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:
- 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

 Discussed in detail in Chapter 20
ZVS-QR Buck

+ Incorporate both \( C_{a} \) and \( L_{s} \) of \( \mu \text{MOSFET} \) into operation
+ \( i_{o_{p,m}} = I_{L} \)
- \( V_{o_{p,m}} \) will increase significantly
- \( > \) does assume ideal

ZVS-QR State Plane

1. \( \frac{I_{1}}{C_{r}} t_{1} = V_{o} \rightarrow \Theta_{1} = \frac{1}{3} \beta_{n}^{\prime} \)
2. \( r_{2} = S_{b}^{2} = S_{b}^{2} + 1 \)
   \( \beta = \pi + \sin^{-1} \left( \frac{1}{3} \right) \)
3. \( \frac{V_{o}}{L_{r}} t_{3} = I_{r} + I_{L} \)
   \( \Theta_{3} = 2 \beta_{n}^{\prime} \)
4. \( \Theta_{4} = \frac{2\pi}{F} \)
Averaging

\[ \langle v_f \rangle = \phi = \langle v_w \rangle - V \]
\[ \phi = v_g - \langle v_{cr} \rangle - \frac{\langle \omega \rangle}{\phi} \]
\[ v = v_g - \langle v_{cr} \rangle \]