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Charging Infrastructure

Lecture-18

Totem pole PFC Converter

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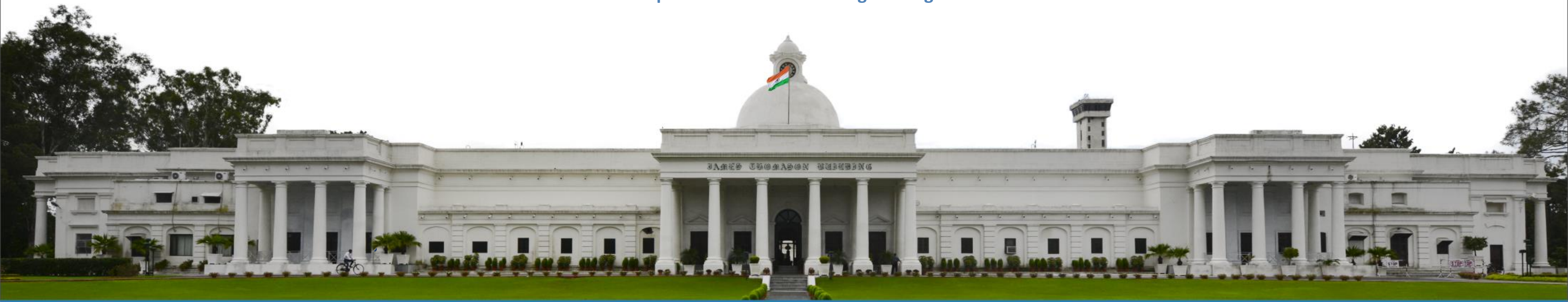
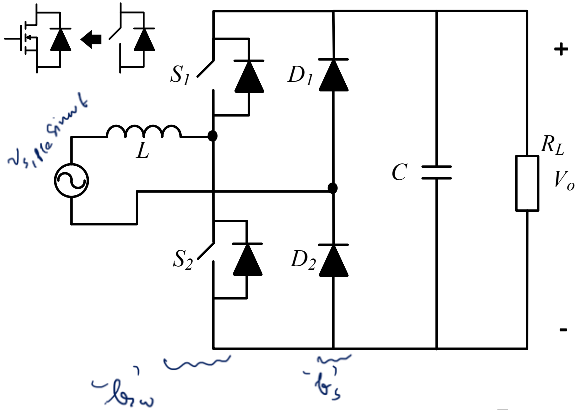


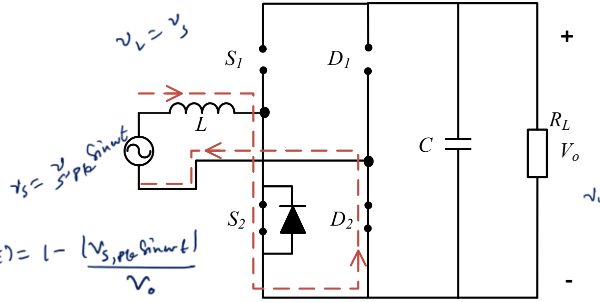
Totem pole PFC



$f_{sw} >> f_s$

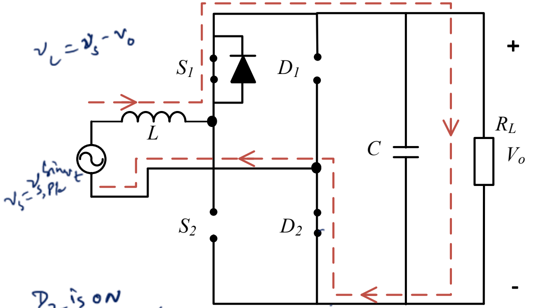
$\Rightarrow d(t) = 1 - \frac{|V_{s,pk}\sin\omega t|}{V_o}$

In positive half cycle ($v_s > 0$)



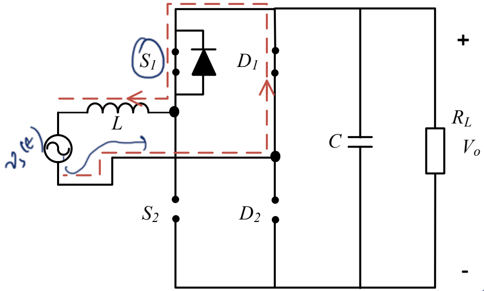
during "DT_s" duration

D_2 is ON



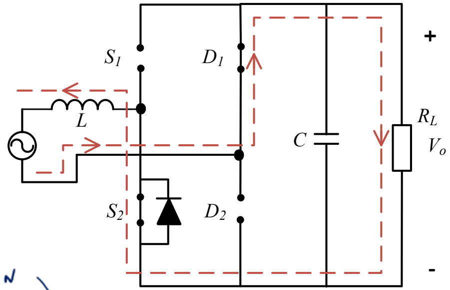
during "$(1-D)T_s$" duration

In negative half cycle



during "DT_s" duration

D_1 is ON



during "$(1-D)T_s$" duration

Totem pole PFC

→ It has two legs, where one of the legs are fast switching leg, while the other one is slow switching leg.

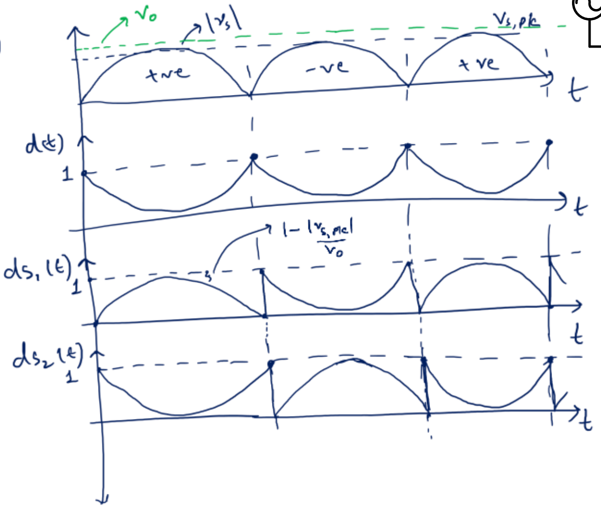
In positive half cycle, (always D_2 is ON)

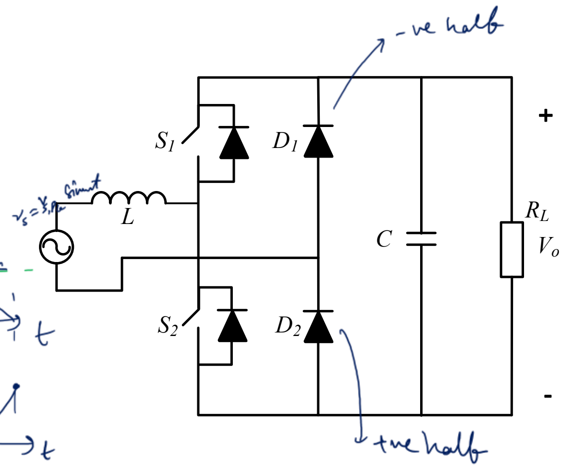
$$d_{S_1}(t) = 1 - d(t)$$
$$d_{S_2}(t) = d(t)$$

In negative half cycle, (always D_1 is ON)

$$d_{S_1}(t) = d(t)$$
$$d_{S_2}(t) = 1 - d(t)$$

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

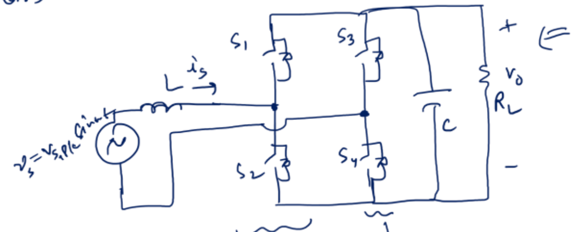




Totem pole PFC

Advantage

1. Only 2 devices are in conduction → less conduction losses
2. 4 devices are needed
3. 2 of the switching is having a low switching freq. (same as that of line frequency)
   ↳ in reducing the switching losses

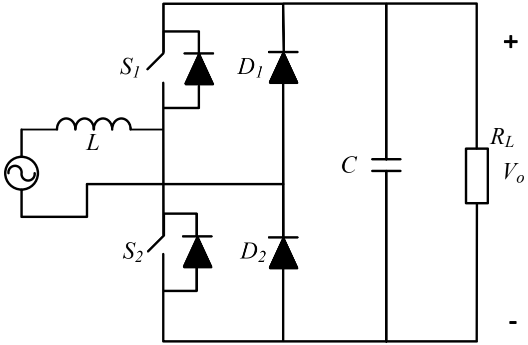


fast switching leg (f_{sw})

slow switching leg (f_s)

f_s = line frequency or 50 Hz/60 Hz

$f_{sw} \gg f_s$



L, C → same as that of Boost PFC case

for S_1, S_2, S_3, S_4

the voltage rating $= 1.4 \times V_o$ (40% safety margin)

$$I_{S1,rms} = \sqrt{\frac{1}{T}\left[\int_0^{T/2}\left((1-d(t))\, i_s^2(t)\right)\cdot dt + \int_{T/2}^{T}\left(d(t)\, i_s^2(t)\right)\cdot dt\right]}$$

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

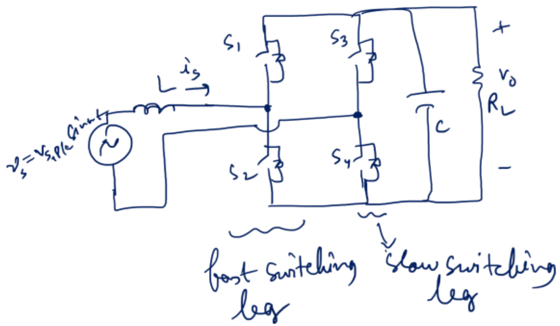
$i_s(t) = I_{s,pk}\sin\omega t$

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

$\omega T = 2\pi$

$$I_{S3,rms} = \sqrt{\frac{1}{T}\int_{T/2}^{T} i_s^2(t)\cdot dt} = \frac{I_{s,pk}}{2}$$

$$I_{S4,rms} = \sqrt{\frac{1}{T}\int_{0}^{T/2} i_s^2(t)\cdot dt} = \frac{I_{s,pk}}{2}$$



$i_s(t) = I_{s,pk}\sin\omega t$

$d(t) = 1 - \frac{|V_{s,pk}\sin\omega t|}{V_0}$

Thank You