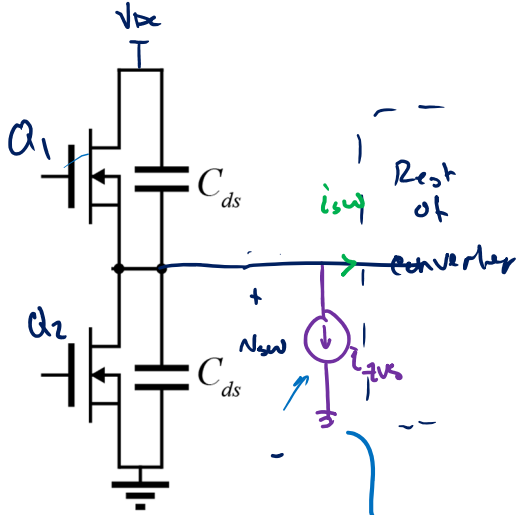
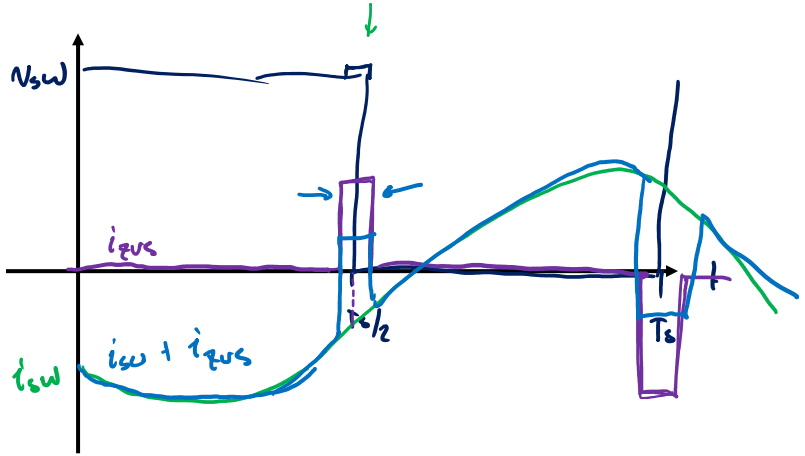
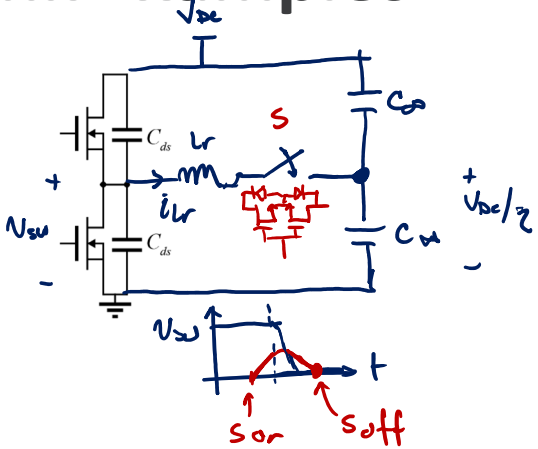
ZVS Assist Circuits

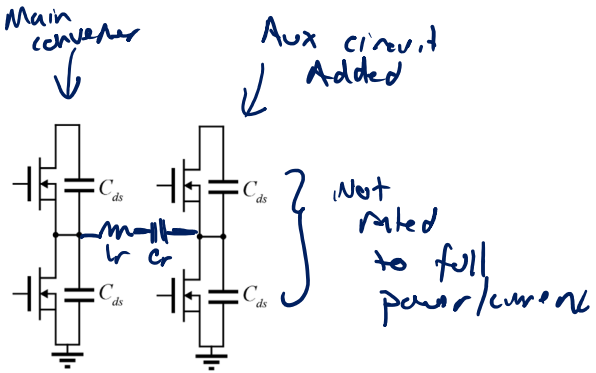


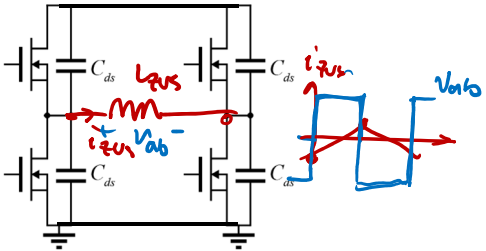


generate currents to assist w/ ZVS with minimal
- impact on main converter operation
- additional i_{rms} losses
other losses

ZVS Tank Examples

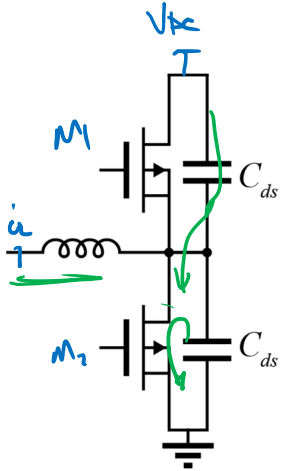


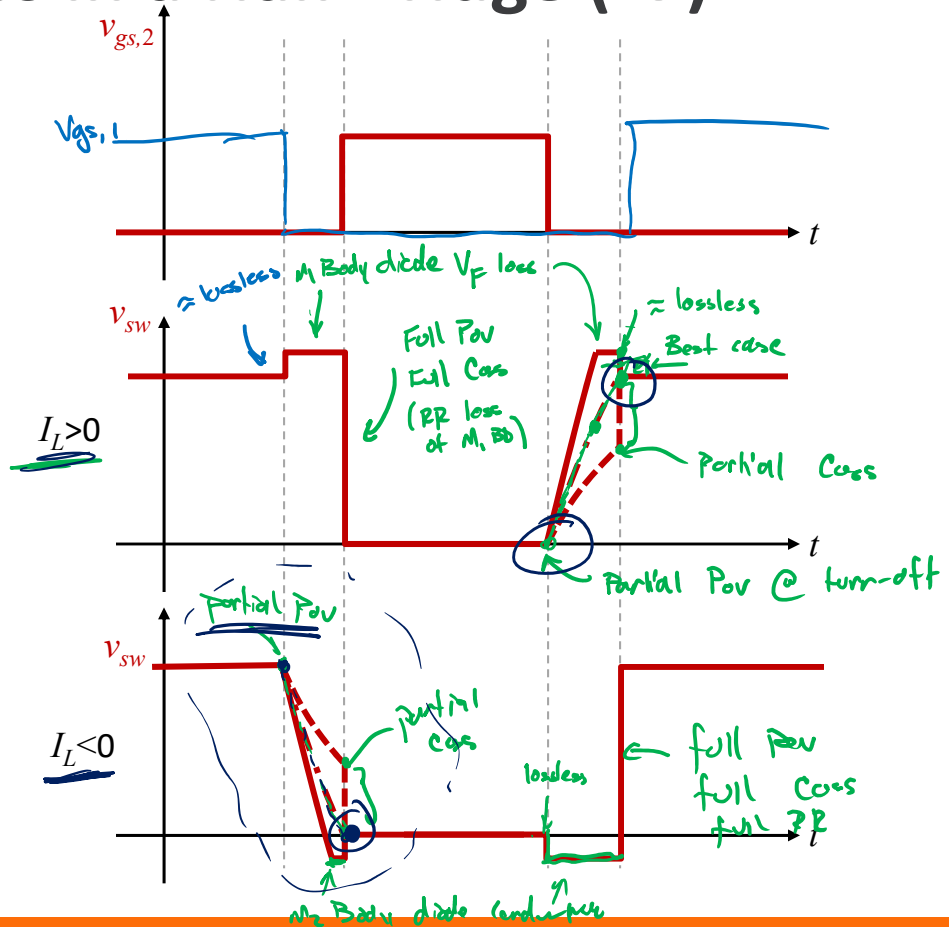


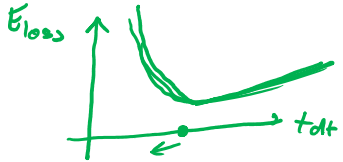


RESONANT SWITCH MODELING

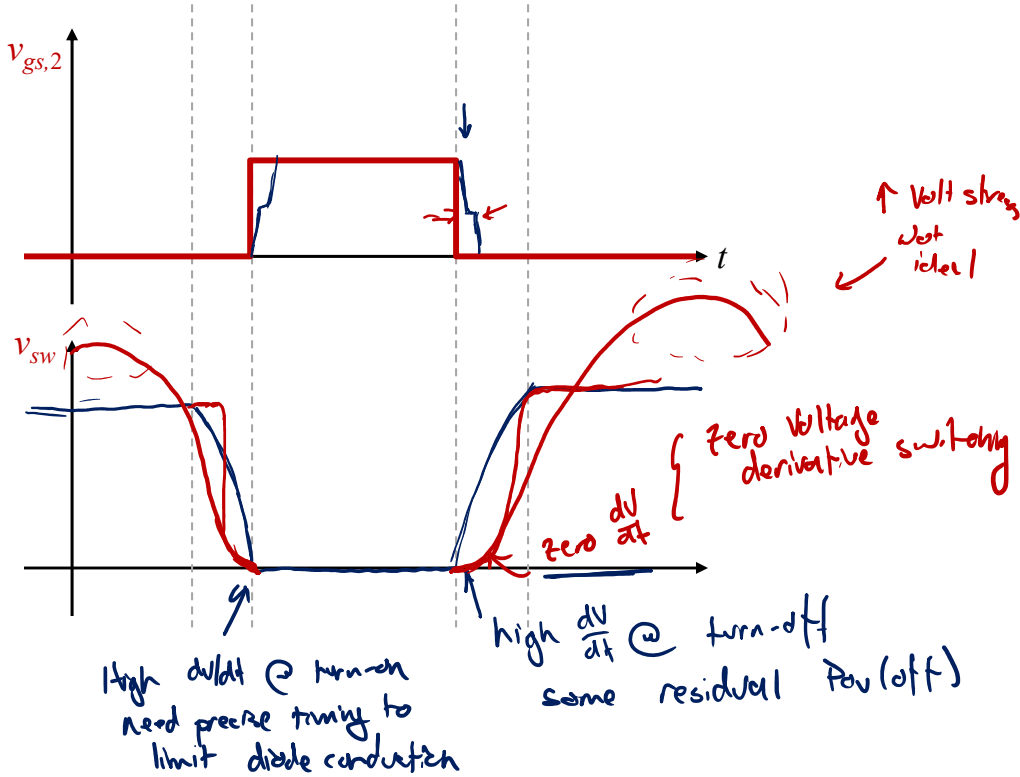
Switching Losses in a Half Bridge (L7)







Ideal Switching Waveforms (L8)



Class-E Amplifier

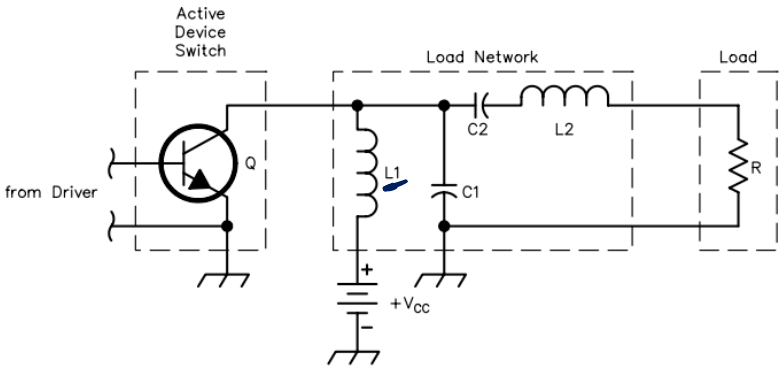
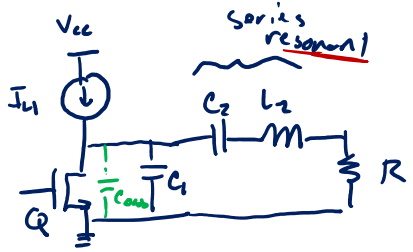


Fig 2—Schematic of a low-order Class-E amplifier.



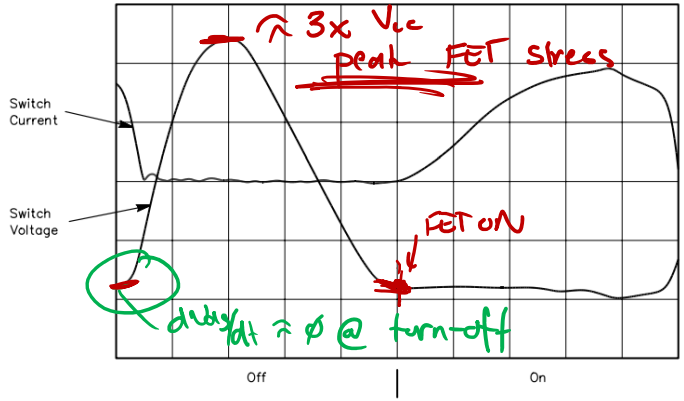
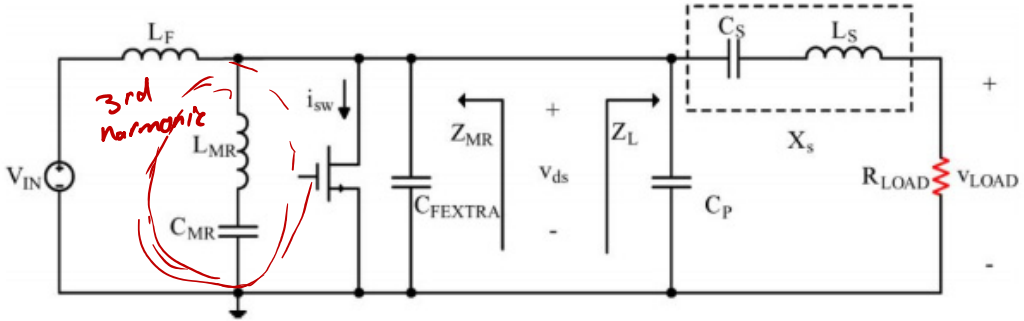
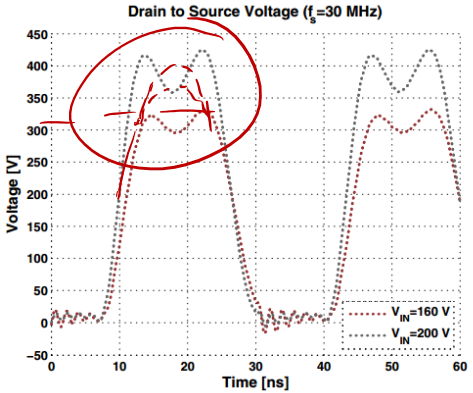
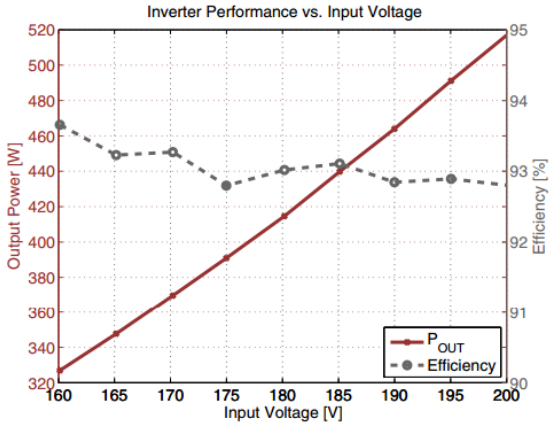


Fig 3—Actual transistor voltage and current waveforms in a low-order Class-E amplifier.

Class Φ_2 Inverter



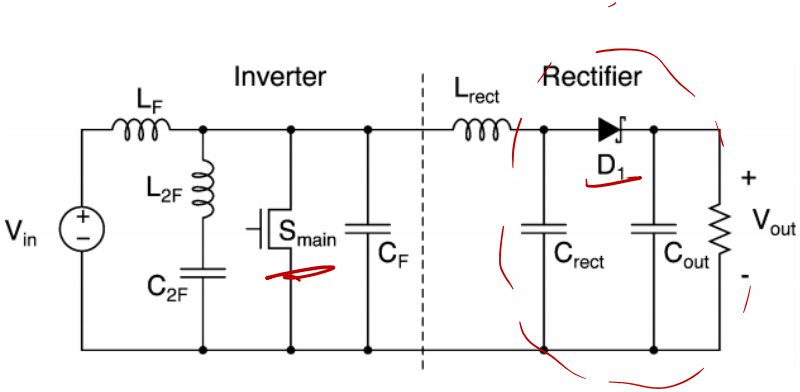


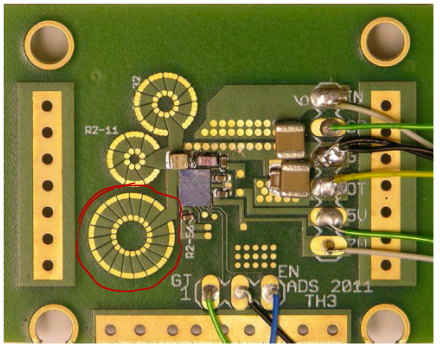


J. M. Rivas, O. Leitermann, Y. Han , A. D. Sagneri, and D. J. Perreault, " A High-Frequency Resonant Inverter Topology With Low-Voltage Stress", 2008

VHF DC-DC Converter

Φ_2 Boost Converter





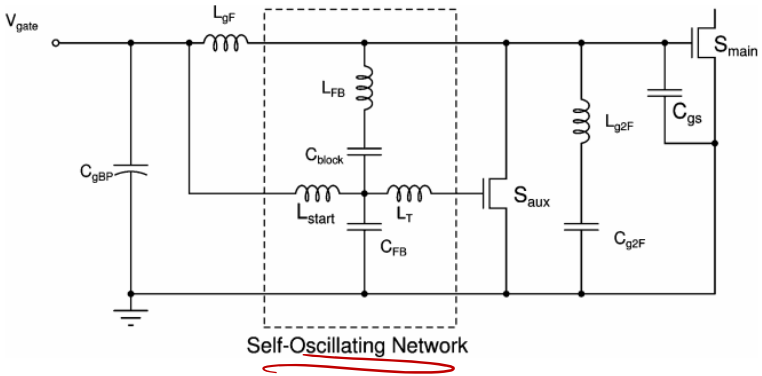


Fig. 5. Trapezoidal resonant gate drive circuit with self-oscillating network. The converter is enabled by applying the voltage V_{gate}, and disabled by setting V_{gate} to zero. This gate driver is employed in the 110-MHz converter (Fig. 9).

Chapter 20: Resonant Switch Topologies

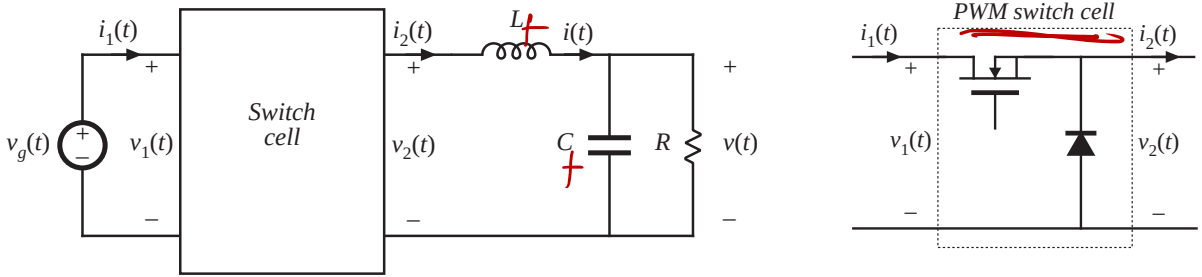
↳ 2nd Edition
Ch 23 in 3rd Edition

- 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

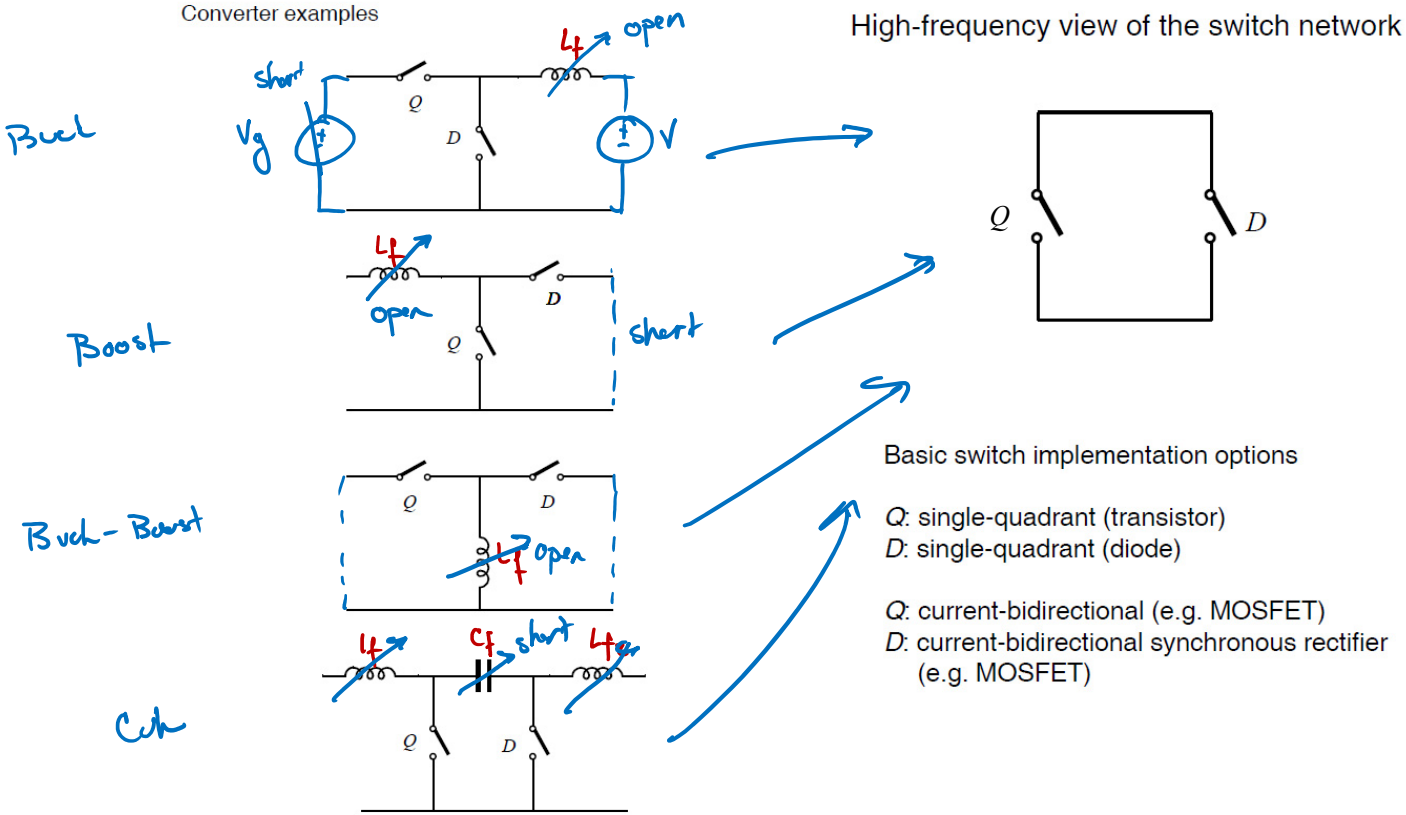
General idea:

- PWM switch network is replaced by a resonant switch network
- This leads to a quasi-resonant or quasi-squarewave version of the original PWM converter



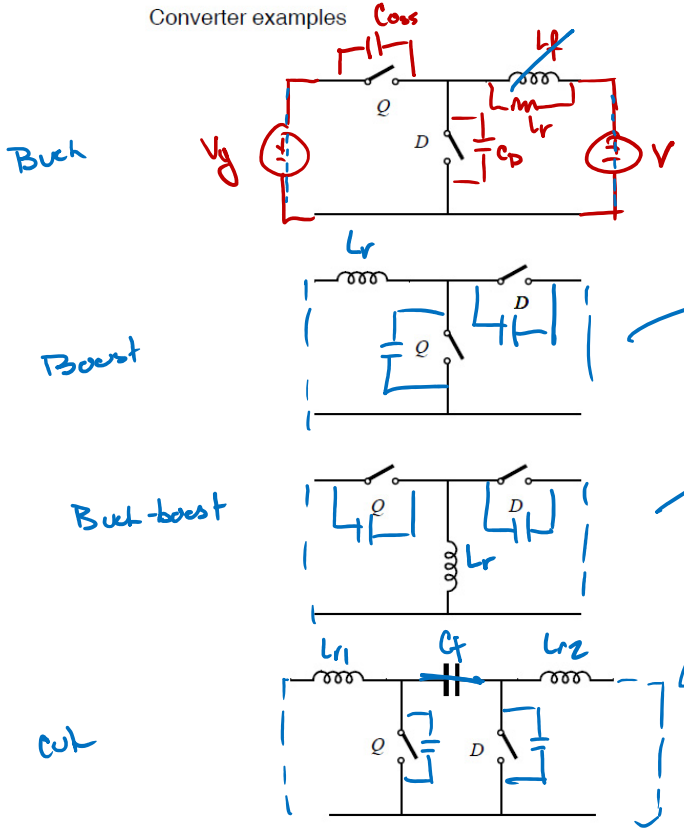
Example: realization of the switch cell in the buck converter

High Frequency Switch Network

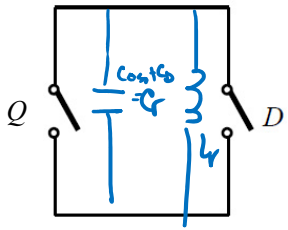


ZVS-QSW: Review

Converter examples



High-frequency view of the switch network



Basic switch implementation options

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

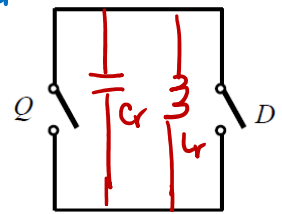
Q: current-bidirectional (e.g. MOSFET)
D: current-bidirectional synchronous rectifier (e.g. MOSFET)

Classification of Resonant-Switch Converters

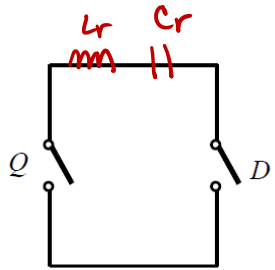
ZVS of Q

Covered previously in class

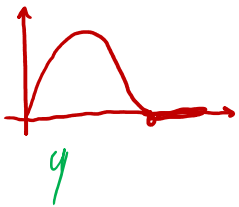
Quasi-square wave

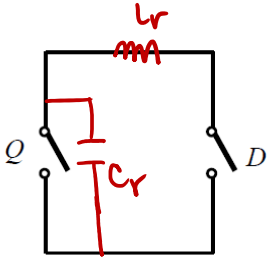


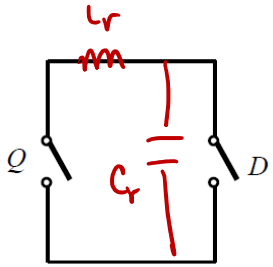
ZCS of Q



Quasi-resonant

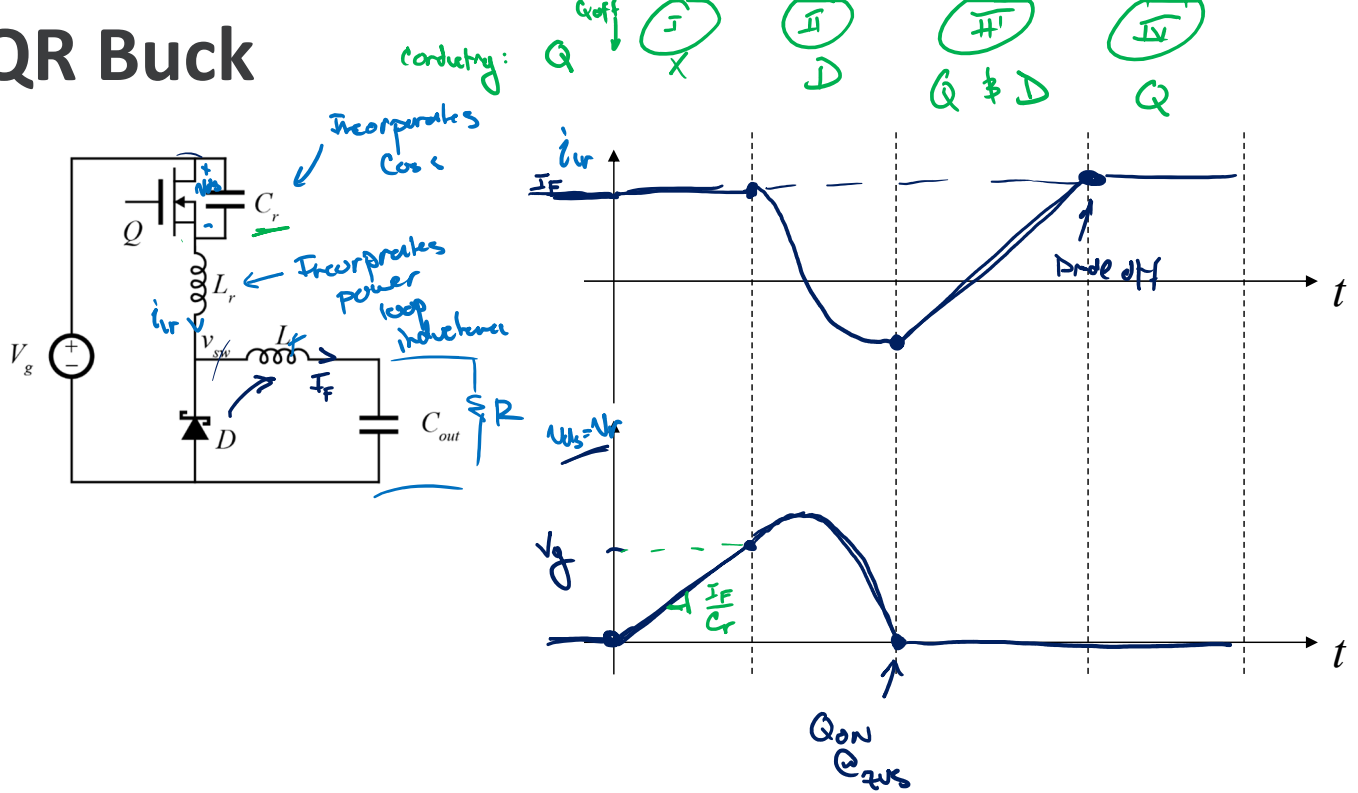






covered in the book

ZVS-QR Buck


Conducting:
Q
D
Q & D
Q
Incorporates Coss
Incorporates power loop inductance
C_r
Q
L_r
i_{Lr}
v_{sw}
L_f
V_g
I_F
D
C_{out}
R
I_F
Diode dH
t
$V_{ds}=V_{sw}$
V_g
$\frac{I_F}{C_r}$
t
Q_{ON}
C_{ZVS}