Analysis: Intervals 4-6

$V_{base} = V_g + \frac{V}{n}$

(4) $-\left(\frac{V_g + \frac{V}{n} - V_s}{L_\ell}\right) t_4 = I_3 + I_4$

$$-(1 - M_s)\,\theta_4 = J_3 + J_4$$

(5)

$$(M_s - 1)^2 + J_4^2 = 1 + J_5^2$$

$$\xi = \pi - \tan^{-1}\left(\frac{J_4}{M_s - 1}\right) - \tan^{-1}\left(\frac{J_5}{1}\right)$$

(6) $\frac{V_g + \frac{V}{n}}{L_\ell} t_6 = I_m + I_5$

$$(1)\,\theta_6 = J_m + J_5$$

Analysis: Averaging

Apply volt-sec / cap-Q balance to all filter elements

In Active Clamp Flyback: C_1, L_m, C_s

Cap-Q Balance to C_s

$$\langle i_{C_s} \rangle |_{T_s} = 0$$

$$\int_0^{T_s} i_{C_s}\, dt = 0$$

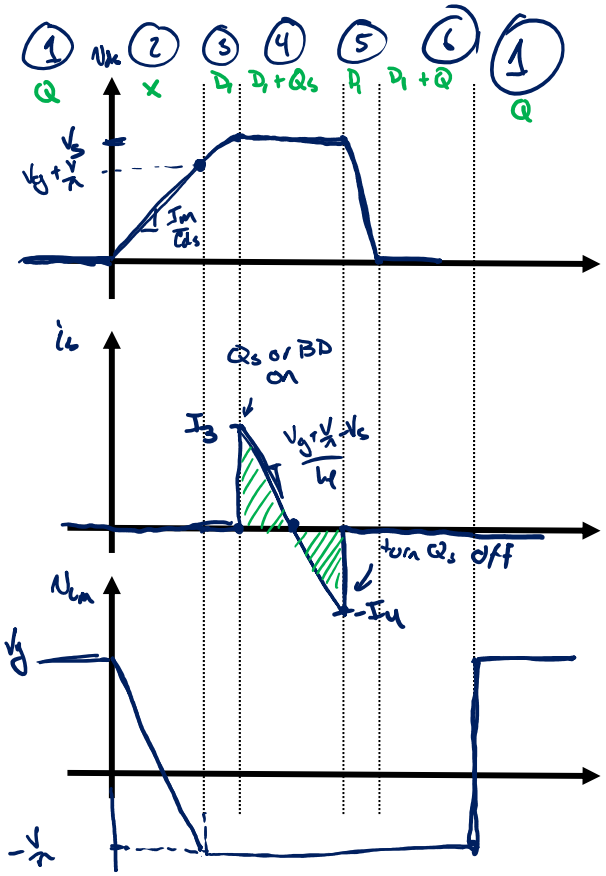
$$\frac{I_3 - I_4}{2} t_4 = 0 \longrightarrow \boxed{I_3 = I_4}$$

Volt-sec Balance on L_m

$$\int_0^{T_s} v_{L_m}\, dt = 0$$

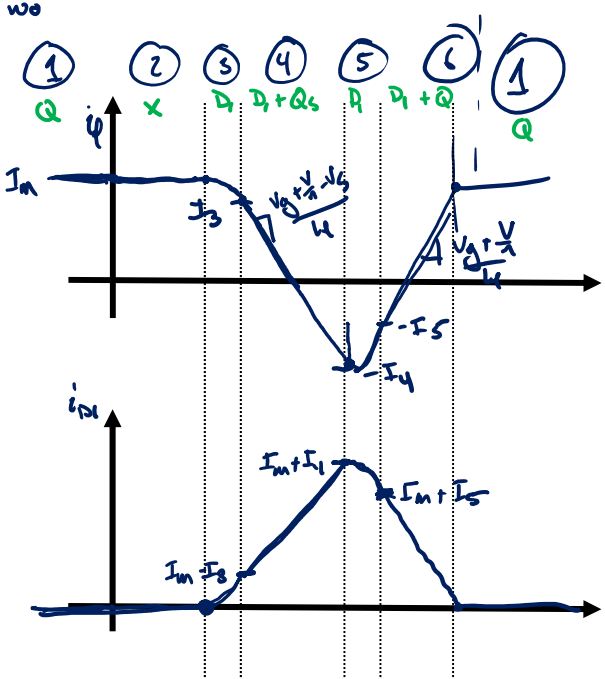
$$0 = \left[V_g t_1 + \frac{V_g - \frac{V}{n}}{2} t_2 + \left(-\frac{V}{n}\right)(t_3 + t_4 + t_5 + t_6) \right]$$

$$\boxed{\frac{V}{V_g} = M = n \frac{t_1 + \frac{t_2}{2}}{\frac{t_2}{2} + t_3 + t_4 + t_5 + t_6}} \approx n \frac{D}{D'} \rightarrow \text{ccm, small-ripple flyback solution}$$



Average Output Current

$C_{ds} R_0 = C_{ds} \sqrt{\frac{L_1}{C_{ds}}} = \sqrt{L_1 C_{ds}} = \frac{1}{\omega_0}$



Cap-Q balance on C

$\int_0^{T_s} i_{co}\,dt = \phi \qquad \frac{1}{T_s}\int_0^{T_s} i_{DS}\,dt = I_{out}$

$n I_{out} = \frac{1}{T_s}\int_0^{T_s} (I_m - i_L)\,dt$

$n I_{out} = \frac{1}{T_s}\left[q_1 + q_2 + q_3 + q_4 + q_5 + q_6 \right]$

$q_3 = I_m t_3 - C_{ds}\left(V_5 - V_g - \frac{V}{n} \right)$

$q_4 = \frac{(I_m + I_4) + (I_m - I_5)}{2} t_4 = I_m t_4$

$q_5 = I_m t_5 + C_{ds}(V_5)$

$q_6 = \frac{I_m + I_5}{2} t_6$

$\left(\frac{1}{I_{base}}\right) n I_{out} = \frac{1}{T_s}\left[I_m t_3 + C_{ds}\left(V_g + \frac{V}{n}\right) + I_m t_4 + I_m t_5 + \frac{I_m + I_5}{2} t_6 \right] \left(\frac{1}{I_{base}}\right)$

$n J_{out} = \frac{1}{T_s}\left[J_m\left(t_3 + t_4 + t_5 + \frac{t_6}{2}\right) + J_5 \frac{t_6}{2} + C_{ds} R_0 \right] \left(\frac{\omega_0}{\omega_0}\right) \rightarrow$

$$n J_{out} = \frac{F}{2\pi}\left[J_m\left(\delta + \theta_4 + \varepsilon + \frac{\theta_6}{2}\right) + J_5 \frac{\theta_6}{2} + 1 \right]$$

Introduction to AC-link topologies