Output Plane

$$J = \frac{n\langle i_{out}\rangle}{I_{base}} = \frac{F}{\pi}\left[2 + \frac{1}{4}\left(J_1^{\,2} - J_2^{\,2}\right) + J_p\left(\frac{\pi}{F} - \alpha - \beta - \delta\right)\right]$$

$F = \frac{f_s}{f_o}$

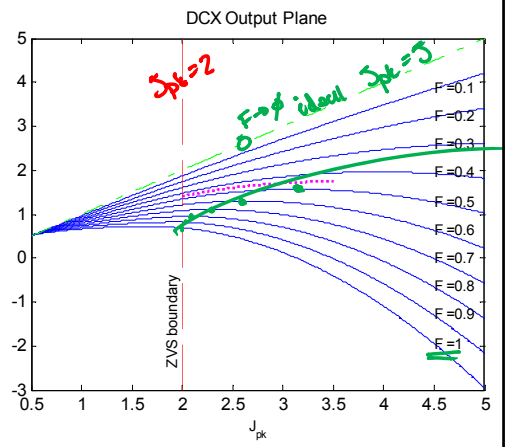
$f_o = \frac{1}{2\pi\sqrt{L_p C_p}}$

$F \to \phi \rightarrow f_o \gg f_s$

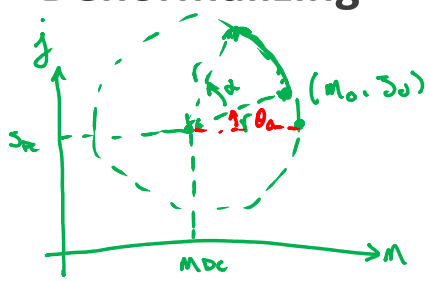
switching transitions occupy negligible portion of T_s

$F \to 1 \rightarrow f_o \to f_s$

approaching fully resonant waveforms



Denormalizing



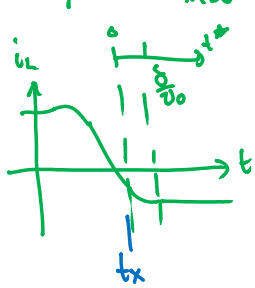
$0 < \theta < \alpha$

$m(\theta) = M_{DC} + r\cos(\theta + \theta_0)$

$j(\theta) = J_{DC} + r\sin(\theta + \theta_0)$

$\Downarrow$ Denormalize

$0 < t < \frac{\alpha}{\omega_0}$



$v(t) = V_{DC} + V_{base}\, r\cos(\omega_0 t^* + \theta_0)$

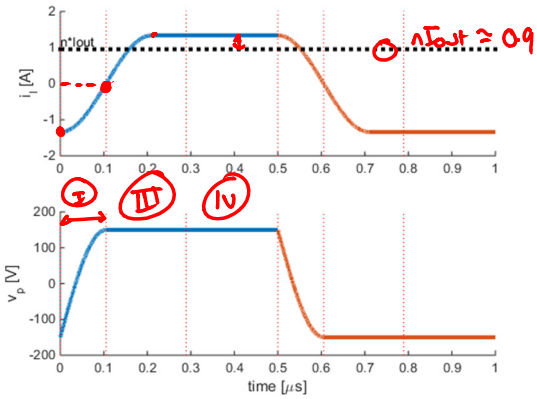
$i(t) = I_{DC} + I_{base}\, r\sin(\omega_0 t^* + \theta_0)$

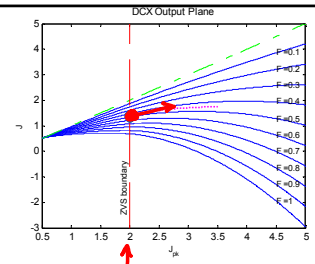
t^* is the time within the subinterval

$i(t) = I_{DC} + I_{base}\, r\sin\left[\omega_0(t - t_x) + \theta_0\right]$

Example Waveforms

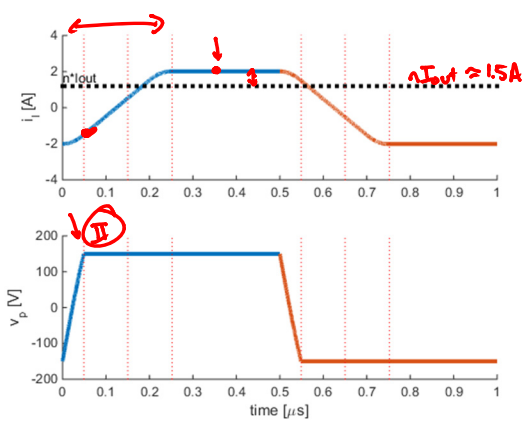
$C_s = \frac{C_p}{n^2}$

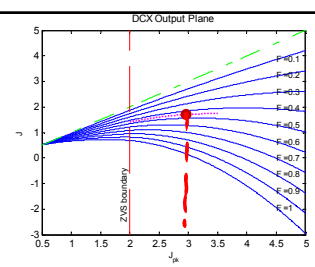




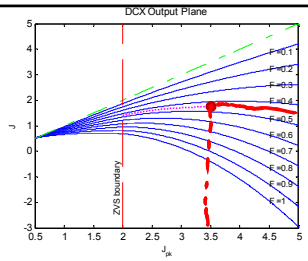
$J_{pk} = 2$ @ ZVS bound

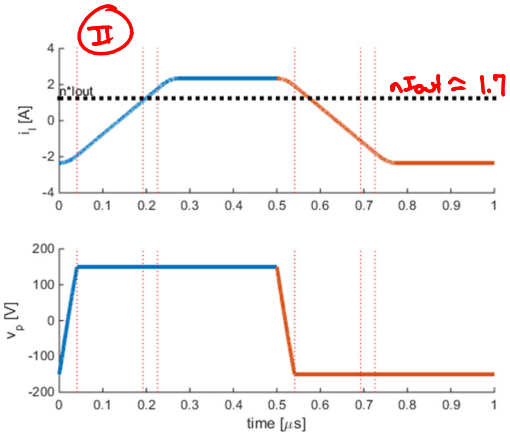
Example Waveforms



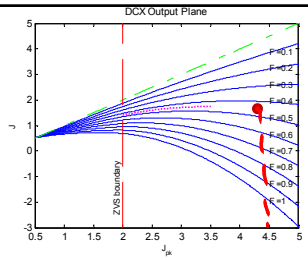


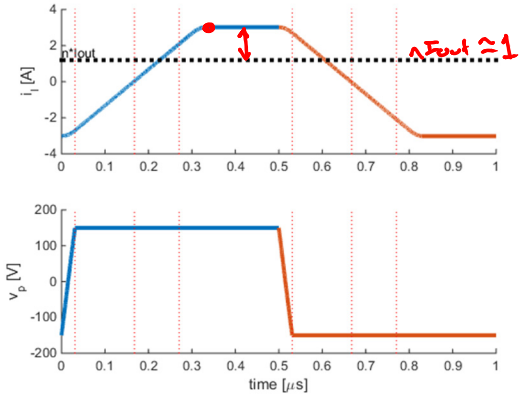
Example Waveforms



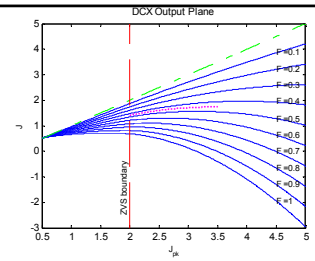


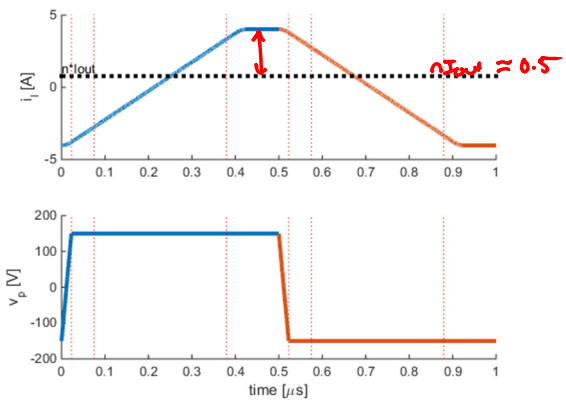
Example Waveforms





Example Waveforms





Designing Inductance

Hard switching ← → ZVS

Pout

Large L_ℓ

$P_{min,ZVS}$ ↕ $f(L_\ell)$

small L_ℓ

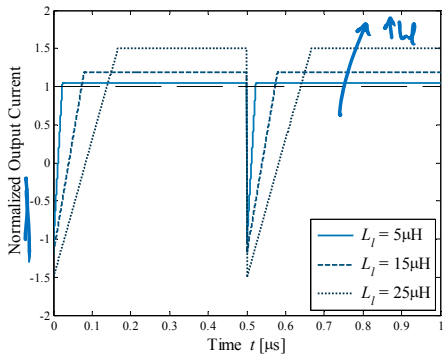
$J_{pk} = 2$ → $\frac{I_{pk}}{V_g}\sqrt{\frac{L_\ell}{C_p}} \geq 2$ for ZVS

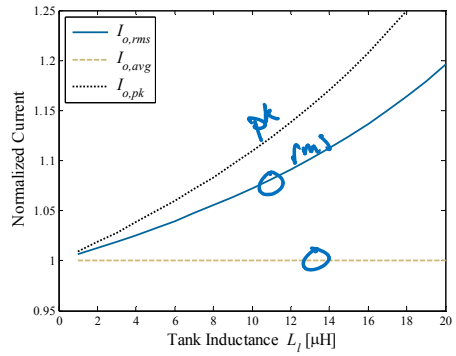
ZVS: want large L_ℓ so ZVS is maintained over a wide range of power ($J_{pk} < 2$ occurs at low power)

Cond loss: want small L_ℓ so that

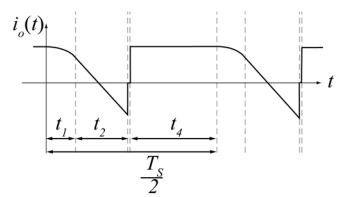
$F = \frac{f_s}{f_0} = f_s 2\pi\sqrt{L_\ell C_p}$ is small

Output Current Vs. Inductance

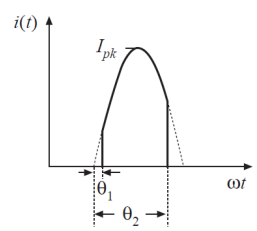




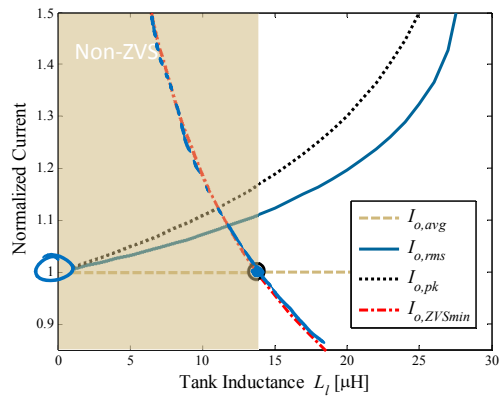
RMS Currents



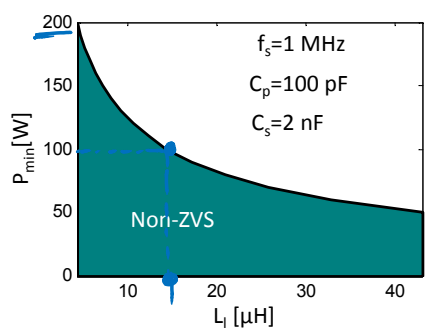
$$u_k = \frac{1}{2} I_{pk}^2 \left(1 - \frac{\sin(\theta_2 - \theta_1)\cos(\theta_2 + \theta_1)}{(\theta_2 - \theta_1)} \right)$$



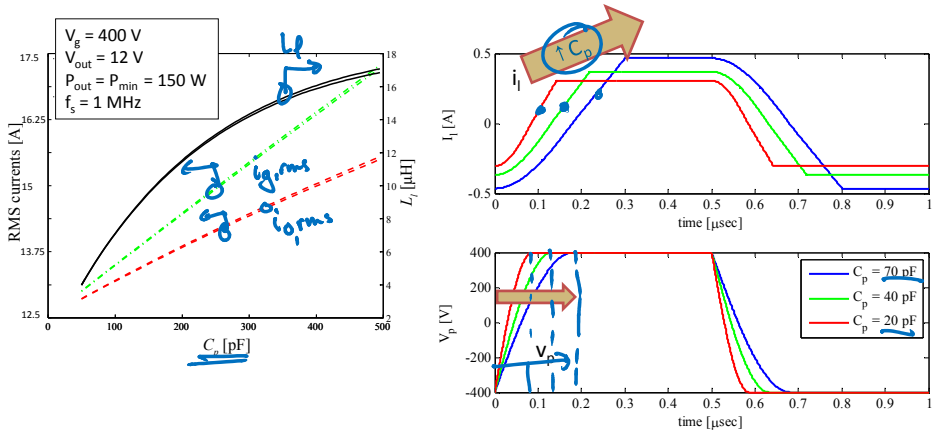
Constraints on Inductance



Selection of Tank Inductance



Effects of primary-side device capacitance



Extending ZVS Range

① Charge Voltage Conversion Ratio