Review:

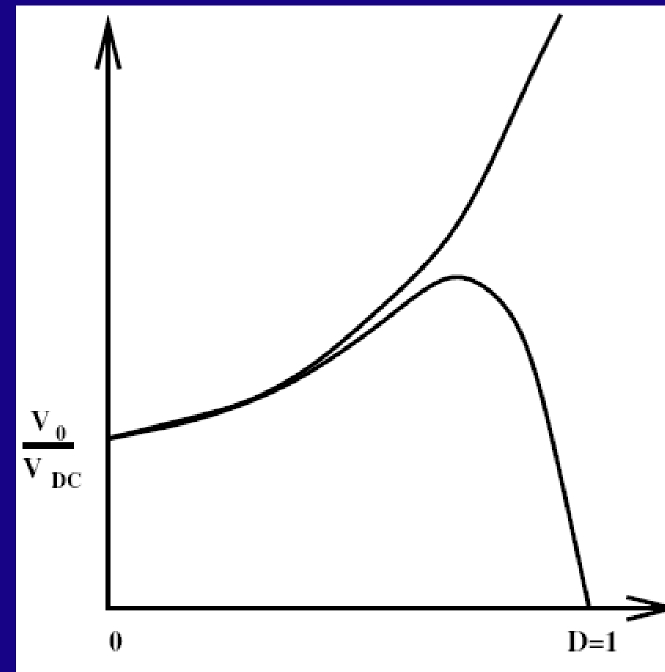
1. If i_L is continuous $V_0 = D\,V_{DC}$

$$= \frac{D\,V_{DC}}{\beta},\quad \underline{\beta < 1}$$

2. ΔV_0 & Δi_L are max at $D = 0.5$

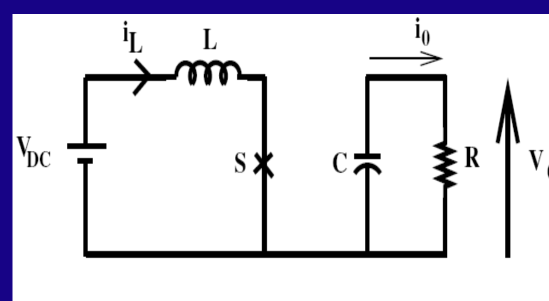
3. $V_0 \rightarrow \infty$ $D \rightarrow 1$ for ideal Boost.

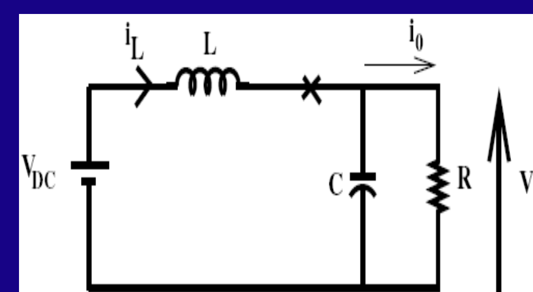
$\rightarrow 0$ for non-ideal Boost.



$$D_{max} = 1 - \sqrt{\frac{r}{R}}$$

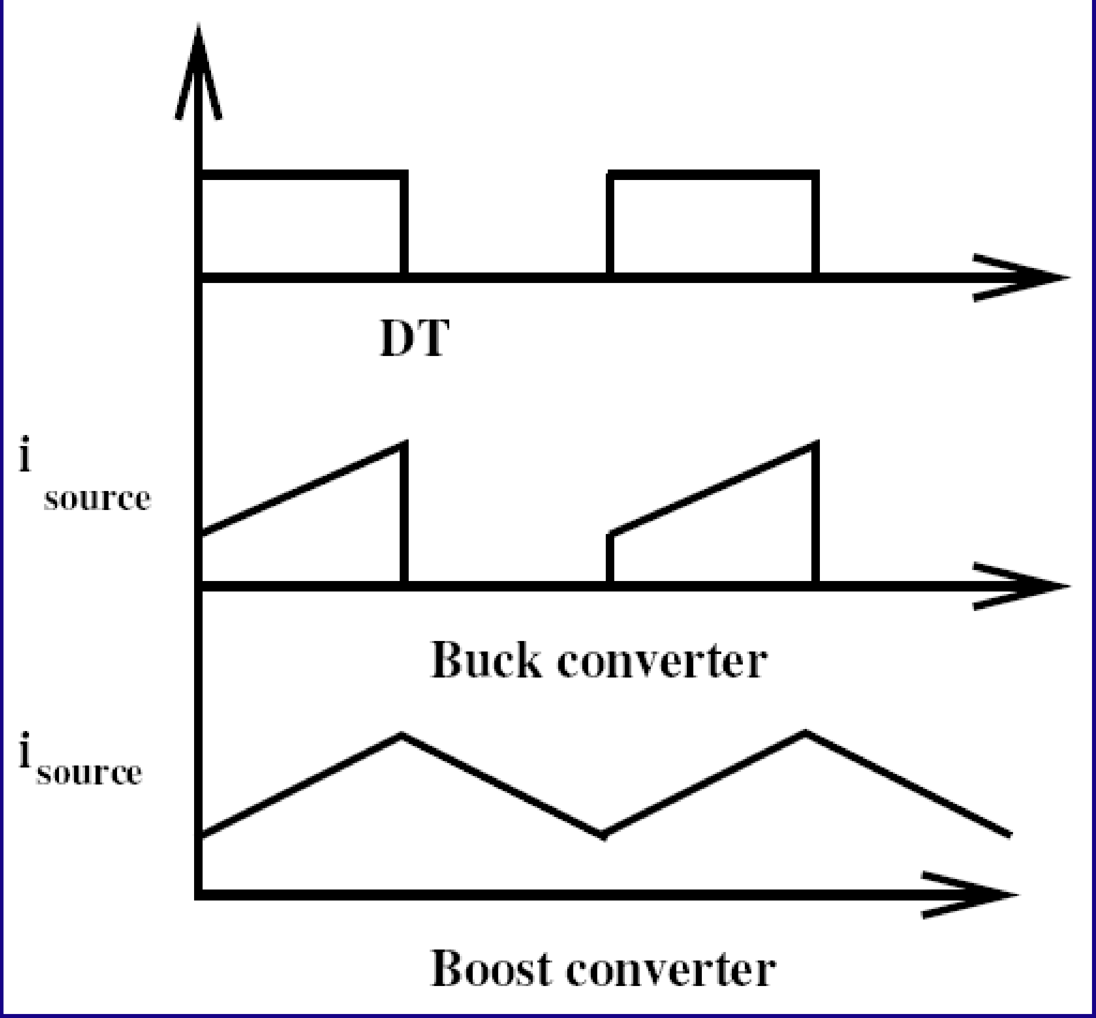
$$V_{0(max)} = \frac{V_{dc}}{2}\sqrt{\frac{R}{r}}$$

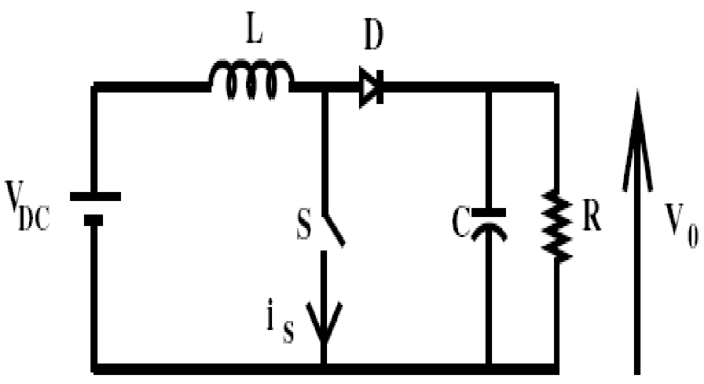


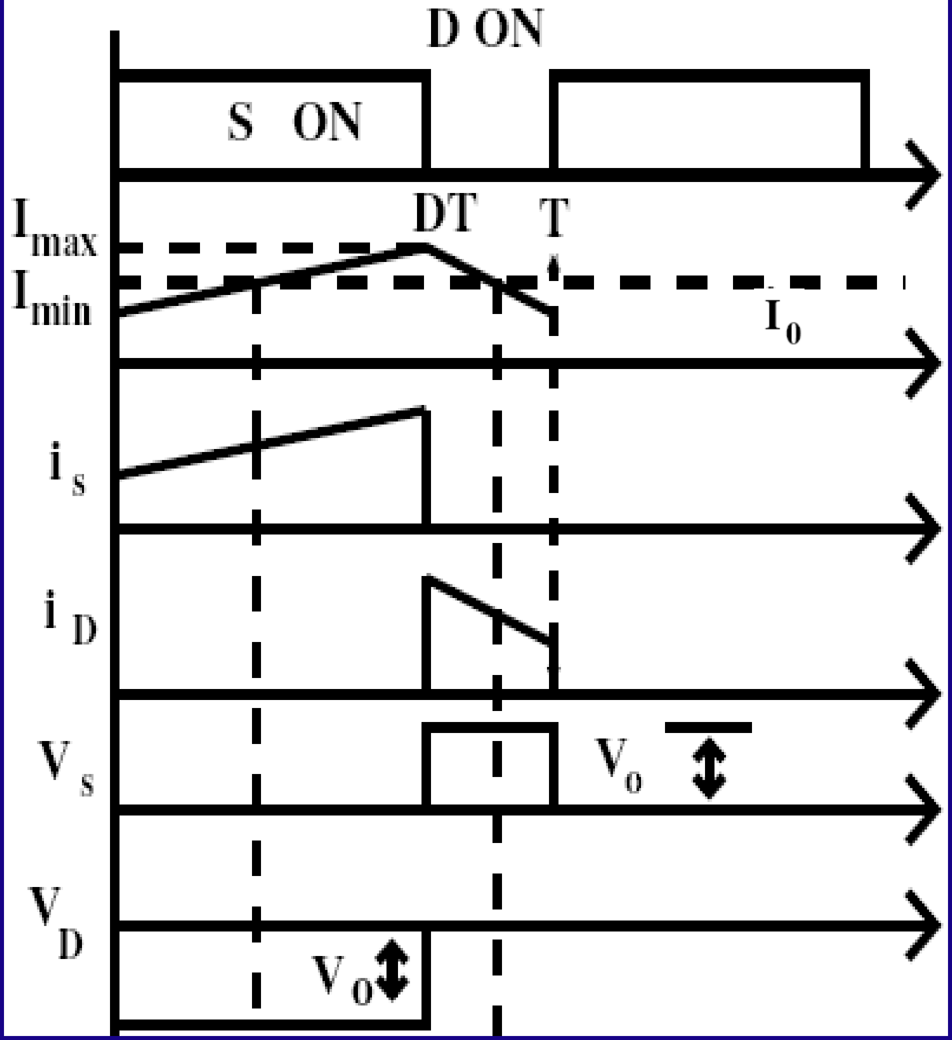


Assumption are not valid for high values of D.

Filtering requirement at the source side.




L
D
V DC
S
C
R
V 0
i S


D ON
S ON
I max
I min
DT
T
I 0
i S
i D
V S
V o
V D
V 0

Ripple in V_0 & I_L :

Nelect 'r' & ΔV_0 to determine ΔI_L

$$L\frac{di_L}{dt} = V_{DC} \qquad 0 < t < DT$$

$$i_L = I_{min} + \frac{V_{DC}}{L}t$$

$$\therefore I_{max} = I_{min} + \frac{V_{DC}}{L}DT$$

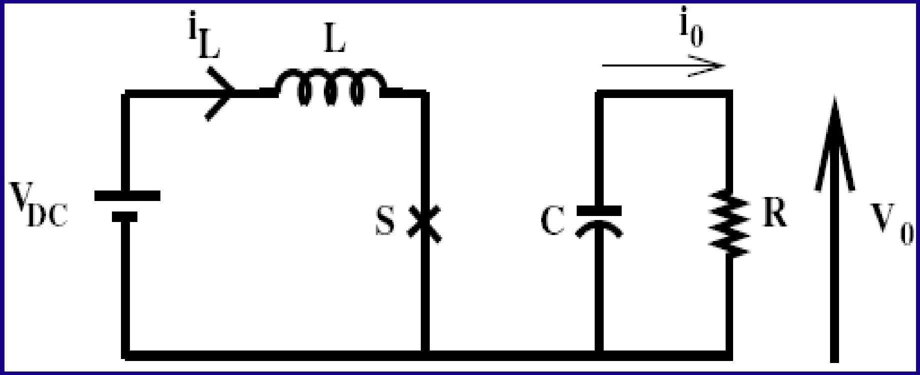
$$L\frac{di_L}{dt} = V_{DC} - V_0 = -\frac{DV_{DC}}{(1-D)} \qquad \because\ V_0 = \frac{V_{DC}}{(1-D)}$$

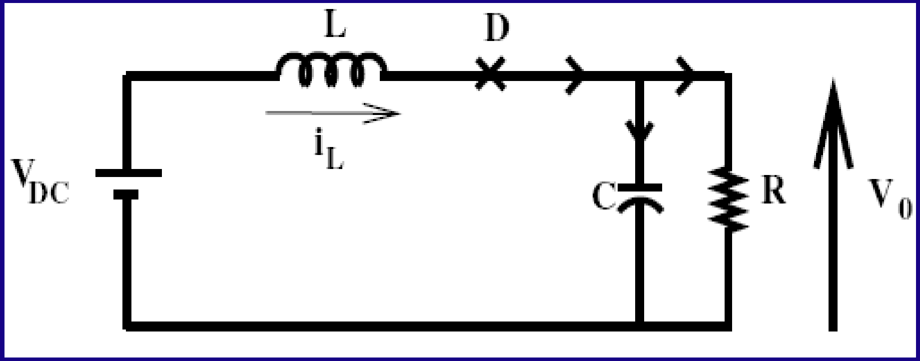
$$\therefore\ V_{DC} - V_0 = -\frac{DV_{DC}}{(1-D)}$$

$$\therefore i_L = I_{max} - \frac{V_{DC}}{L}\frac{D}{(1-D)}(t-DT)$$

$$I_{min} = I_{max} - \frac{V_{DC}}{L}\frac{D}{(1-D)}(T-DT)$$

$$\therefore \Delta i_L = \frac{V_{DC}}{L}DT \quad \propto D$$





ii) Neglect Δi_L while deriving ΔV_0

$$0 = C\frac{dV_0}{dt} + \frac{V_0}{R}$$

$$RC\frac{dV_0}{dt} + V_0 = 0 \qquad \therefore \ V_0 = V_{0(max)}e^{-t/RC}$$

At $t = DT$, $V_0 = V_{min}$, $V_0 = V_{max}$ at $t = 0$ or T

$$V_{0(min)} = V_{0(max)}\, e^{-\frac{DT}{RC}}$$

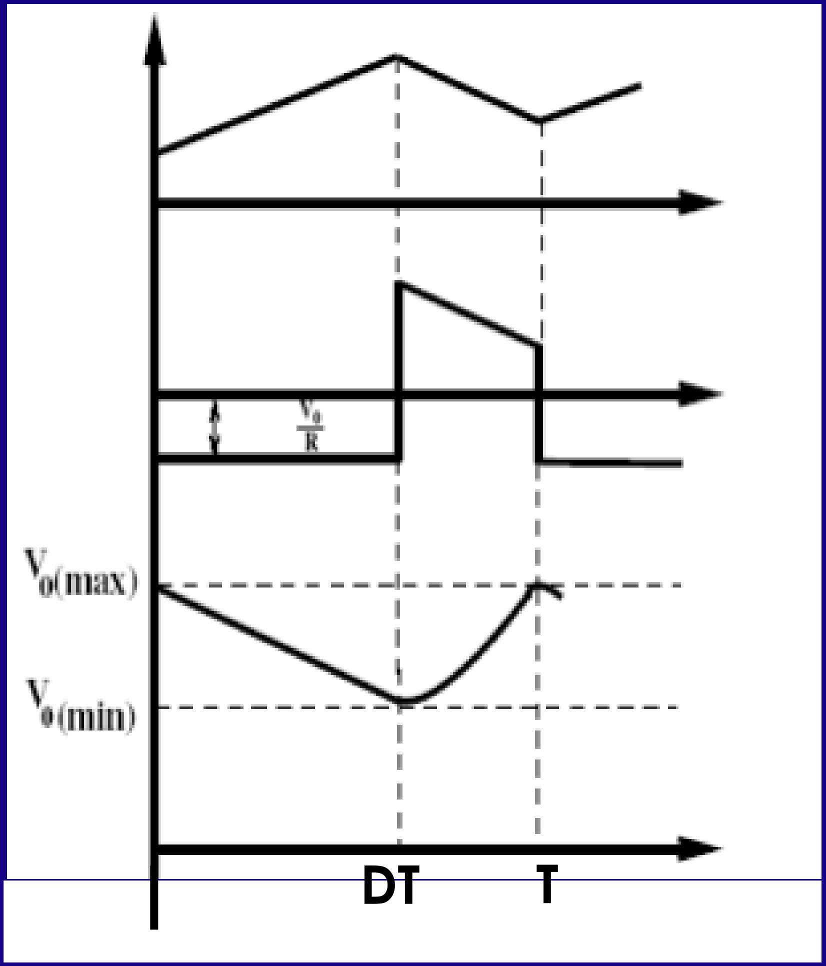
$$I = C\frac{dV_0}{dt} + \frac{V_0}{R} \qquad DT < t < T$$

$$RC\,\frac{dV_0}{dt} + V_0 = RI$$

$$\therefore\ V_0 = (V_{0(min)} - RI)\, e^{-\left(\frac{t - DT}{RC}\right)} + RI$$

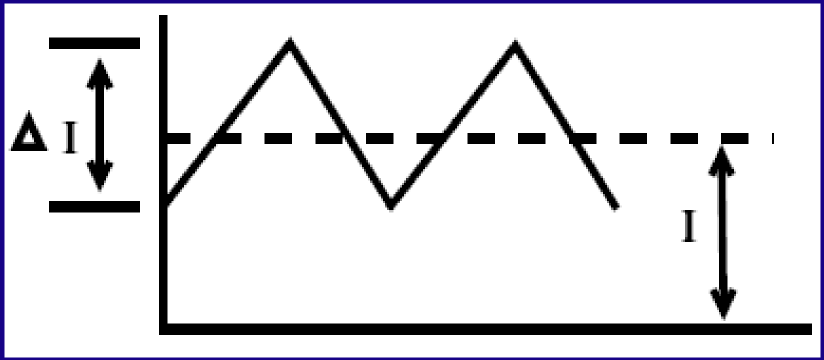
$V_0 = V_{0(max)}$ at $t = T$

$$\therefore\ \Delta V_0 \approx RI(1-D)\frac{DT}{RC}$$



Discontinuous current:

$$\text{Av. value of source } I = \text{inductor } I = \frac{V_{DC}}{R(1-D)^2}$$



The above I is always +ve

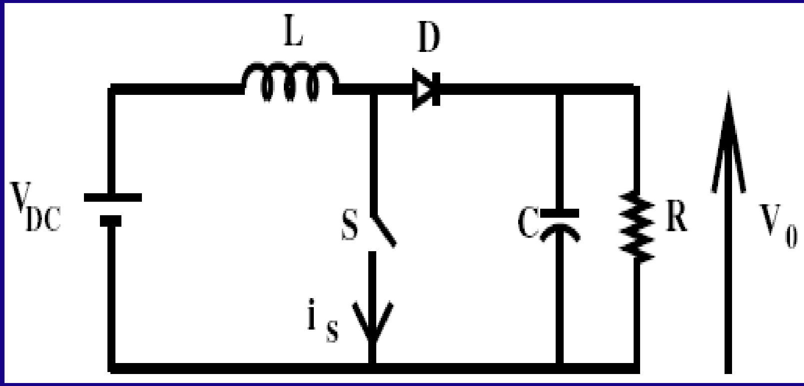
$$\text{if} \quad > \frac{\Delta I}{2}$$

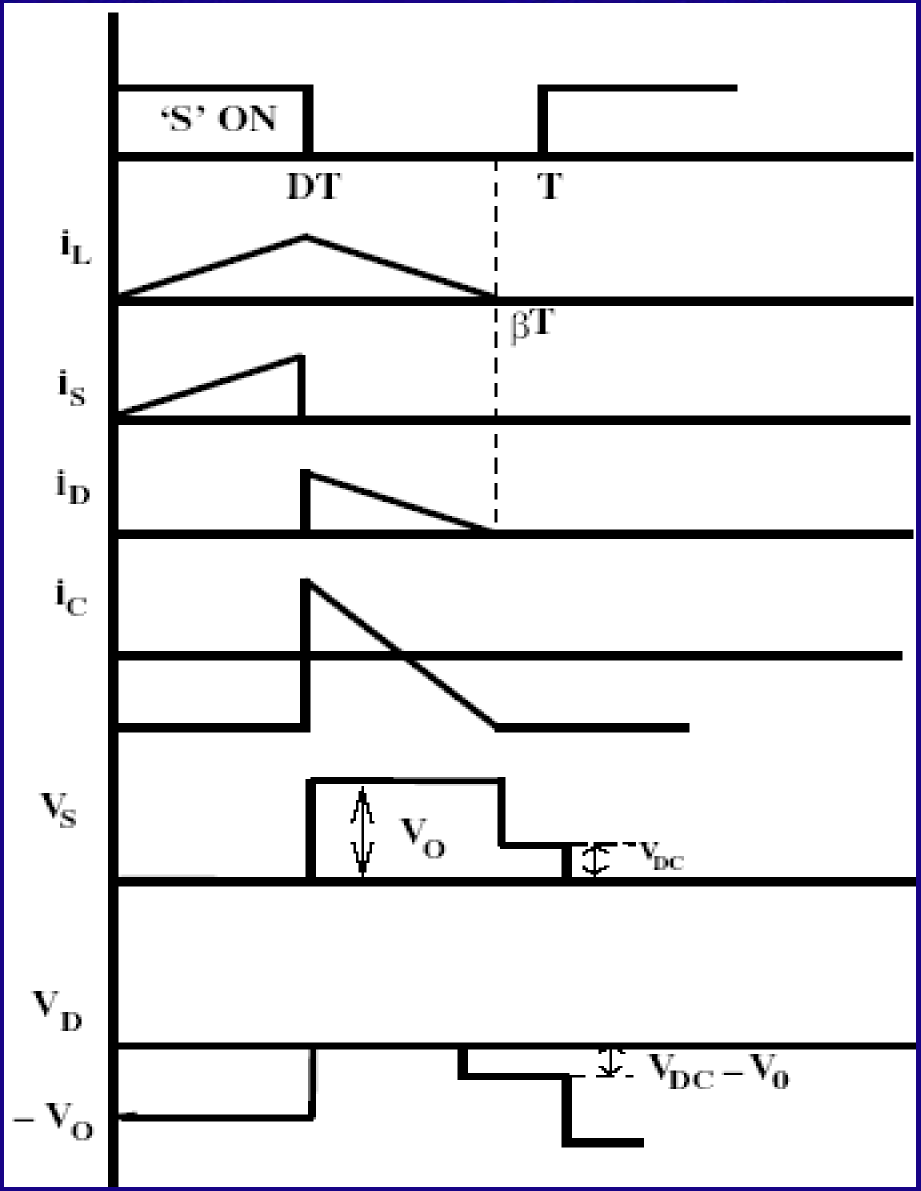
$$> \frac{V_{DC}}{2L} DT$$

$$\therefore R_{CR} \le \frac{2L}{(1-D)^2 DT}$$

If load $R > R_{CR}$

Inductor $I \Rightarrow$ Discontinuous


L
D
V_DC
S
C
R
V_0
i_S


'S' ON
DT
T
i_L
βT
i_S
i_D
i_C
V_S
V_O
V_DC
V_D
– V_O
V_DC – V_0

$$i_L = \frac{V_{DC}}{L} t \quad \text{for } 0 < t < DT$$

$$L \frac{di_L}{dt} = V_{DC} - V_0 \quad \text{for } DT < t < \beta T$$

$$i_L = \frac{V_{DC}}{L} DT + \frac{V_{DC} - V_0}{L}(t - DT)$$

$$i_L = 0 \quad t = \beta T$$

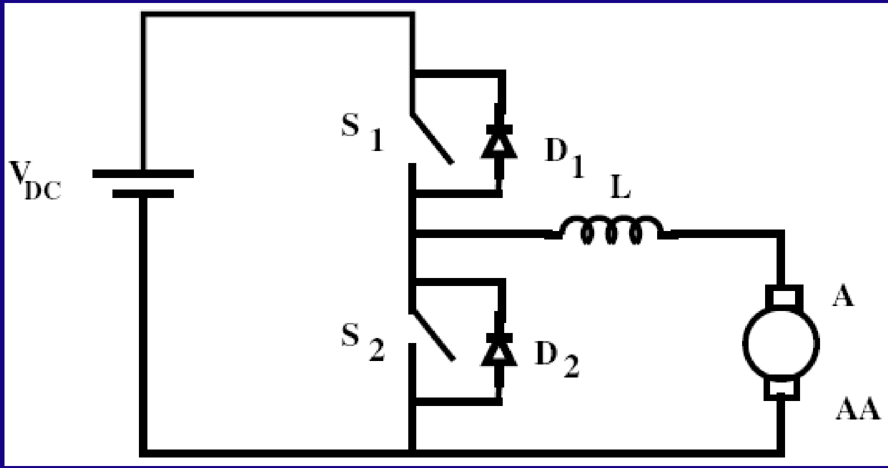
$$\therefore \frac{V_{DC}}{L} DT + \frac{V_{DC} - V_0}{L}(\beta - D)T = 0$$

$$V_0 = \frac{\beta}{\beta - D} V_{DC}$$

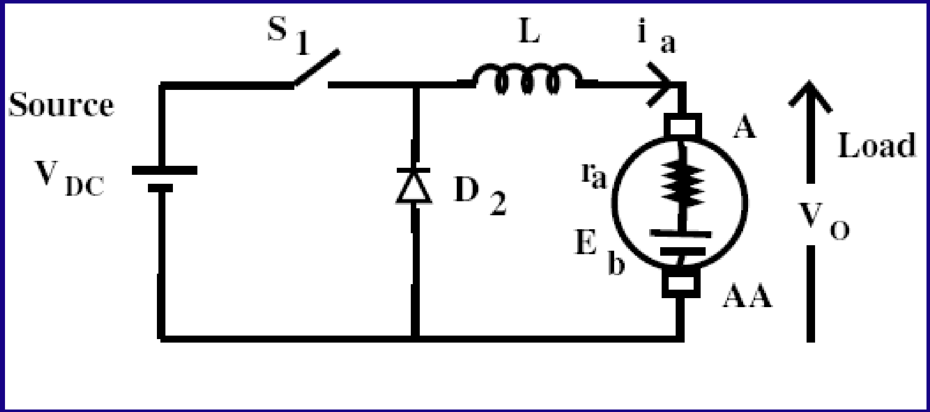
$$\beta < 1 \ \ \& \ D < \beta$$

$$\therefore \frac{\beta}{\beta - D} > \frac{1}{1 - D}$$

Use of boost & buck converter in speed control of DC motor



'S_2' is kept open & 'S_1' is controlled

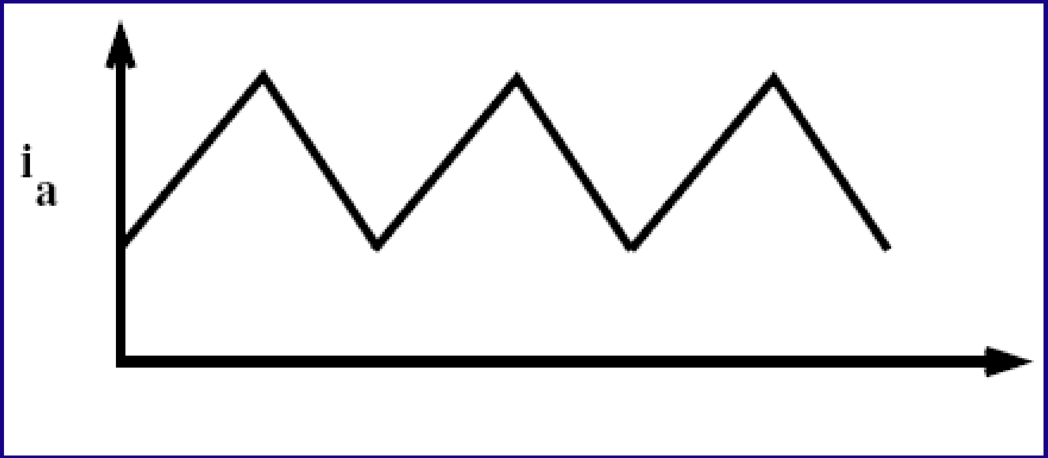


Buck Converter:

$$V_0 = V_{DC} D$$

for $0 < \omega < \omega_{rated}$

$$0 < D < 1$$



Regenerative braking

Keep S_1 open & control S_2 :

During Regenerative braking

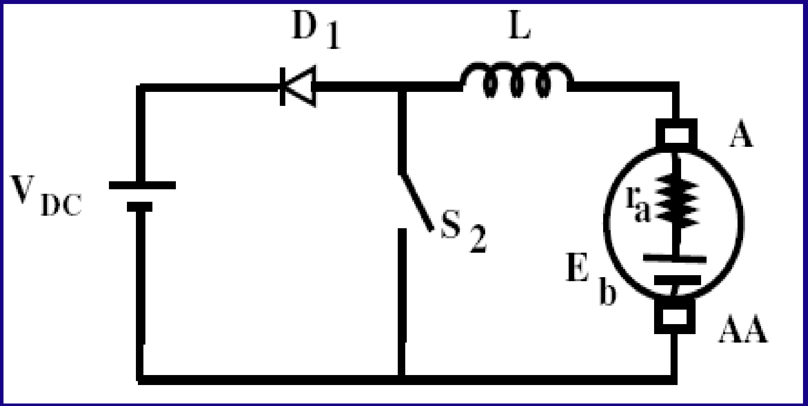
Source $\rightarrow$ Load & load $\rightarrow$ Source

i_a should leave 'A' terminal

Neglect 'r'

During motoring mode

$$V_{DC} > V_0 = E_b + i_a r_a$$



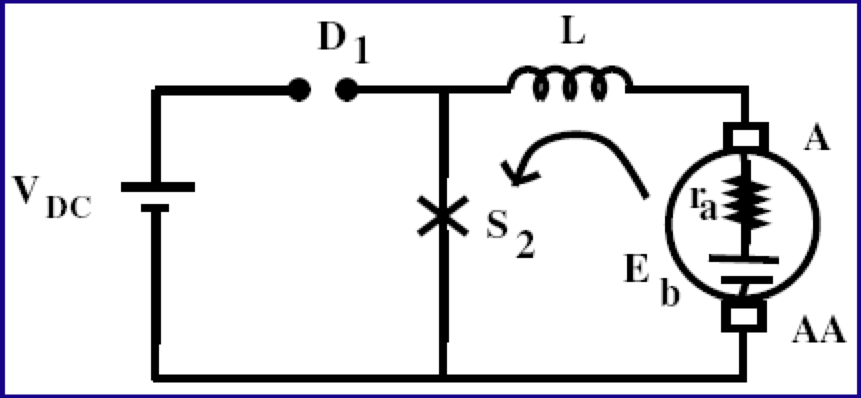
Boost converter

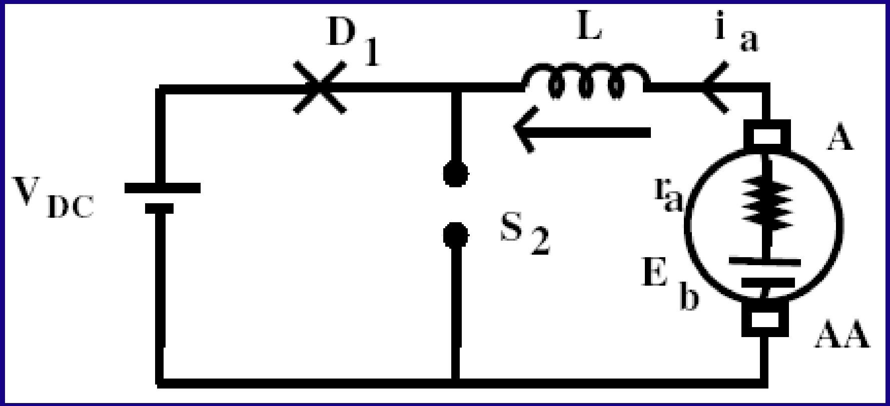
with 'E$_b$' as source &

V_{DC} as Load

$E_b < V_{DC}$

Close 'S' : After a while open 'S'



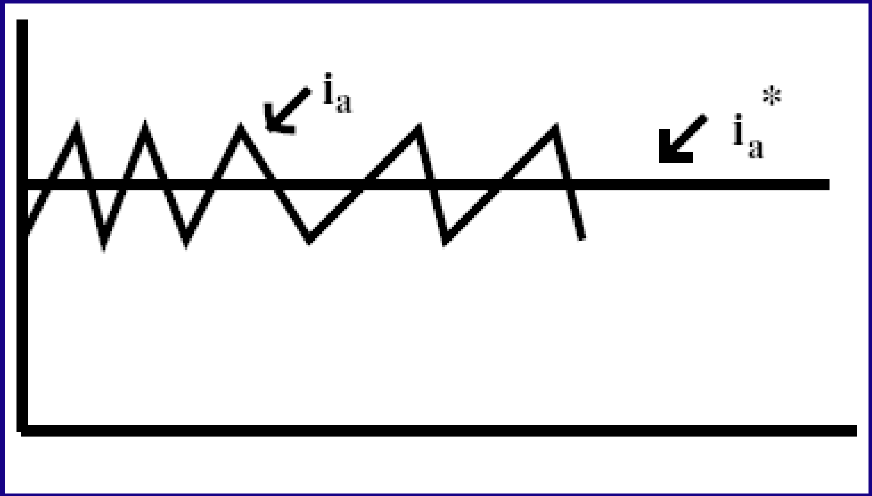


Stored energy is fed back to the source

Braking with constant $T = -K\varphi i_a$

$i_a^* \rightarrow$ reference i_a

Control 'i_a' within the Hysteresis band.



$\Rightarrow$ No mech. o/p

$\Rightarrow \therefore \omega$ & $E_b \downarrow$

Forcing function $(E_b)\downarrow$

$\Rightarrow$ For same 'i_a', 'S' is closed for a longer time.