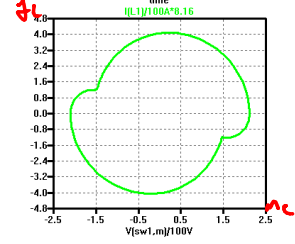
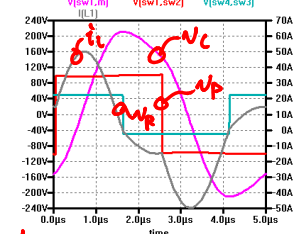
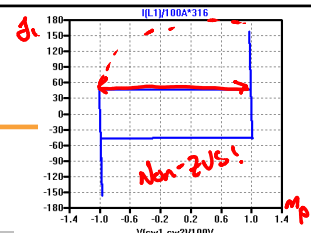
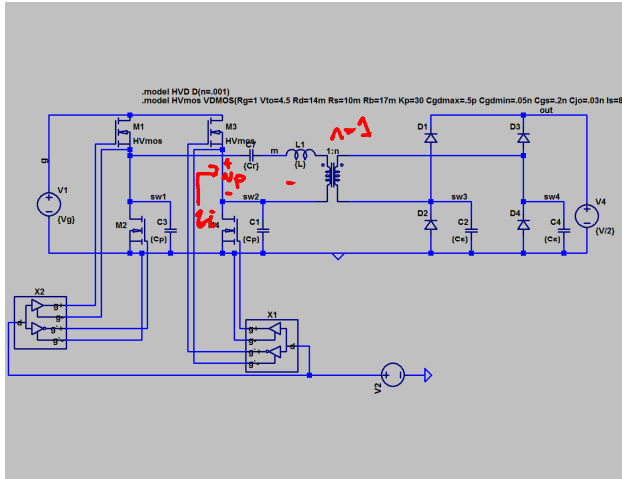
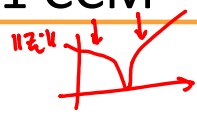


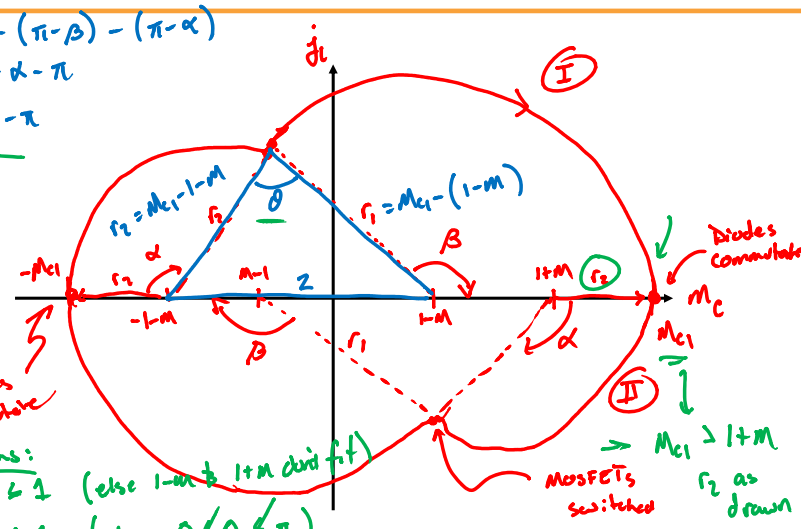


Issues with k=1 CCM

$M = \frac{1}{2}$
 $F = 0.69$



$\theta = \pi - (\pi - \beta) - (\pi - \alpha)$
 $\theta = \beta + \alpha - \pi$
 $\theta = \frac{\pi}{F} - \pi$



Assumptions:
 $0 \leq m \leq 1$ (else $1-m$ & $1+m$ dir diff)
 $\frac{1}{2} \leq F \leq 1$ (else $0 \neq \theta \neq \pi$)

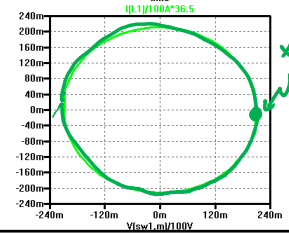
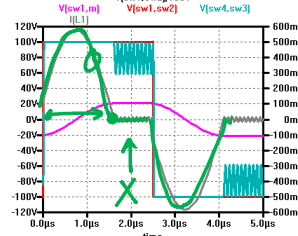
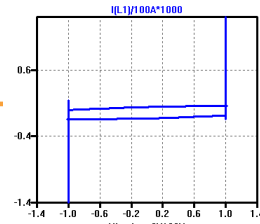


Mode Boundary

$$\frac{M = 1}{F = 0.7}$$



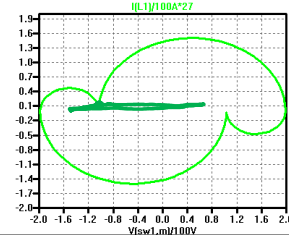
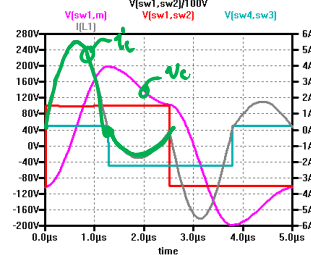
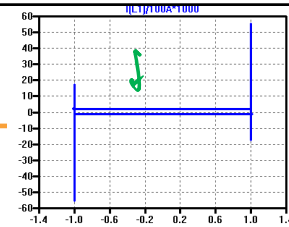
$k=1$ DCM



Mode Boundary

$$\frac{M = \frac{1}{2}}{F = \frac{1}{2}}$$

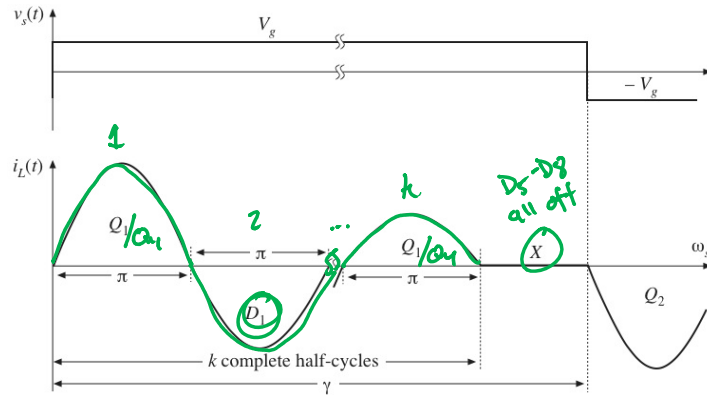
$k=2$
CCM/DCM Boundary





Discontinuous Conduction Modes

• In the “type k ” discontinuous conduction mode, the tank rings through k complete half cycles during each half switching period. The output diode rectifiers then become reverse-biased, and remain off until the input bridge transistors switch to initiate the next half switching period.



The left side of the diagram shows several waveforms over one half-cycle of the input voltage $\omega_0 t$. The top plot is the load current i_L , showing a positive pulse of height q during the first half-cycle (Q1) and a negative pulse of height $-q$ during the second half-cycle (Q2). The conduction angle is $\gamma - \pi$. The second plot is the capacitor voltage v_C , which is a sine wave. The third plot is the capacitor voltage v_{C1} , which is a half-cycle sine wave. The fourth plot is the negative capacitor voltage $-v_{C1}$, which is a half-cycle sine wave. The fifth plot is the transistor voltage v_T , which is a square wave between $V_g - V$ and $-V_g + V$. The bottom plot is the absolute value of the load current $|i_L|$, showing two pulses of height q and average value $\langle |i_L| \rangle$.

The $k = 1$ DCM

The circuit diagram shows a full-bridge inverter with four IGBTs (Q_1, Q_2, Q_3, Q_4) and four diodes (D_1, D_2, D_3, D_4). The bridge is connected to an LC tank circuit consisting of an inductor L and a capacitor C . The tank is connected to a transformer with a 1:n turns ratio, which is then connected to a diode bridge rectifier and a load resistor R .

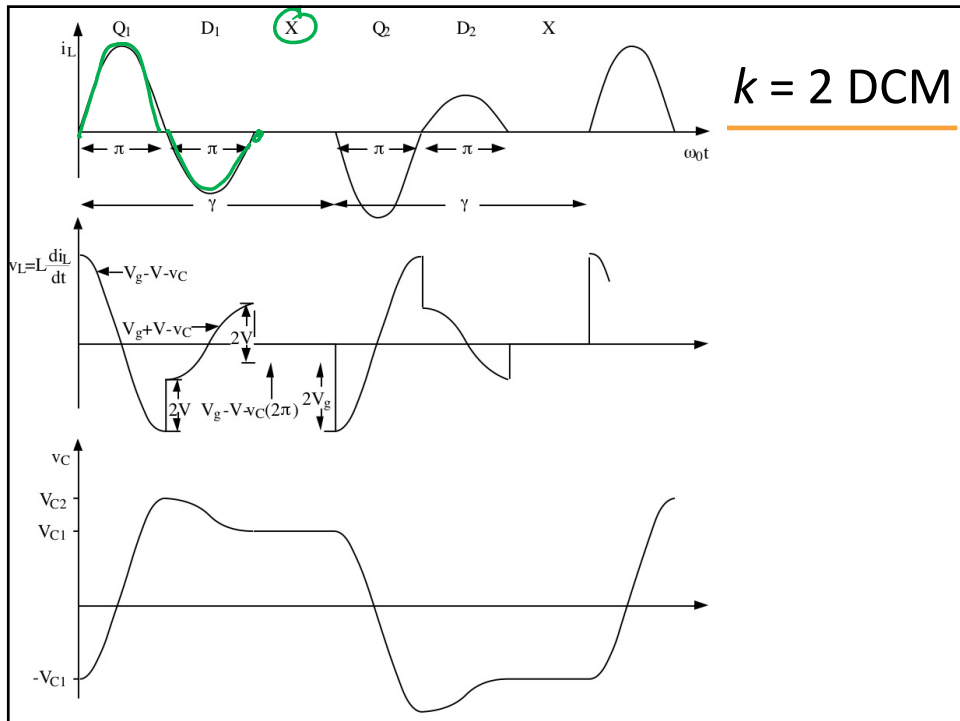
$F \leq 1$ necessary
 \downarrow
 $m_{C1} \neq 1 + M \leftarrow$
 $\frac{\pi}{2} < 1 + M \rightsquigarrow$ light load

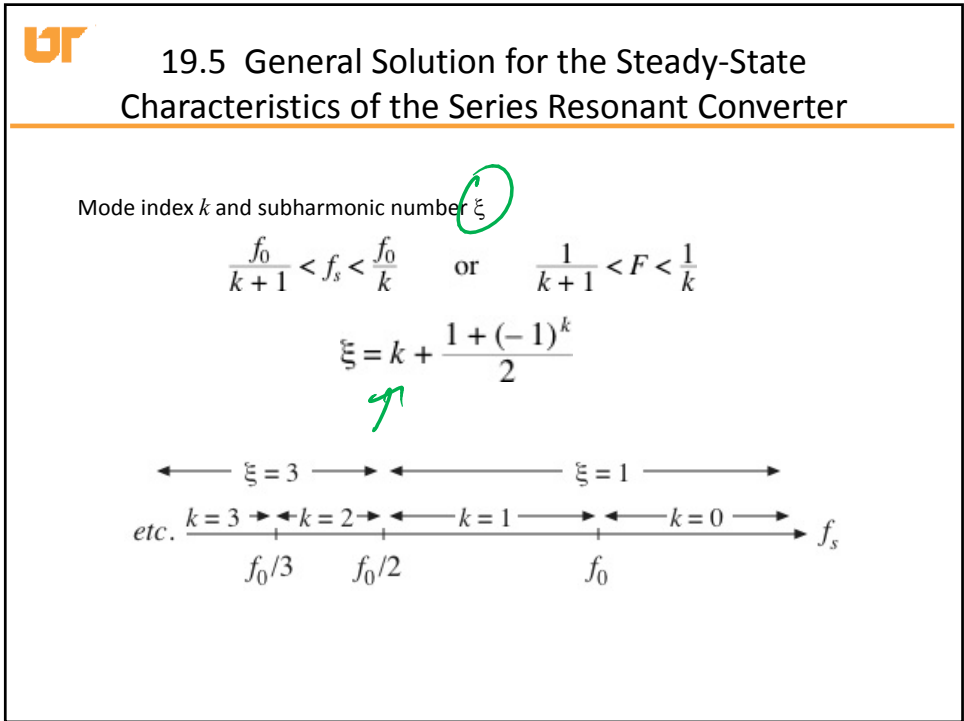
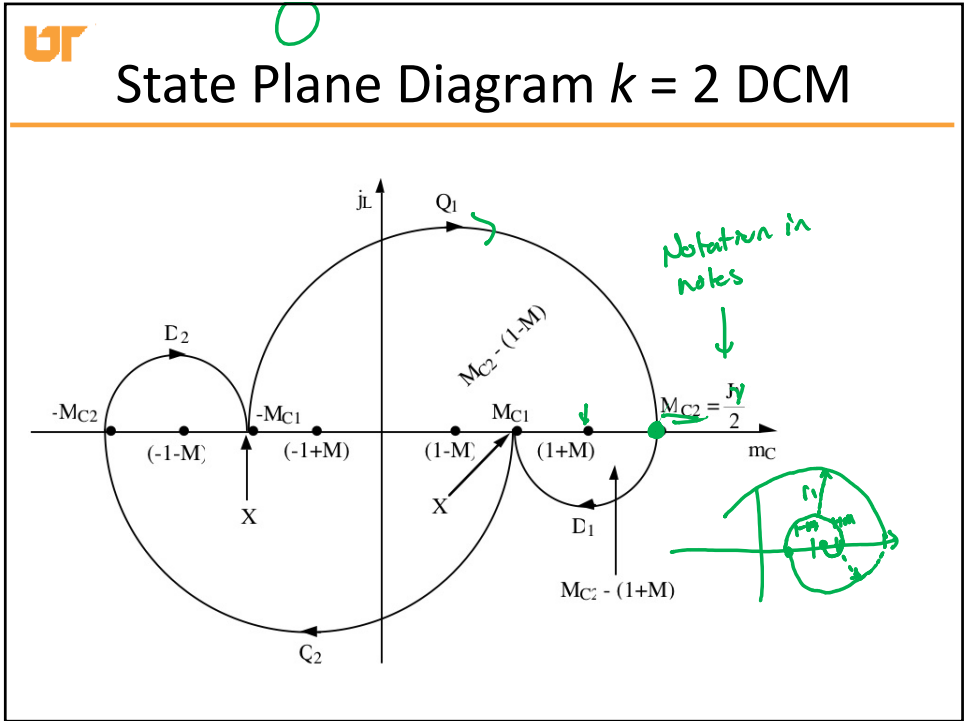


Summary of results $k = 1$ DCM

$$|i_i| = i_g = i_o$$

$$\hookrightarrow v = v_g \rightarrow m = 1$$







Type k CCM

Steady-State Solution

Elliptical output characteristic

$$M^2 \xi^2 \sin^2\left(\frac{\gamma}{2}\right) + \frac{1}{\xi^2} \left(\frac{J\gamma}{2} + (-1)^k\right)^2 \cos^2\left(\frac{\gamma}{2}\right) = 1$$

with

$$M = \frac{V}{nV_g} \quad J = \frac{InR_0}{V_g} \quad 0 \leq M \leq \frac{1}{\xi}$$

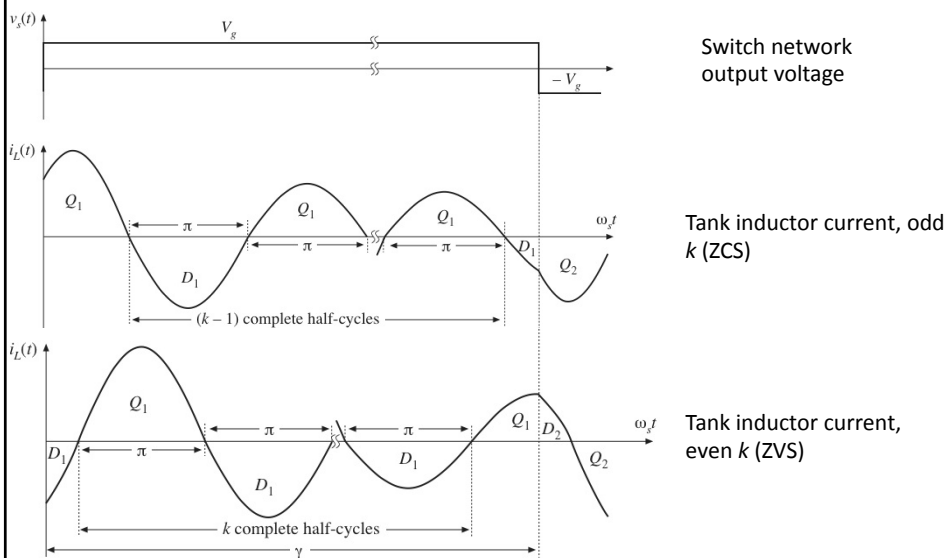
Control plane characteristic

$$M = \frac{\left(\frac{Q\gamma}{2}\right)}{\xi^4 \tan^2\left(\frac{\gamma}{2}\right) + \left(\frac{Q\gamma}{2}\right)^2} \left| (-1)^{k+1} + \sqrt{1 + \frac{\left|\xi^2 - \cos^2\left(\frac{\gamma}{2}\right)\right| \left[\xi^4 \tan^2\left(\frac{\gamma}{2}\right) + \left(\frac{Q\gamma}{2}\right)^2\right]}{\left(\frac{Q\gamma}{2}\right)^2 \cos^2\left(\frac{\gamma}{2}\right)}} \right|$$



Type k CCM

Waveforms





Type k DCM

Steady State Solution

Type k DCM, odd k

Output voltage $M = \frac{1}{k}$

Mode boundaries

$$f_s < \frac{f_0}{k}$$

and

$$\frac{2(k+1)}{\gamma} > J > \frac{2(k-1)}{\gamma}$$

Type k DCM, even k

Output current $J = \frac{2k}{\gamma}$

Mode boundaries

$$f_s < \frac{f_0}{k}$$

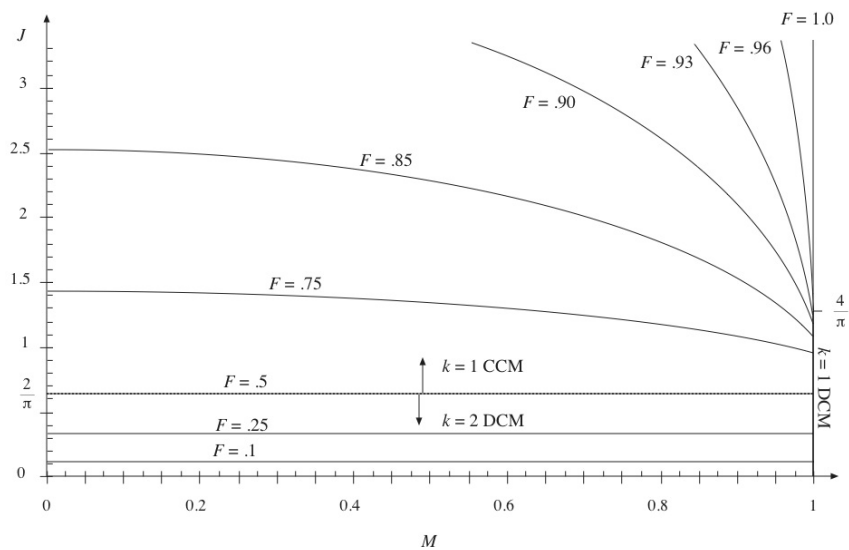
and

$$\frac{1}{k-1} > M > \frac{1}{k+1}$$



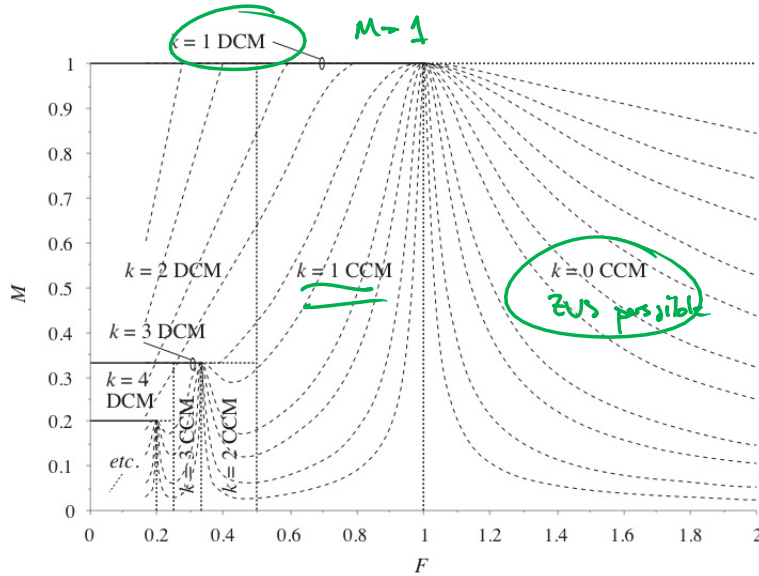
SRC Output Characteristics

Selected Modes Below Resonance





CCM and DCM Boundaries



Complete SRC Characteristics

Control Plane

