IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

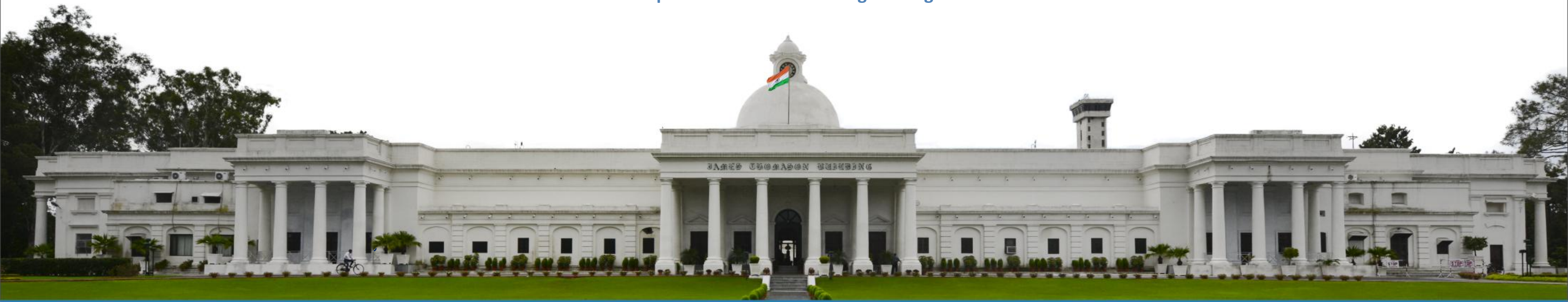
Charging Infrastructure

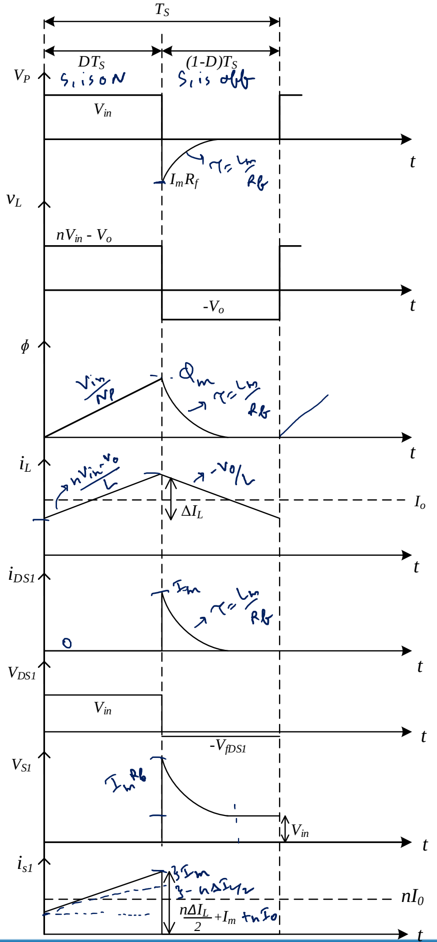
Lecture-31

Revisiting Isolated DC-DC Converters-II

Dr. Apurv Kumar Yadav

Department of Electrical Engineering





Recap

Disadvantage

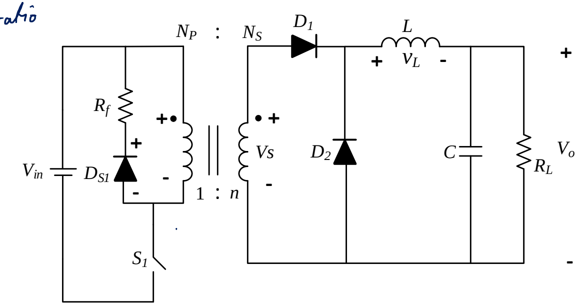
1. Sufficient $(1-D)T_s$ → limits the switching freq. } – limited duty ratio
   as flux in the transformer core must get reset to 0.

2. The reverse recovery losses of the diode

3. lossy reset of the flux in the transformer

4. Core utilization is limited = half

5. The switch 'S_1' voltage rating is higher than V_{in}.



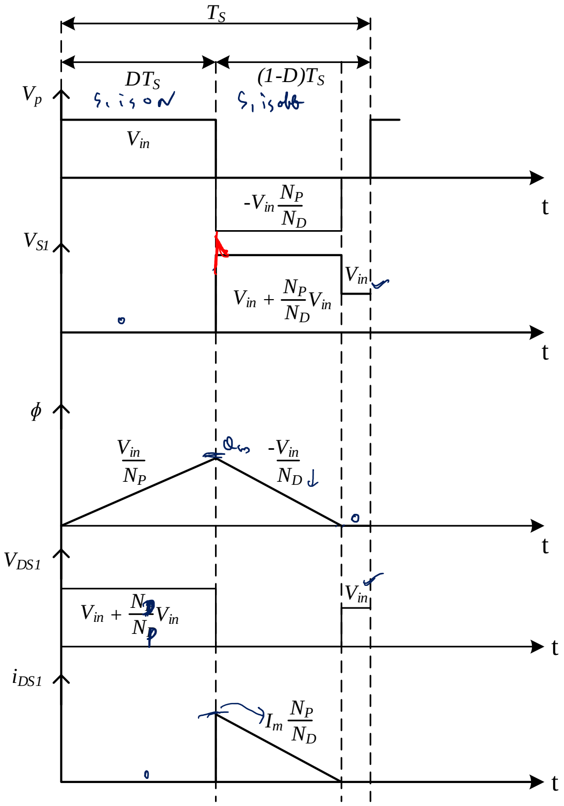
$$V = N \Delta B \cdot A \cdot f \quad (\Delta B: 0 \text{ to } B_{max})$$

$$A_c = \frac{V}{N B_{max} f}$$

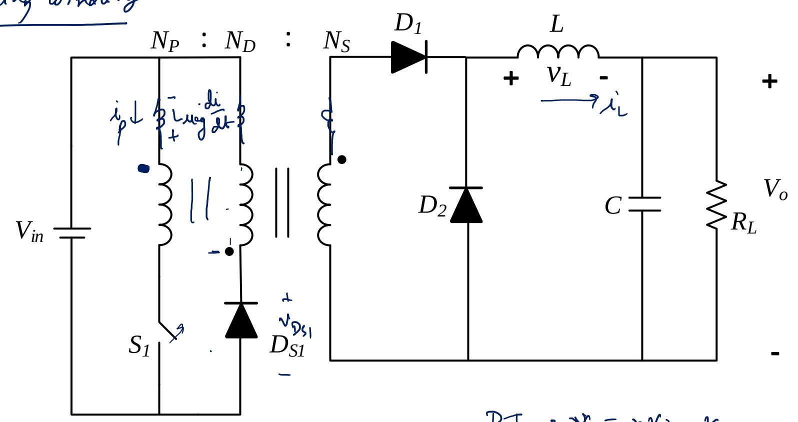
if the ΔB → $+B_{max}$ to $-B_{max}$

$$A_c = \frac{V}{2 N B_{max} f}$$

Forward Converter with Demagnetizing winding

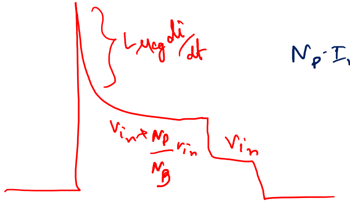


$I_m \rightarrow$ magnetizing component of current, which led to ϕ_m



Disadvantage

1. Multi winding transformer
2. limited switching freq.
3. 'S_1' rating is greater than V_{in}
4. Transformer is under utilization
5. The voltage kick on switch 'S_1' due to leakage inductance



$V_{S_1} = V_{in} + \frac{N_P}{N_D} V_{in}$

$I_m \rightarrow \phi_m$

$N_P \cdot I_m = I_{DS_1} \cdot N_D$

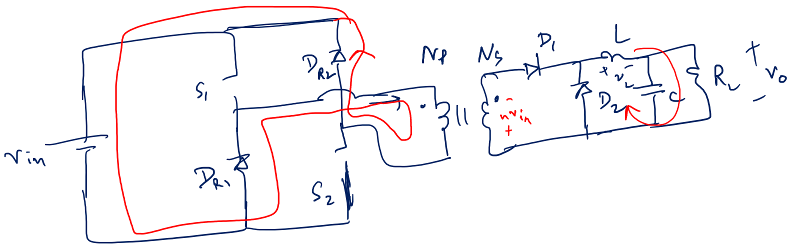
$DT_S \rightarrow v_L = nV_{in} - V_o$

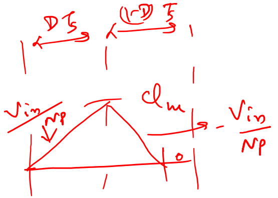
$(1-D)T_S \rightarrow v_L = -V_o$

$\Rightarrow V_o = nV_{in}D$

Source: Power Electronics: Essentials & Applications by L Umanand

Dual switch forward converters





DT_s period $\rightarrow$ S_1 & S_2 is ON

$\Rightarrow v_L = nV_{in} - V_o$

$\Rightarrow (1-D)T_s$ period $\rightarrow$ S_1 & S_2 is off

$\Rightarrow v_L = -V_o$

volt-sec across 'L'

$\Rightarrow V_o = nV_{in}D$

$\Rightarrow S_1$ & S_2 $\rightarrow$ voltage rating = V_{in}

$\Rightarrow$ but it uses two switch & two diodes in primary side.

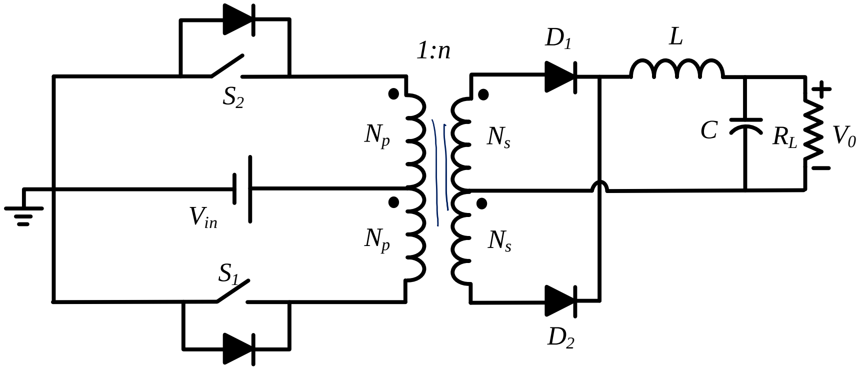
$\Rightarrow$ limited switching freq.

$\Rightarrow$ reverse recovery losses (D_1 & D_2)

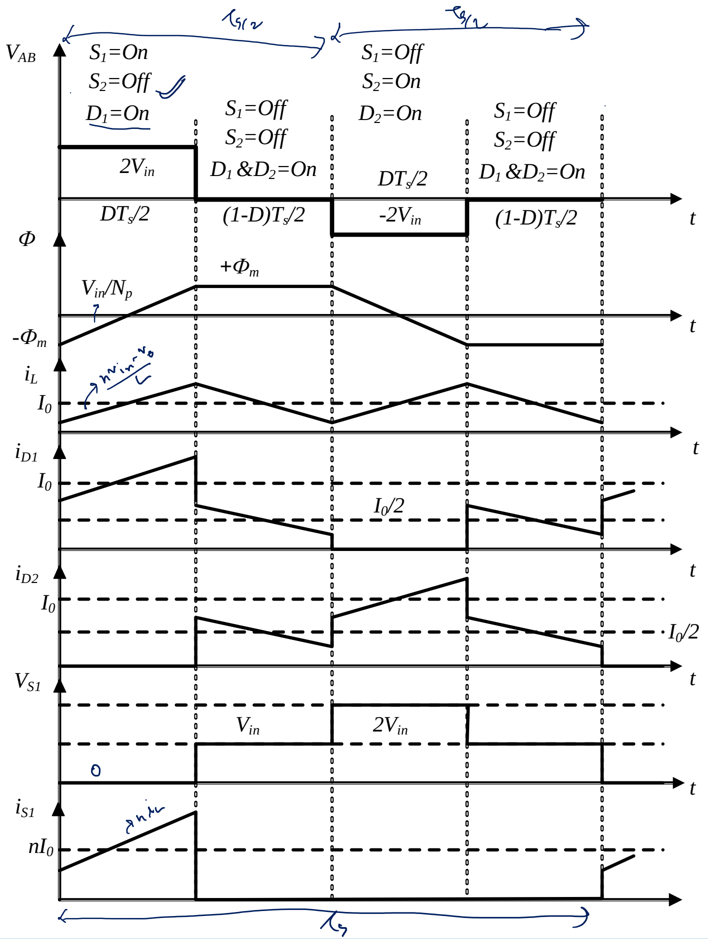
$\Rightarrow$ Core utilization is half

Push-Pull based DC-DC Converter.

→ 4 sets of transformer winding



Source: Power Electronics: Essentials & Applications by L Umanand

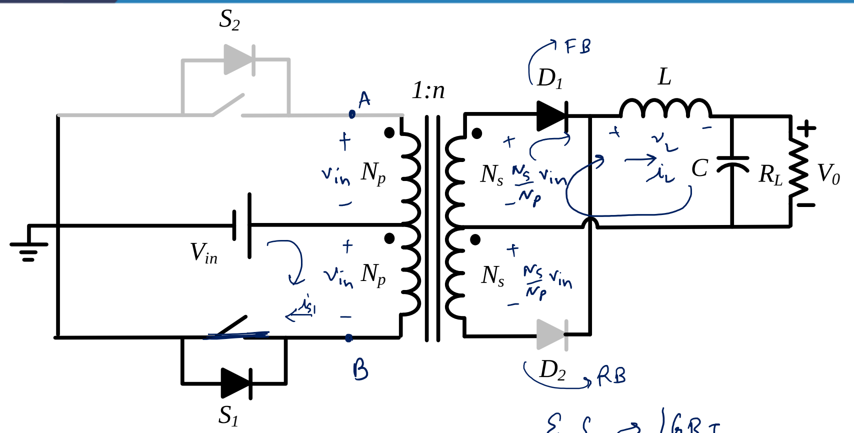


$\frac{N_s}{N_p} = n$

$\left(\frac{DT_s}{2} \text{ period}\right)$

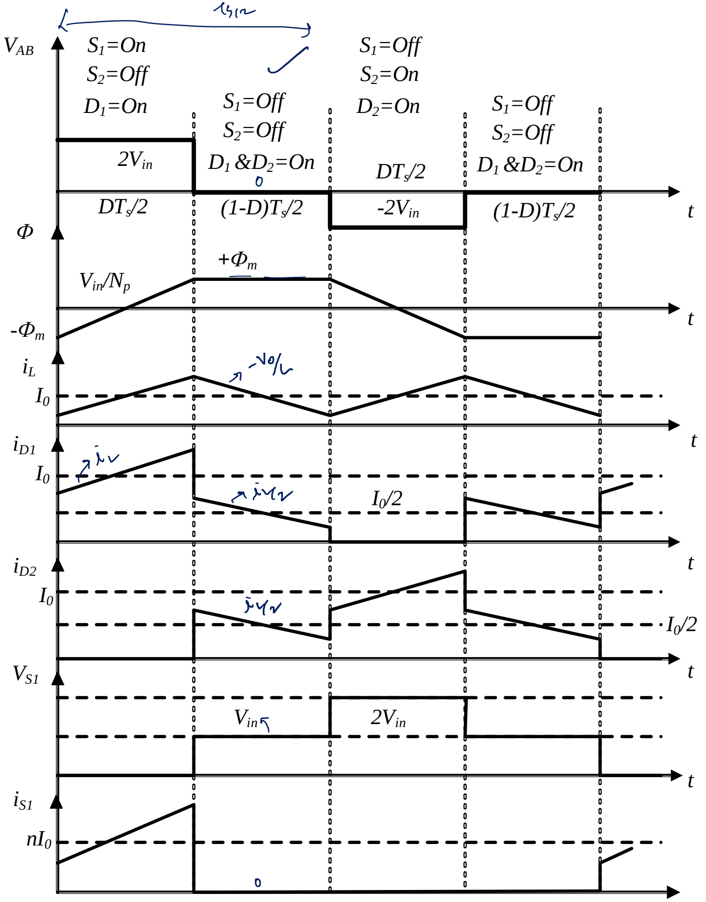
$(v_L = nV_{in} - V_0)$

$nV_{in} > V_0$



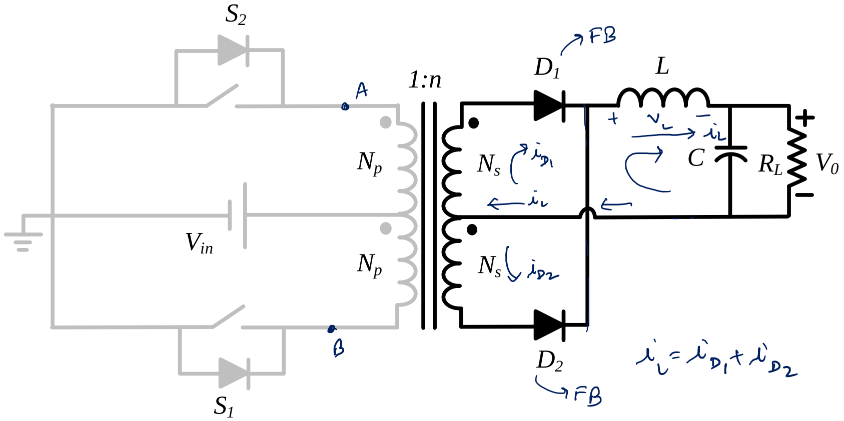
$S_1, S_2 \rightarrow$ IGBT or MOSFET

Source: Power Electronics: Essentials & Applications by L Umanand



$\frac{(1-D)T_s}{2}$ period

$v_L = -v_0$

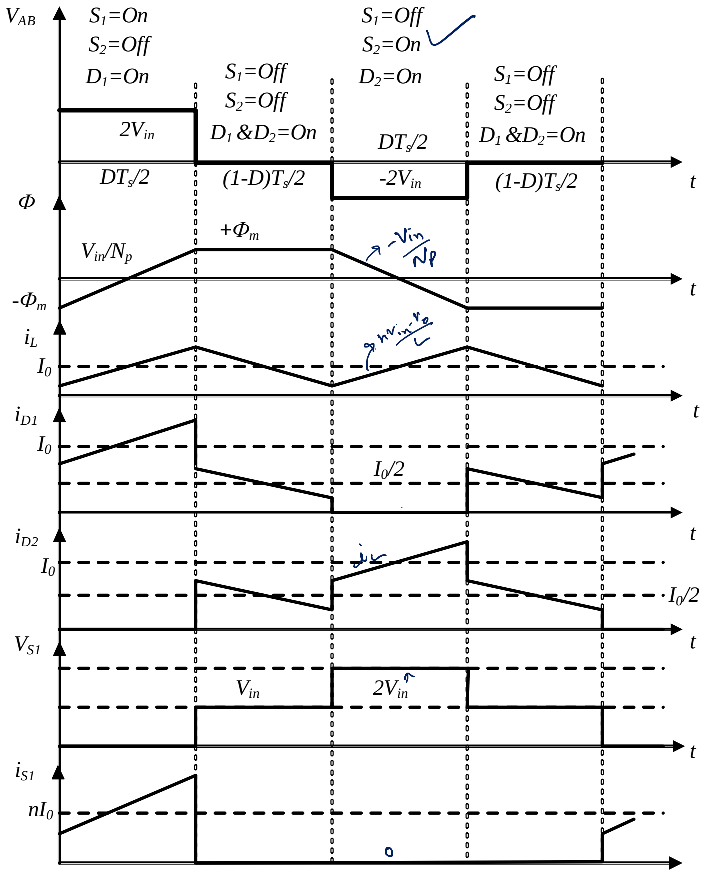


$i_L = i_{D_1} + i_{D_2}$

$N \frac{d\phi}{dt} = v$

$\frac{d\phi}{dt} = 0$

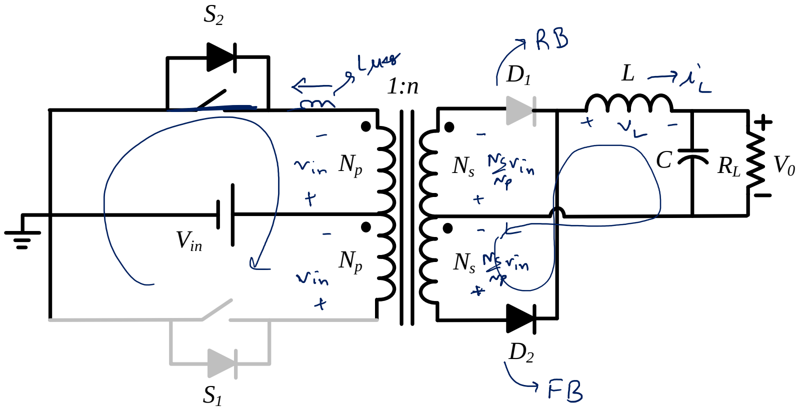
Source: Power Electronics: Essentials & Applications by L Umanand



Next, $\frac{DT_s}{2}$, period

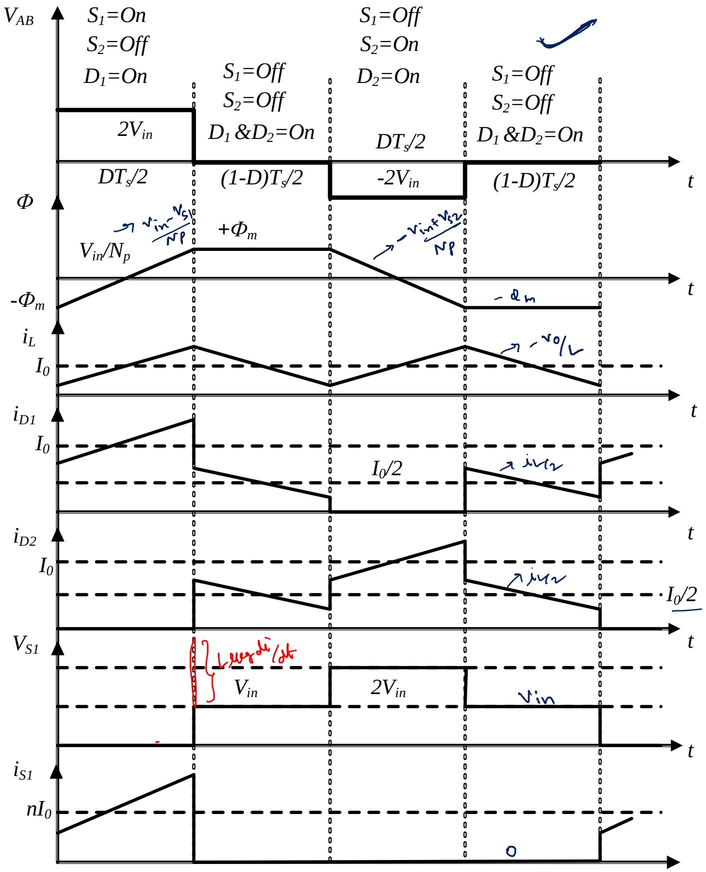
$v_L = nv_{in} - v_o$

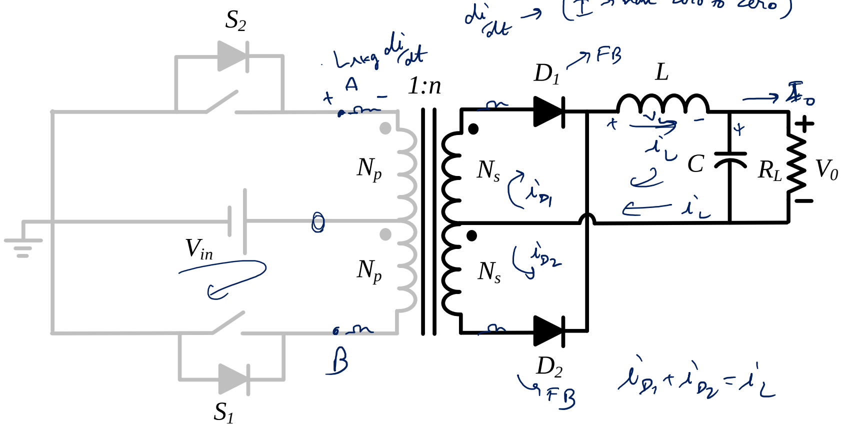
$nv_{in} > v_o$



$V_{S_1} = 2v_{in}$

Source: Power Electronics: Essentials & Applications by L Umanand





$\frac{di}{dt} \rightarrow$ (I → non-zero to zero)

Next $\frac{(1-D)T_s}{2}$

$v_L = -V_0$

$v_{S_1} = v_{in}$

$i_{D_1} + i_{D_2} = i_L$

volt-sec of L

$(nV_{in} - V_0)\frac{DT_s}{2} + (-V_0)\frac{(1-D)T_s}{2} = 0$

$\Rightarrow \quad V_0 = nDV_{in}$

$+B_{max}$ to $-B_{max}$

$V = N \Delta B \cdot A_c \cdot f$

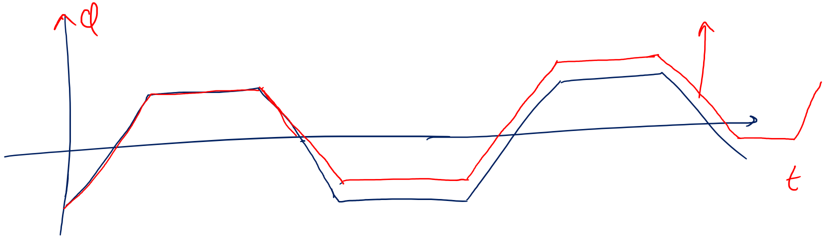
$\Rightarrow \quad A_c = \frac{V}{2N B_{max} f}$

Source: Power Electronics: Essentials & Applications by L Umanand

Advantage

① Core is fully utilized

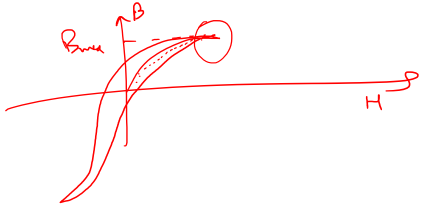
② The cut-off frequency is $2 \times f_{sw}$ (of L&C)



Disadvantage

① S_1, S_2 rating are doubled ($2V_{in}$)

② flux walking phenomenon which lead to core saturation



③ The voltage kick (on S_1 & S_2 switch) due to the sudden breaking of current through leakage inductance $\longrightarrow$ V_{S_1} & V_{S_2}

④ 4 winding transformer need to be wound.

Source: Power Electronics: Essentials & Applications by L Umanand

Thank You