IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Charging Infrastructure

Lecture-30

Revisiting Isolated DC-DC Converters-I

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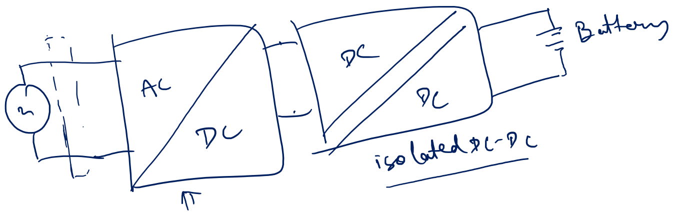
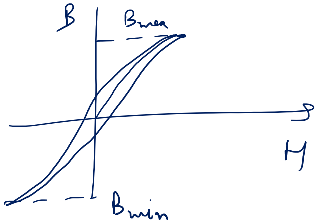
Recap

- Single-phase AC-DC Converter: operation, Design, small signal model, closed loop control, CCM, DCM operation.

- Three-phase AC-DC Converter: operation, Design, small signal model, closed loop control.

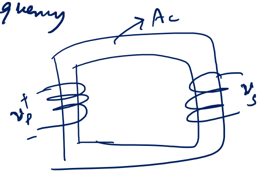


Isolated DC-DC Converter



1. Forward converter
2. Flyback converter
3. Push-Pull converter
4. half-bridge converter
5. full-bridge converter → Phase-shift full bridge converter (PSFB)
6. Dual active bridge converter → Resonant based DAB, multilevel DAB
7. Resonant based converter → LLC, or CLLC based converters

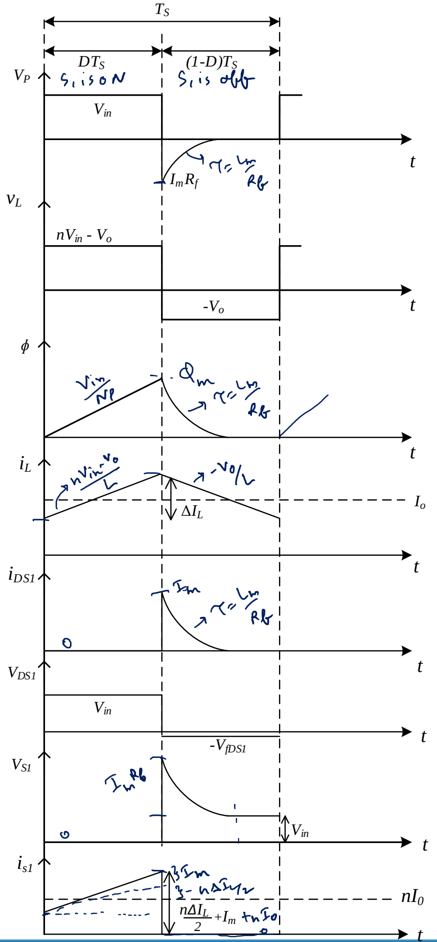
→ All have transformers for isolation, which is supplied by high frequency AC voltages



$$V = N\frac{d\phi}{dt} \Rightarrow V = N\,\Delta\phi\, f$$

$$\Rightarrow V = N\,\underbrace{\Delta B}_{\text{flux density}} \cdot A_c\, f$$

$A_c \propto 1/f \Rightarrow f\uparrow,\ A_c\downarrow$



Forward Converter (Buck derived topology)

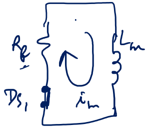
during 'DT_s',

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

$\Rightarrow V_s = nV_{in}$

$v_L = nV_{in} - V_o$

during $(1-D)T_s$



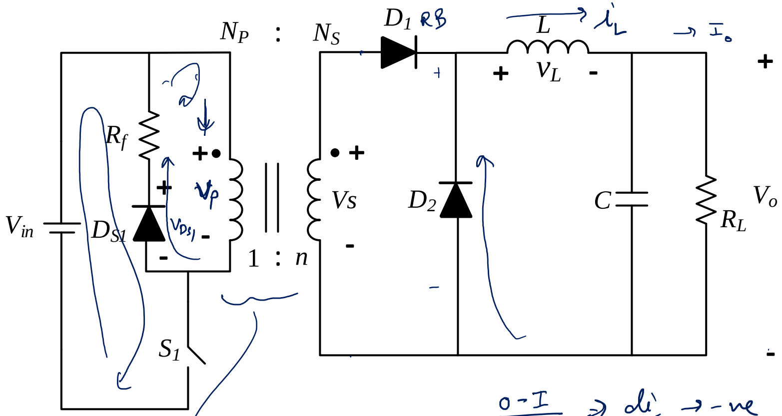
$v_L = -V_o$

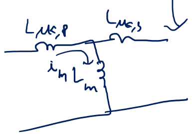
volt-sec balance of 'L'

$$(nV_{in} - V_o)DT_s + (-V_o)(1-D)T_s = 0$$

$\Rightarrow V_o = nV_{in} \cdot D$

$(D \approx 0 \text{ to } 1)$



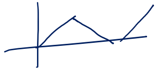


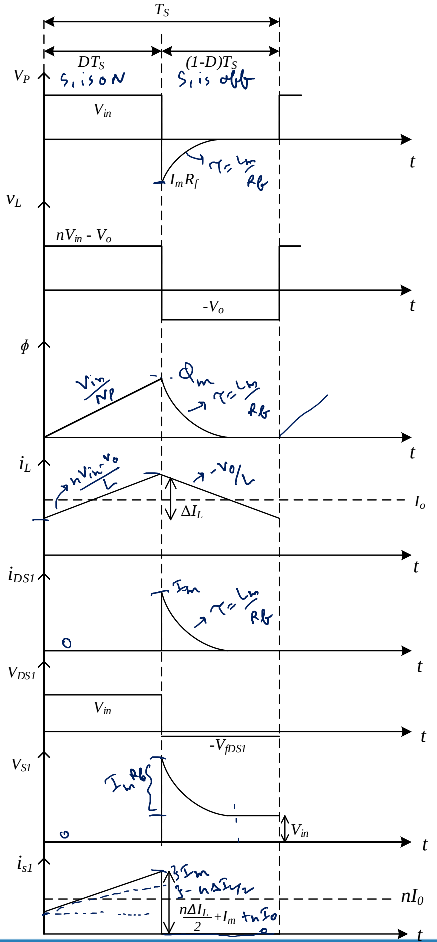
$T_s = 1/f_{sw}$

$\frac{0 - I}{\Delta t} \Rightarrow di/dt \rightarrow -ve$

$\Rightarrow -L\, di/dt$

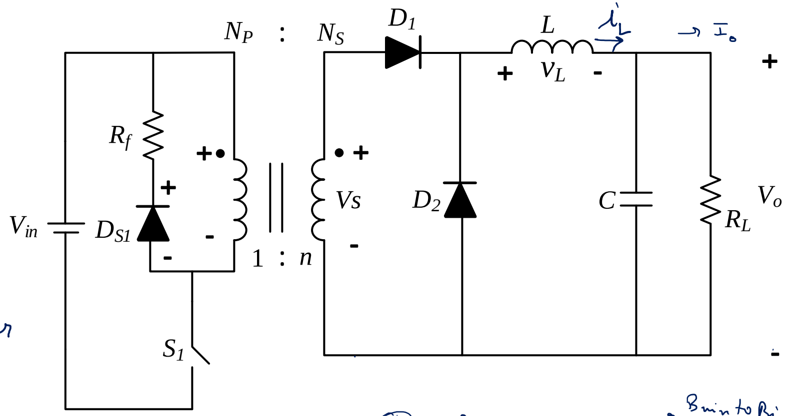
$V_{S1} = I_m R_f + V_{in}$

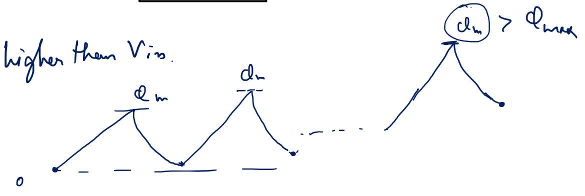




Disadvantage

1. Sufficient $(1-D)T_s$ → limits the switching freq. 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}.





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

↗ B_{min} to B_{max}

↳ 0 to B_{max}

↳ larger core area is required

Thank You