IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Charging Infrastructure

Lecture-13

Closed Loop Control of Single-phase Boost PFC Converter

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Recap

$$d(t) = 1 - \frac{|v_{s,pk} \sin\omega t|}{V_o}$$

$$L = \frac{V_o}{4\,\Delta i_{L,max}\, f_{sw}}$$

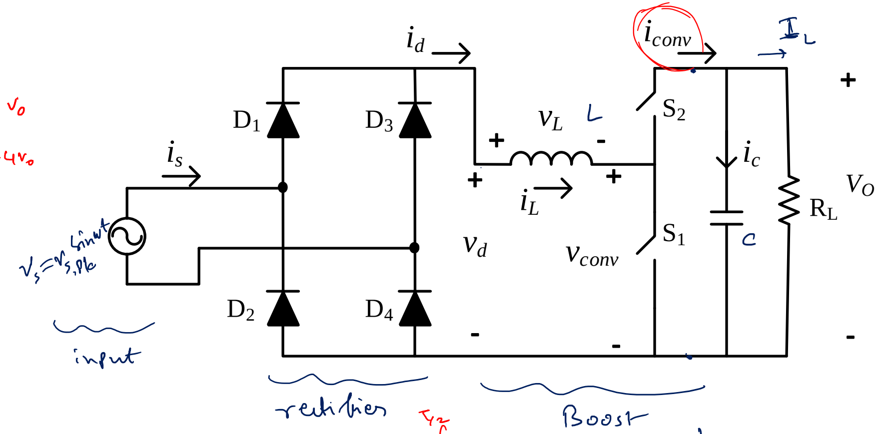
$$C = \frac{P_L}{2\pi f_s\, \Delta V_o \cdot V_o} \rightarrow \text{2nd line harmonic component}$$

voltage rating of S_1 & S_2 = V_o $\simeq 1.4V_o$

$D_1, D_2, D_3, D_4 \rightarrow V_{RRM} = V_{s,pk}$

$$I_{avg} = \frac{I_{s,pk}}{\pi}$$

$$I_{rms} = \frac{I_{s,pk}}{2}$$



$$I_{avg,S_2} = \frac{1}{T/2}\int_0^{T/2} \left(i_s(t)\,(1-d(t))\right) \cdot dt \rightarrow I_{avg,S_1} = \frac{1}{T/2}\int_0^{T/2} (i_s(t)\, d(t)) \cdot dt$$

$$I_{S1,rms} = \sqrt{\frac{1}{T/2}\int_0^{T/2} (i_s(t))^2 \cdot d(t) \cdot dt}$$

$$I_{L,rms} = \frac{I_{s,pk}}{\sqrt{2}} \qquad I_{s,pk} = \frac{2P_{in}}{V_{s,pk}}$$

$$I_{rms,S2} = \sqrt{\frac{1}{T/2}\int_0^{T/2} \left((i_s(t))^2 \cdot (1-d(t))\right) \cdot dt}$$

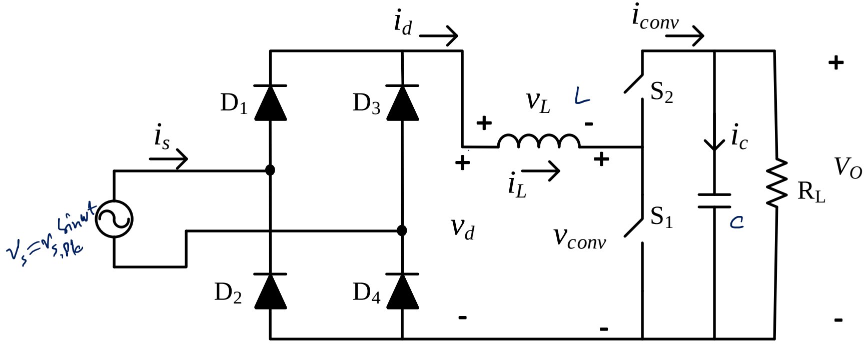
$$I_{rms,C} = \sqrt{\underbrace{I_{rms,conv}^2}_{I_{rms,S2}} - \underbrace{I_L^2}_{\left(\frac{V_o}{R_L}\right)}}$$

Closed Loop Control

Control objective

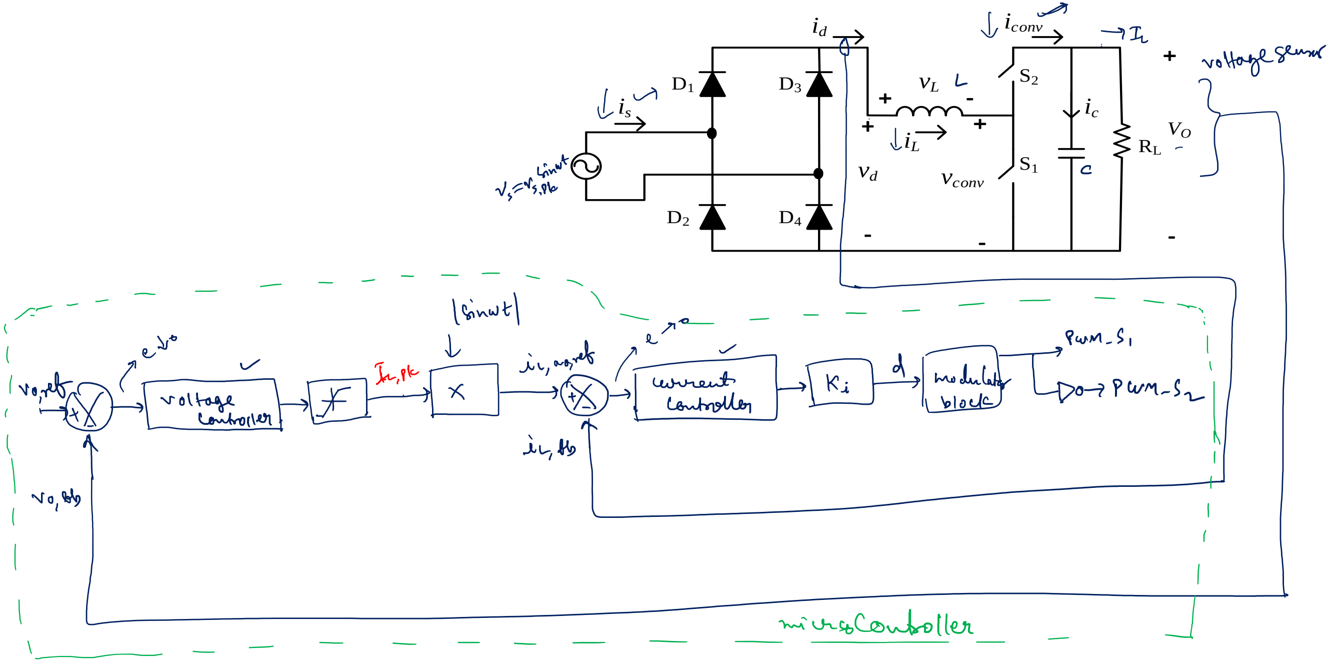
① The regulation or controlling of output DC voltage at its desired ($V_o > V_{s,pk}$)

② The upf current is being drawn from the input AC source or grid



T_s

$T_s = \frac{1}{f_{sw}} \gg f_s$

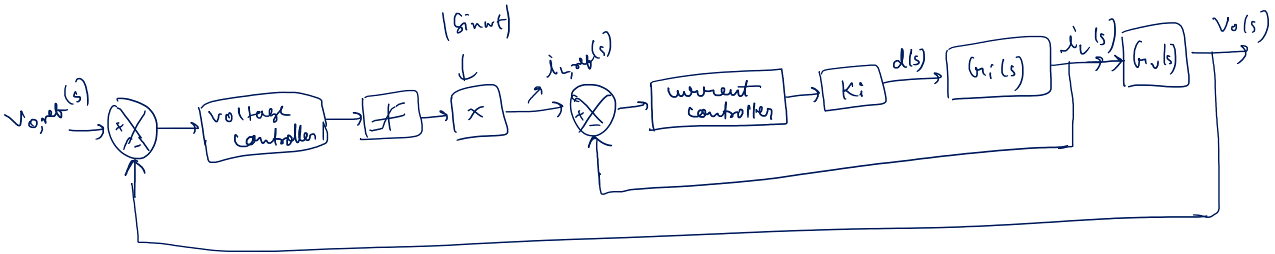


$V_{o,fb} > V_{o,ref} \Rightarrow$ the capacitor need to discharge

$i_{conv}\downarrow \rightarrow i_L\downarrow \rightarrow i_s\downarrow$

$V_{o,fb} < V_{o,ref} \rightarrow$ the capacitor need to charge

$i_{conv}\uparrow \rightarrow i_L\uparrow \rightarrow i_s\uparrow$



$$G_i(s) = \frac{i_L(s)}{d(s)}$$

$$G_v(s) = \frac{V_o(s)}{i_L(s)}$$

$$V_o(s) = V_c(s)$$

Small Signal Model

Average large signal model using state equations

↓

perturbation

↓

linearize the state equation around the operating point

↓

time-domain to s-domain

Thank You