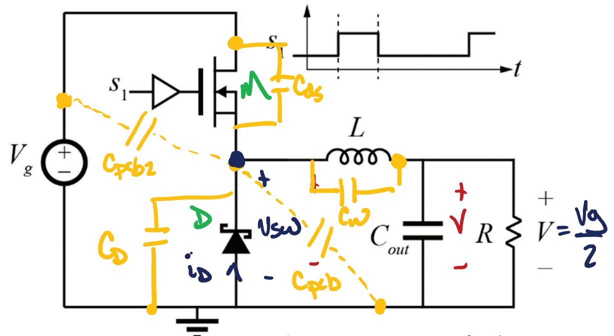
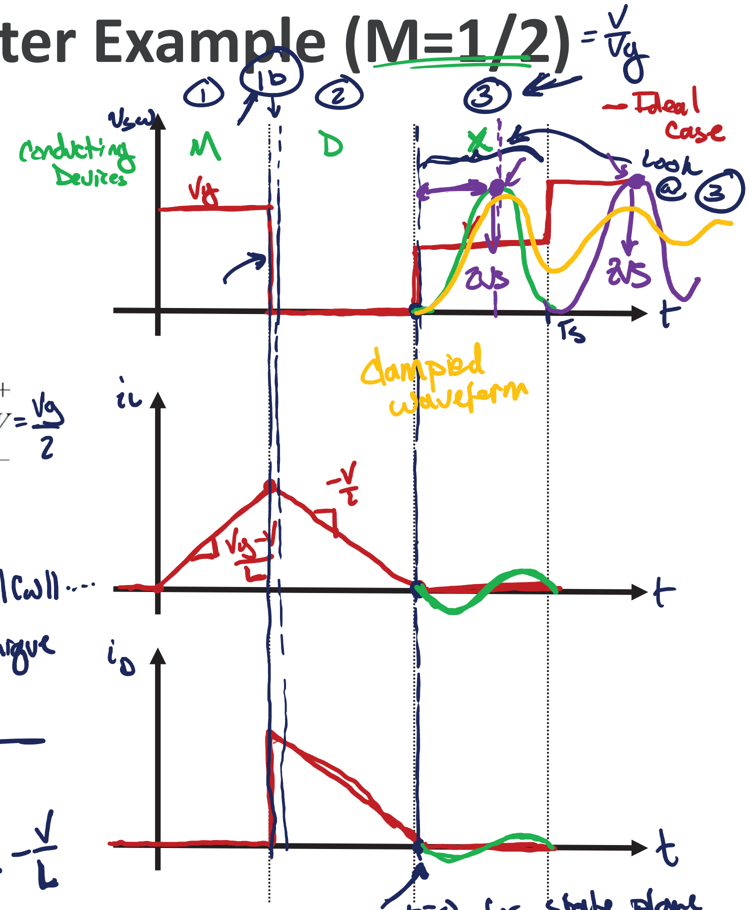
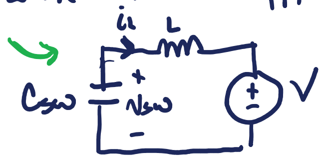
DCM Buck Converter Example (M=1/2) $= \frac{V}{V_g}$





when both M & D off, ac equivalent:



$C_{sw} = C_{ds} || C_D || C_W || \ldots$

← not unique

DC solution

$V_{sw} = V$

$i_L = 0$

Initial Conditions

$$@_{t=0} \begin{cases} V_{sw} = 0 \\ i_L = 0 \\ \frac{dV_{sw}}{dt} = 0 \quad \frac{di_L}{dt} = -\frac{V}{L} \end{cases}$$

DCM Buck State Plane

$V_{base} = V_g$ $\quad I_{base} = \frac{V_g}{R_o}$

DC solution → **center**

$V_{sw} = V$ → $m_c = \frac{V}{V_g} = M$ (conversion ratio)

$i_L = 0$ → $j_L = 0$

Initial Conditions → **starting point**

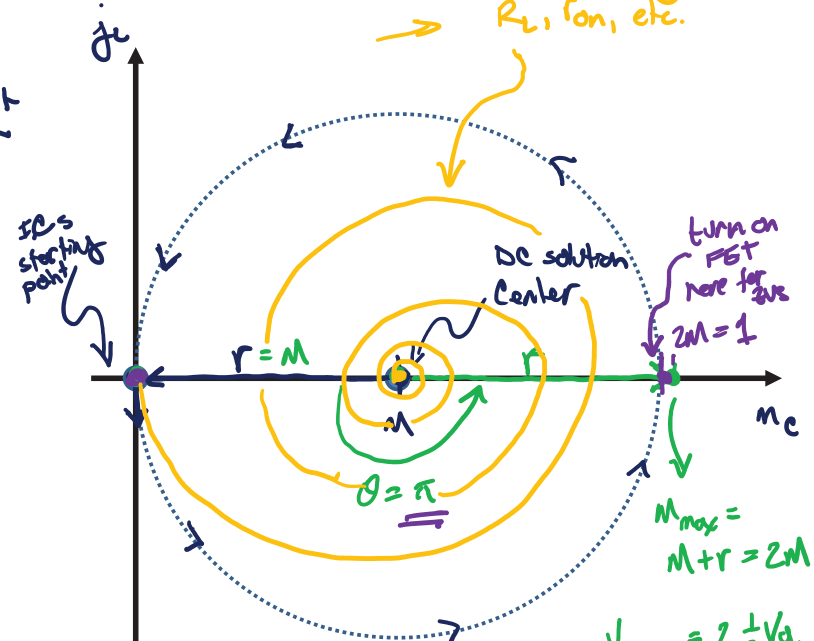
$V_{sw} = 0$ → $m_c = 0$

$i_L = 0$ → $j_L = 0$

$\frac{d}{dt}$ **Initial values** → **direction**

$\left.\frac{dV_{sw}}{dt}\right|_{t=0} = 0$ → $\left.\frac{dm_c}{dt}\right|_{t=0} = 0$

$\left.\frac{di_L}{dt}\right|_{t=0} = \frac{-V}{L}$ → $\left.\frac{dj_L}{dt}\right|_{t=0} < 0$



$M_{max} = M + r = 2M$

$V_{max} = 2 \frac{1}{2} V_g$

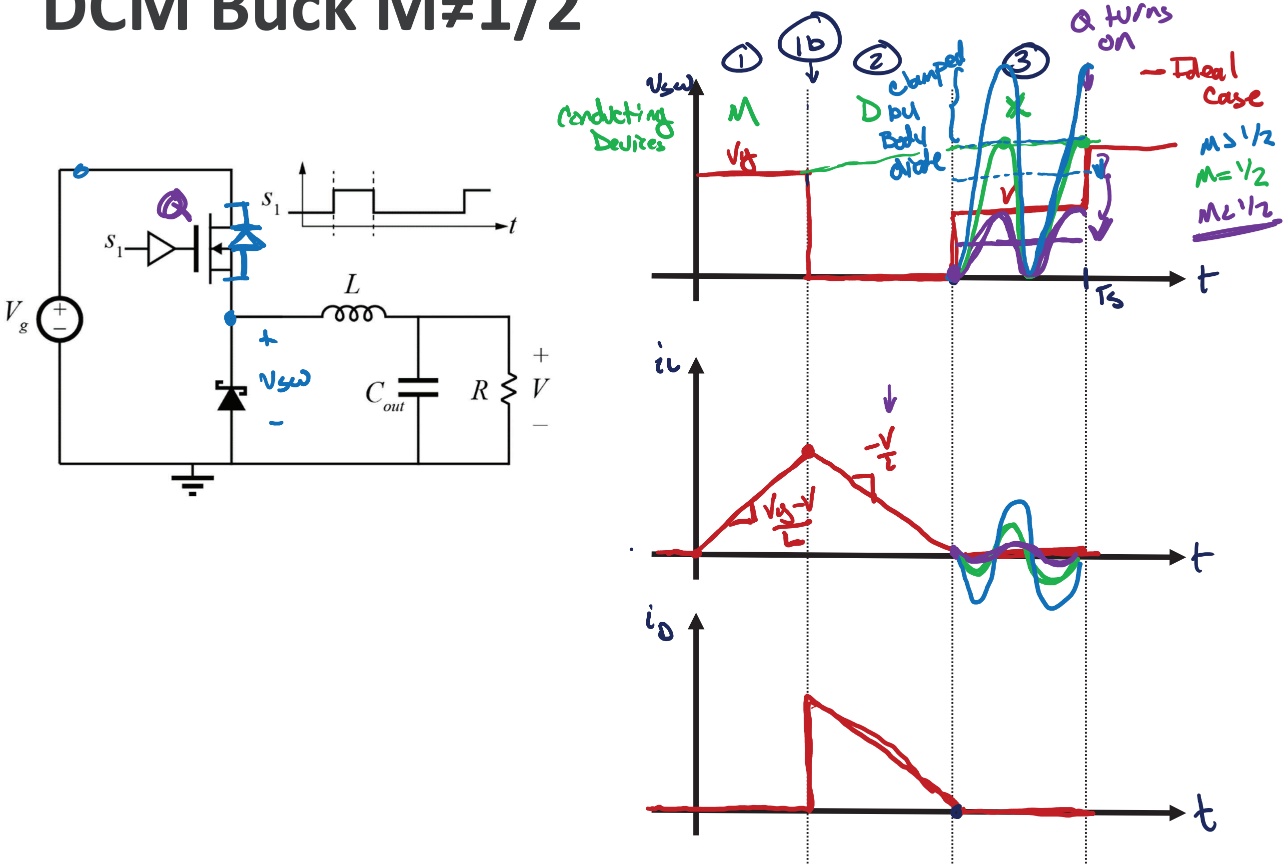
$V_{max} = V_g$

ZVS switching times:

$t = (\pi + N2\pi)\frac{1}{\omega_0}$

ZVS: turn on FET when $V_{sw} = V_g$ ↳ $m_c = 2M = 1$

DCM Buck M≠1/2



DCM Buck State Plane (M<1/2)

I.C.'s still zero

DC op point & Initial values of d/dt expressions unchanged

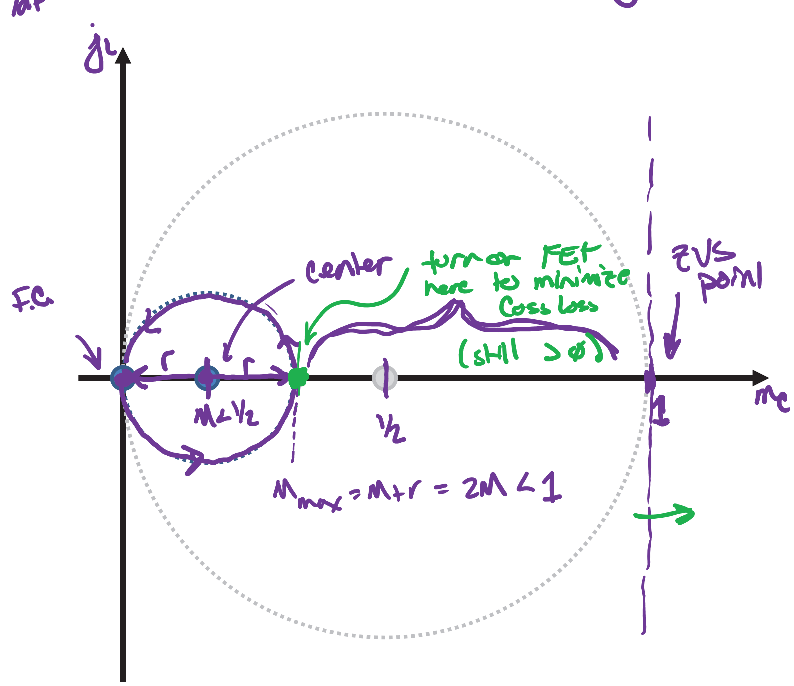
$V_{base} = V_g$

ZVS condition:

$M_{max} = M + r = 2M \geq 1$

$M \geq 1/2$

$V \geq \frac{V_g}{2}$



DCM Buck State Plane (M>1/2)