IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Charging Infrastructure

Lecture-20

DCM operation of Boost PFC Converter

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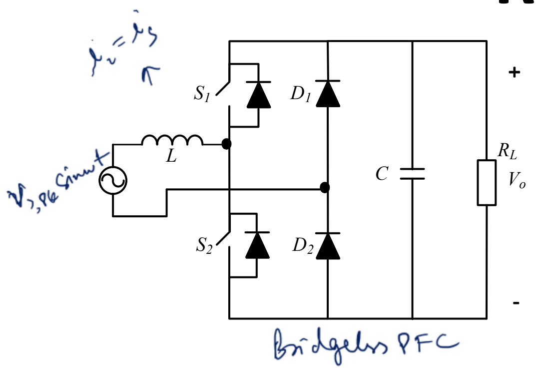
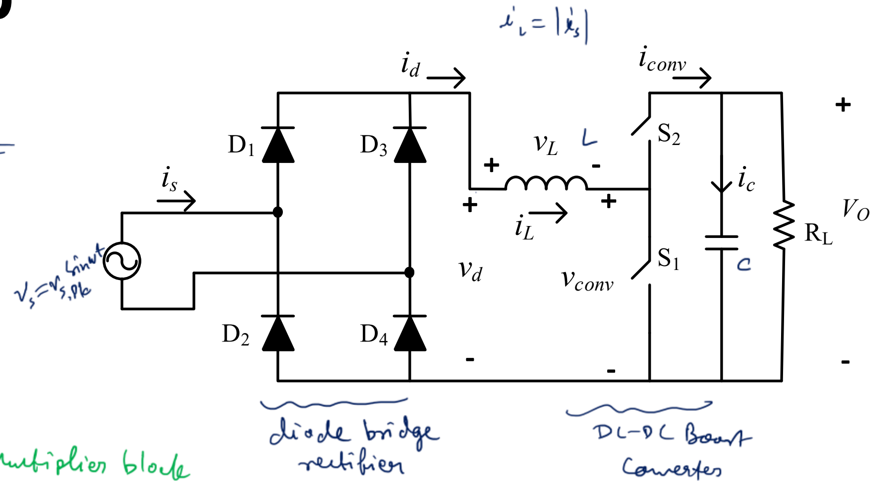
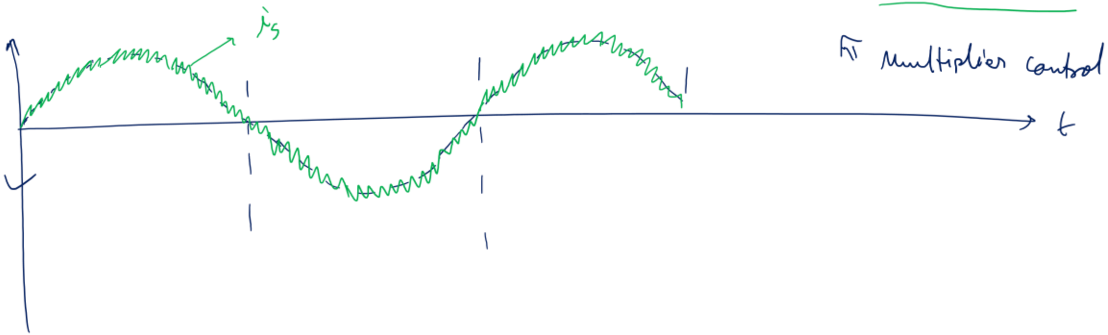
Recap





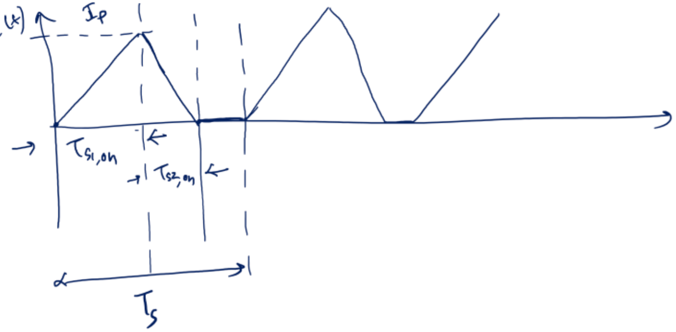
⇒ Multiplier block

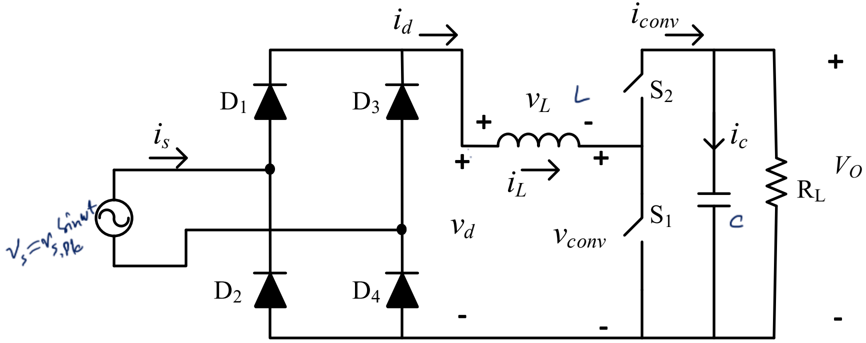
⇒ Multiplier control approach



DCM of Boost PFC, in one of the switching cycle 'T_s'

$T_{S_1,on} \rightarrow$ switch 'S_1' is ON





$$v_L = L \frac{di}{dt} = |v_s|$$

$$|v_s| = \frac{L I_p}{T_{S_1,on}}$$

$$\Rightarrow I_p = \frac{|v_s| T_{S_1,on}}{L}$$

$v_d = |v_s|$

$\Rightarrow i_s = i_L, \quad v_s > 0$

$\quad = -i_L, \quad v_s < 0$

if $T_{S_1,on}$ is constant, then the I_p (pk of inductor current) follows the $|v_s|$ variation $\Rightarrow$ AC voltage

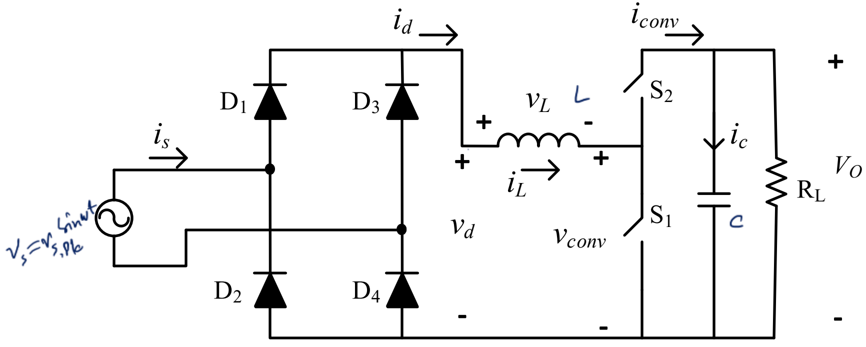
I_p is varying in sinusoidal manner.

$$\langle i_L(t) \rangle_{T_s} = \frac{1}{2} \times \frac{|v_s| \cdot T_{s1,on}}{L} \times \frac{(T_{s1,on} + T_{s2,on})}{T_s}$$

let, $D_1 = \frac{T_{s1,on}}{T_s}$; $D_2 = \frac{T_{s2,on}}{T_s}$

$$\Rightarrow \langle i_L(t) \rangle_{T_s} = \frac{1}{2} \frac{|v_s(t)|\, T_{s1,on}}{L} [D_1 + D_2]$$

$$\langle i_L(t) \rangle_{T_s} = \frac{1}{2} \frac{|v_s(t)|\, D_1 T_s}{L} [D_1 + D_2] \longrightarrow (1)$$



volt-sec

$$|v_s(t)| D_1 T_s + (|v_s(t)| - v_o) D_2 T_s = 0$$

$$\Rightarrow D_2 = \frac{|v_s(t)|}{v_o - |v_s(t)|} \cdot D_1 \longrightarrow (2)$$

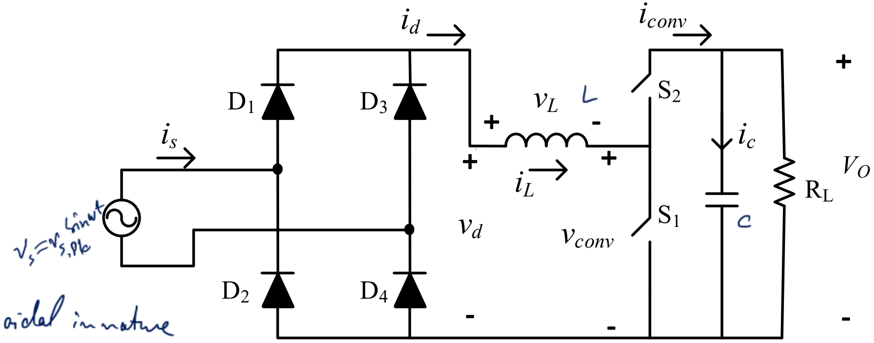
Substitute (2) in (1)

$$\langle i_L(t) \rangle_{T_s} = \frac{1}{2} |v_s(t)| \cdot D_1 T_s \cdot \left[D_1 + \frac{|v_s(t)|}{v_o - |v_s(t)|} \cdot D_1 \right]$$

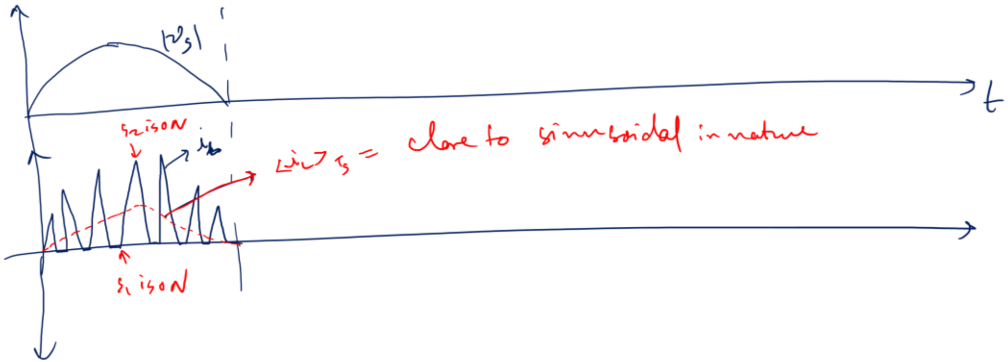
$$\Rightarrow \langle i_L(t)\rangle_{T_s} = \frac{1}{2}\cdot |v_s(t)|\cdot D_1^2 T_s \left[\frac{V_o}{V_o - |v_s(t)|}\right]$$

$$i_s(t) = i_L(t), \quad v_s > 0$$
$$= -i_L(t), \quad v_s < 0$$

$$\Rightarrow \langle i_s(t)\rangle_{T_s} = \frac{1}{2}\left|V_{s,pk}\sin\omega t\right| D_1^2 T_s \left[\frac{V_o}{V_o - |V_{s,pk}\sin\omega t|}\right]$$



if we keep D_1 & T_s constant i.e, $T_{s,on}$ is kept constant, we can ensure that $\langle i_L(t)\rangle_{T_s}$ is sinusoidal in nature



Advantages

(1) The current drawn from the source, follows the AC voltage.

(2) The use of multiplier, dual loop, unit sinωt waveform (' ided.

(3) Reduced switching loss or if diode is used in place of S2, the reverse recovery losses of diode is nearly zero.

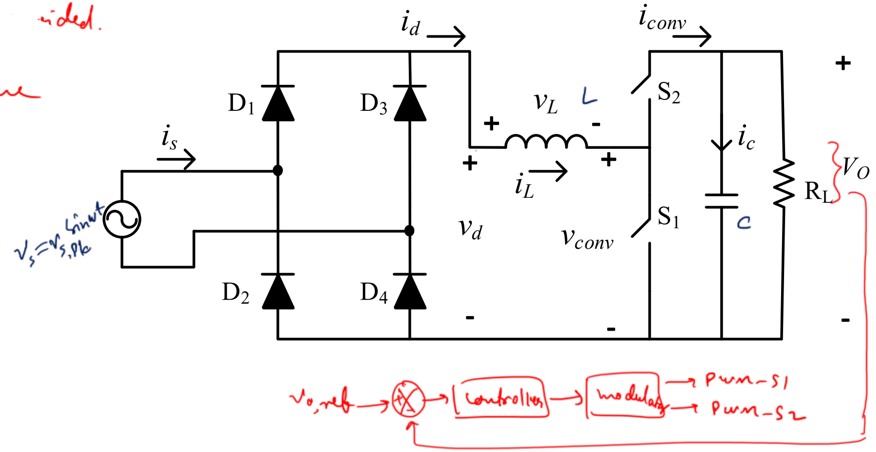
Disadvantage

(1) (average) Input current is close to sinusoidal, THD is more

(2) Ripple is more

(3) RMS currents of S1, S2, L, D1, D2, D3, D4 are more

(4) S1 turns off with higher current.



Thank You