

Converter examples



High-frequency view of the switch network



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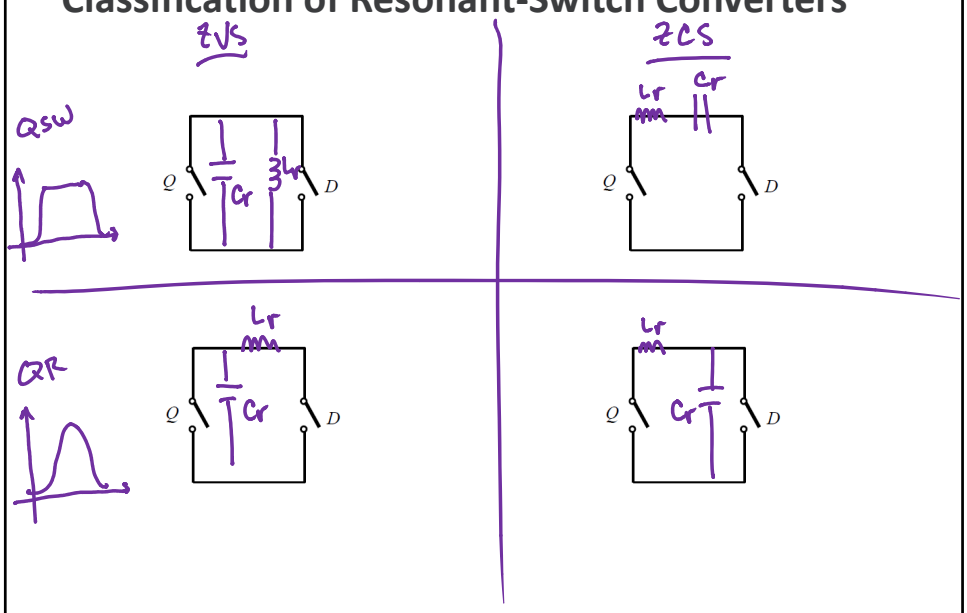
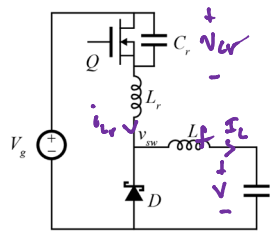
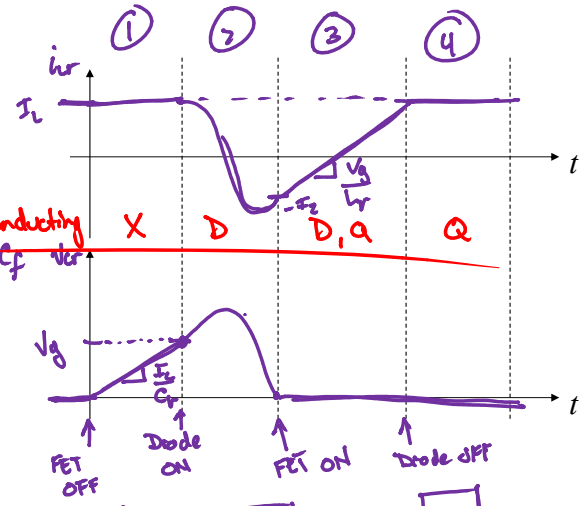
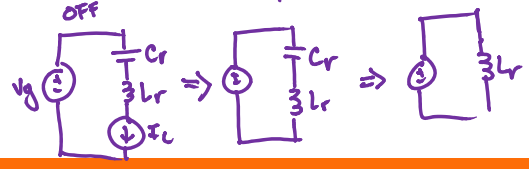
Classification of Resonant-Switch Converters



ZVS-QR Buck







Merits:

1. L & C parasitics of Q FET incorporated
2. $i_{pk} = I_L$

Issues:

1. No diode parasitics integrated
2. $V_{ds,pk} \gg$ PWM case

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ZVS-QR State Plane

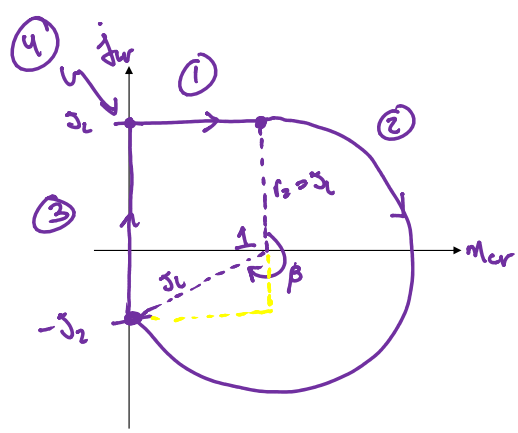
$V_{base} = V_g$ $\quad Z_0 = \sqrt{\frac{L_r}{C_r}}$

1. $\frac{I_L}{C_r} t_1 = V_g \rightarrow \theta_1 = \frac{1}{J_L}$
2. $J_2 = \sqrt{J_L^2 - 1}$

   $\beta = \pi + \sin^{-1}\left(\frac{1}{J_L}\right)$

   ZVS condition $\rightarrow J_L \geq 1$
3. $\frac{V_g}{L_r} t_3 = J_2 + I_L$

   $\theta_3 = J_2 + J_L$
4. $\frac{2\pi}{P} = \theta_1 + \beta + \theta_3 + \theta_4$



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