Buck: $V_0 = D\,V_{DC}$

Boost: $V_0 = \dfrac{V_{DC}}{1-D}$

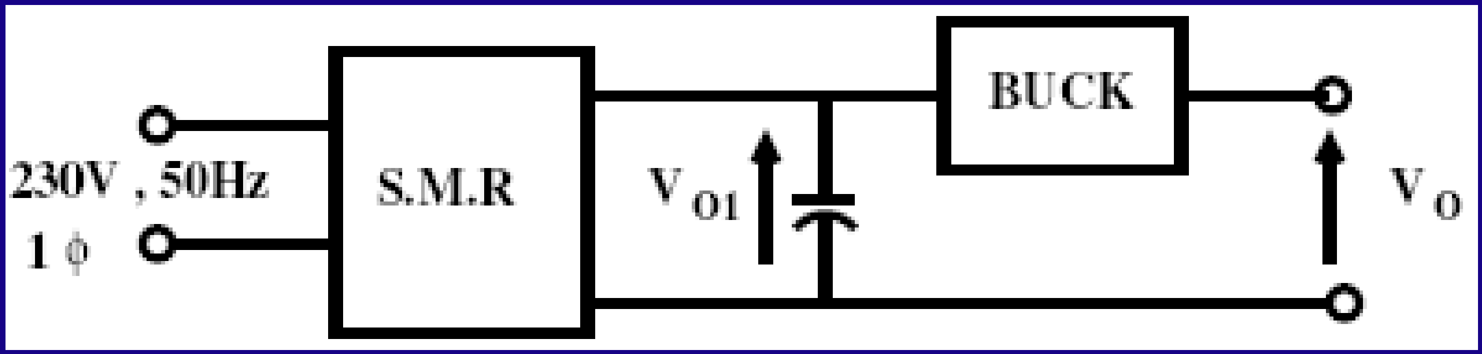
Buck – Boost & CUK: $\dfrac{DV_{DC}}{1-D}$

True only if 'i_L' is continuous (independent of i_L)

If it is discontinuous 'V_0' is higher than the above value

$\rightarrow$ I/P, O/P are not isolated

i) <u>Consider</u>: $V_0 = 5V$, I/p is $230V$, 1ϕ, P.F. ≈ 1



$\left(V_{01}\right) > 325V, \ V_0 = 5V \quad \therefore D \rightarrow \frac{5}{325} \rightarrow \underline{\underline{0.01}}$

230 is the RMS value whereas the capacitor will give peak value

If F_s = 100kHz, T = 10 μs $\therefore$ DT = 0.1μs ! = 100 ns

<u>Assumption :</u> All ckt elements are ideal, T_{on} & T_{off} of devices = 0

'DT' itself comparable with T_{on}.

ii) As $D \rightarrow 1$, ΔV_0 & Δi_L in Boost, Buck – Boost & CUK inverter $\uparrow$

$\Rightarrow \uparrow$ device V & I rating

$\Rightarrow$ Assumption made during analysis are not valid for high values of 'D'

$V_0 \rightarrow 0$ & not to ∞ as $D \rightarrow 1$ & V_0 depends on $\frac{r}{R}$ ratio

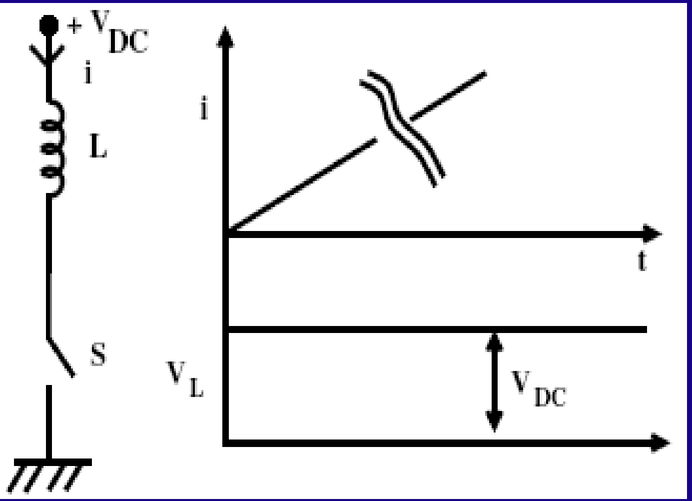
$\therefore$ $|V_{DC}|$ can not be greatly different from $|V_0|$

$\Rightarrow$ Use a transformer

$\Rightarrow$ Do not allow it to saturate

If there is $\frac{d\phi}{dt}$, 'V' will be induced in the secondary.

Recovery of trapped energy



L & S are ideal

i ↑ linearly

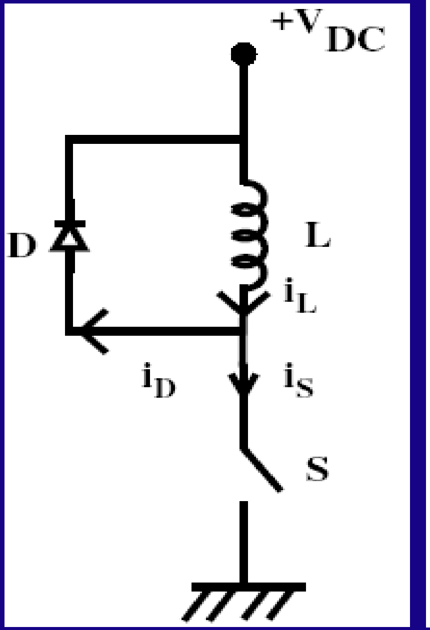
$$i = \frac{V}{L} t$$

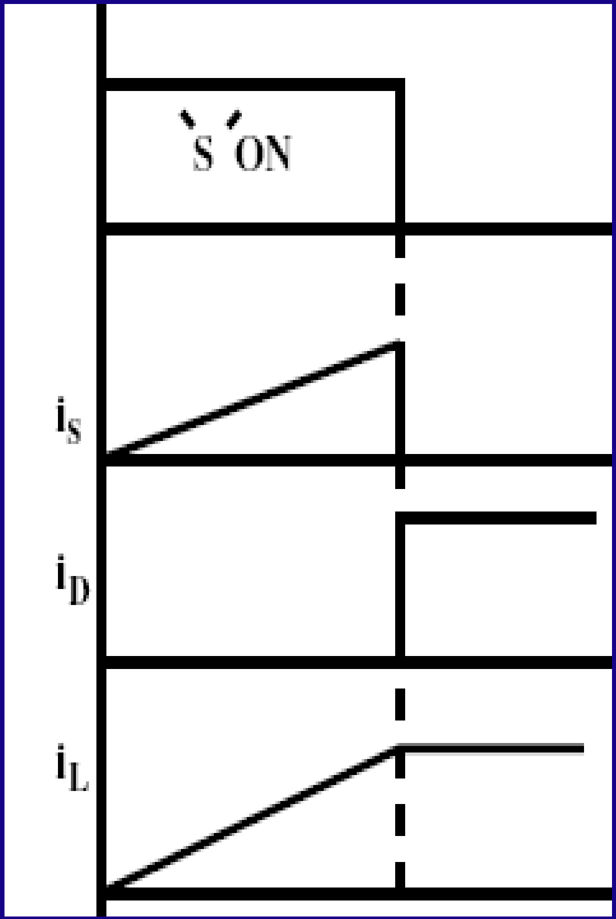
⇒ Can the switch be opened ?

⇒ If opened a large 'V' spike will appear across the device.

⇒ May get damaged.

- ⇒ Connect a diode 'D' across 'L'
- ⇒ 'i' will flow through 'D'
- ⇒ Circuit is lossless
- ⇒ Same 'i' continues to flow



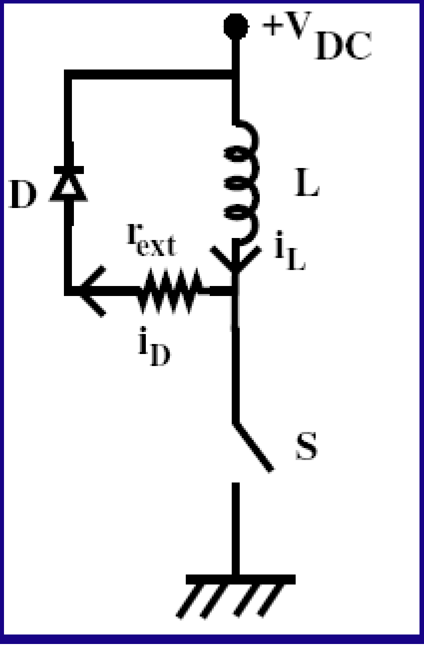


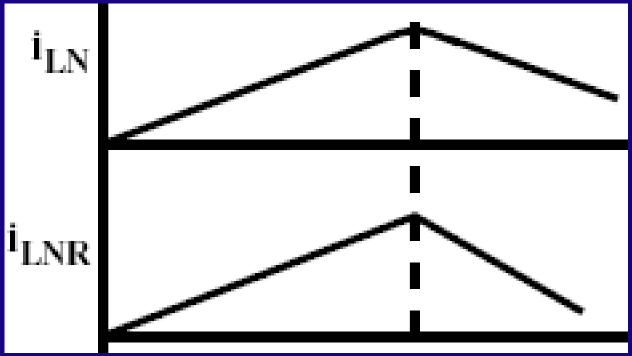
⇒ In non-ideal circuit, both 'L' and 'D' have finite resistance

⇒ Stored energy is dissipated as heat in the internal 'r' of 'L' and 'D'

⇒ Rate of decay can be ↑ by connecting r_{ext} in series with 'D'

⇒ All the energy is dissipated as heat



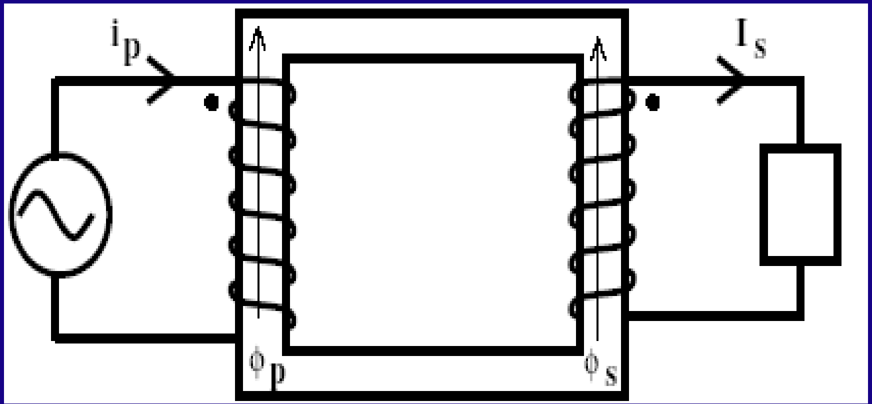


Can it be fed back to the source or some other load?

⇒ YES

Consider a transformer.

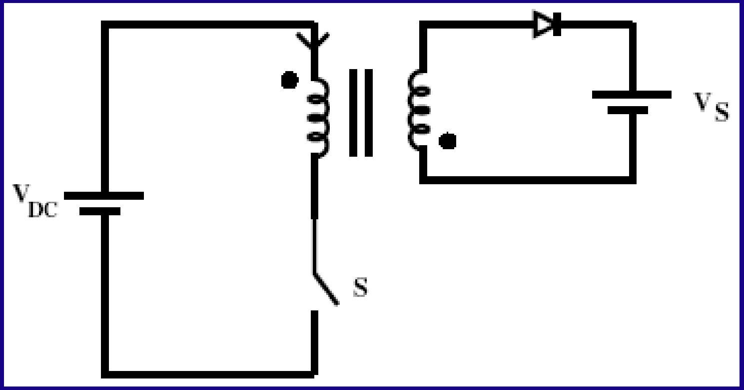
Both coils are carrying 'I'.



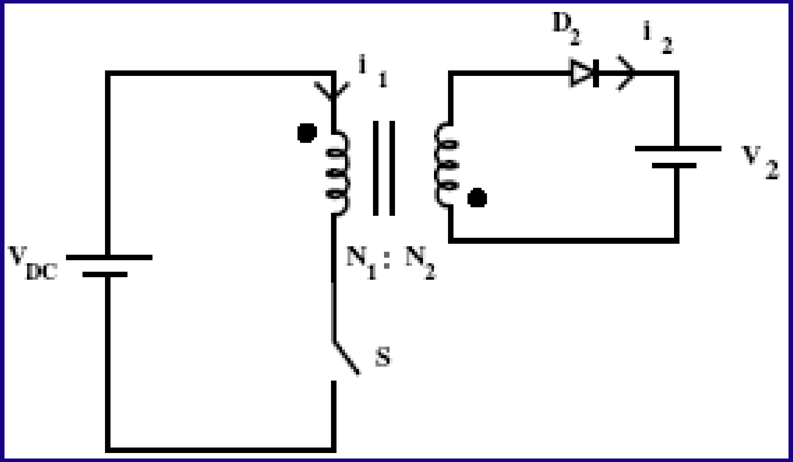
Direction of 'ϕ' due to I_P is opposite to that of the direction of 'ϕ' due to I_S.

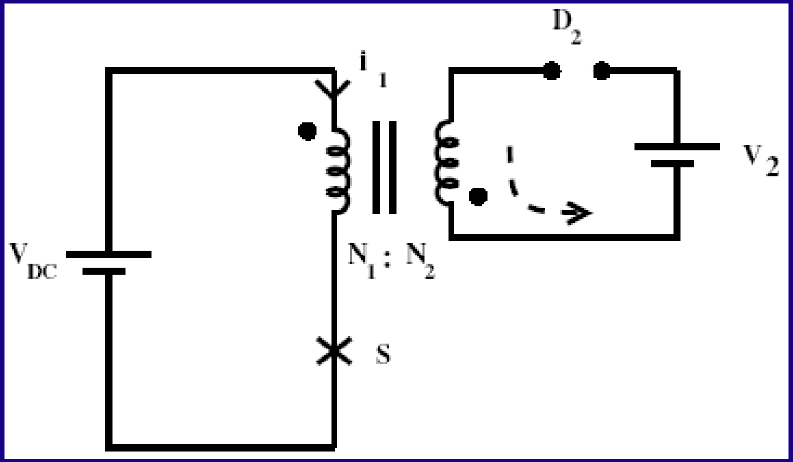
$\therefore$ If i_P enters the dot, I_S will leave the dotted terminal at the secondary. (In that case ϕ_S opposes ϕ_P)

What if only one winding carries 'I'?



Close 'S' for 'DT' duration:





'i_1' starts flowing $\Rightarrow$ Enters the dot in the primary

$\Rightarrow$ Correct direction of 'i_2' is to leave the dot.

Not possible due to diode D_2.

$\therefore$ No current flows in the secondary when 'i_1'

is flowing in the primary. '$\bullet$' is +ve.

'V' applied to primary winding of N_1 turns = V_{DC}

$\because$ 'V' induced in the secondary winding of N_2 turns = $V_{DC}\dfrac{N_2}{N_1}$

with ' $\bullet$ ' as +ve.

Anode pot. of D_2 w.r.t ' $\bullet$ ' terminal = $-V_{DC}\dfrac{N_2}{N_1}$

Cathode pot. of D_2 w.r.t ' $\bullet$ ' terminal = V_2

$\because$ 'V' across D_2 = $-\ V_{DC}\dfrac{N_2}{N_1} - V_2 = -(V_{DC}\dfrac{N_2}{N_1} + V_2)$

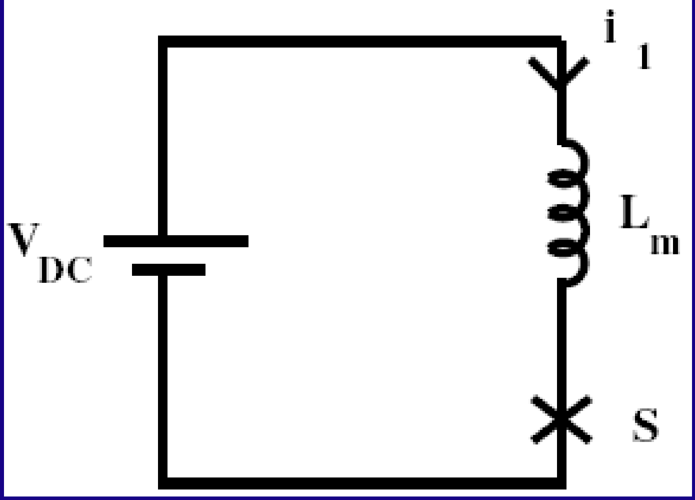
No i_2 $\therefore$ $i_1 = i_m$ source supplying as the magnetising current.

Flux is established in the core.

Neglect winding resistance & leakage reactance.

$\Rightarrow V_{DC}$ is applied to L_m

$\rightarrow$ 'i_m' & $\therefore$ 'ϕ' in the core $\uparrow$ linearly.



'S' is opened after DT seconds.

'ϕ' in the core must be continuous .

$\Rightarrow$ 'ϕ' can not collapse i.e cannot become zero instantaneously.

'ϕ' tries to $\downarrow$.

$\rightarrow \frac{d\phi}{dt} \rightarrow$ -ve $\therefore$ '$\bullet$' becomes -ve

$\therefore$ Other polarity (anode terminal) becomes +ve.

$\Rightarrow D_2$ starts conducting

$\Rightarrow i_2$ starts flowing, charges the source V_2

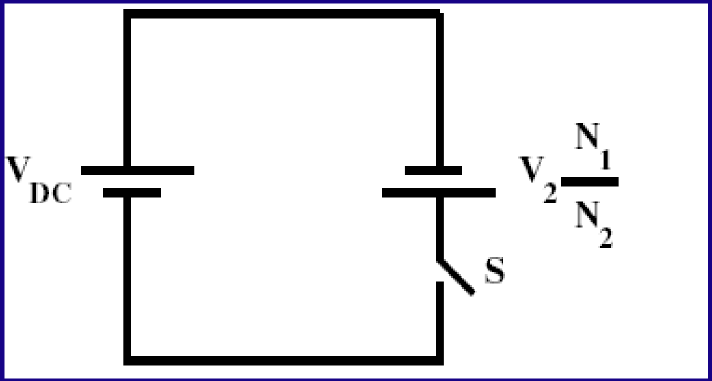
$\Rightarrow$ 'ϕ' due to i_2 should be in the same direction as that due to i_1(they are not produced at the same time). If it is in the opposite direction , 'ϕ' in the core, collapses.

$\Rightarrow$ If i_1 enters the '$\bullet$', then i_2 also enters the '$\bullet$'

'V' across N_2 turns $= V_2$, with '$\bullet$' as -ve.

'V' induced in N_1 turns $= V_2 \dfrac{N_1}{N_2}$

$\therefore$ 'V' across 'S' $= \left(V_{DC} + V_2 \dfrac{N_1}{N_2} \right)$



OR : Neglecting all leakage 'L' & resistance 'r'.

$$n = \frac{N_1}{N_2}$$

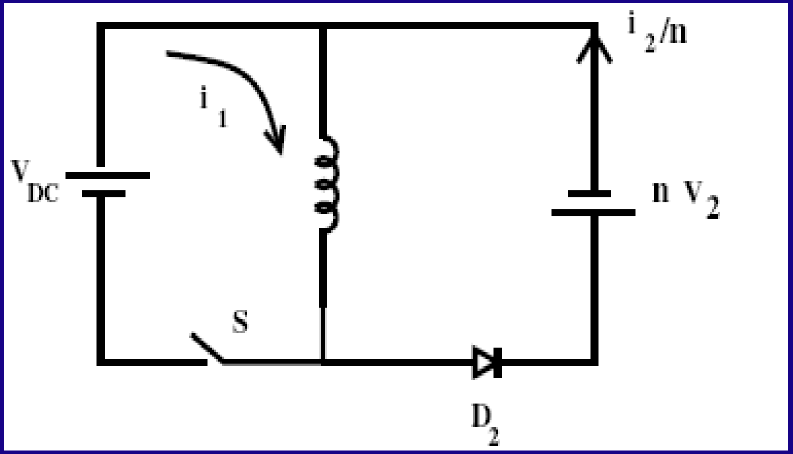
'S' is closed

'i_1' ↑linearly(flows in L_m $\therefore i_1 = i_m$)

No i_2 flows in the secondary due to D_2

$\because$ 'V' induced in the secondary winding of N_2 turns = $V_{DC}\dfrac{N_2}{N_1}$

with '•' as +ve.



Open 'S'

$i_1 = i_m$ should be continuous.

$\Rightarrow$ Starts flowing in the secondary

$\Rightarrow$ Stored energy in L_m in transferred to nV_2

Assume nV_2 is constant.

$\therefore$ $i_2 \downarrow$ linearly.

i_2 may not be zero ,when 'S' is closed again.

If $i_2 = 0$

$\Rightarrow$ flux in the core = 0

$\Rightarrow$ i_1 again starts from zero.

Flux resetting (DC flux).

Operation in 1st quadrant only.

If $i_2 \neq 0$

$\Rightarrow$ flux in the core $\neq 0$

$\Rightarrow$ i_1 starts from finite value.

$\therefore$ Energy stored in L_m can be fed back to the another source.

$\Rightarrow$ Or to a capacitor feeding a load

$\Rightarrow$ Fly back converter