Re view :

1.AC $\rightarrow$ Avg. value of o/p V = 0

$\rightarrow$ There has to be AC to

DC conversion to provide input DC

Features

$\Rightarrow$ Input is 12V DC

O/P - 230V, 50Hz AC

Induction Machine

$\rightarrow$ For $T_L = \text{constant}$

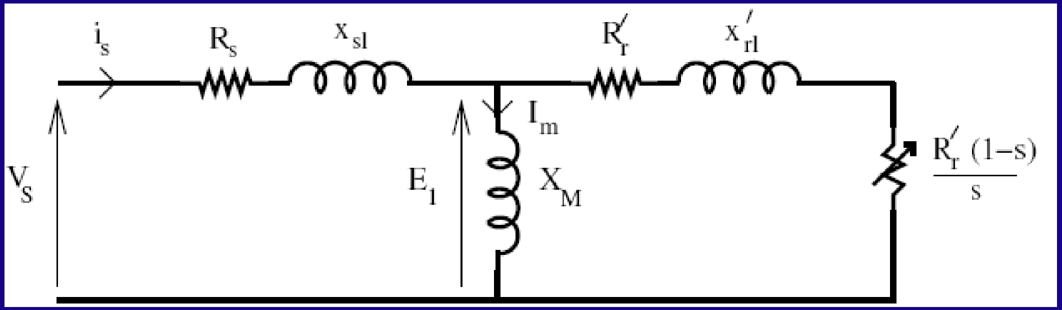
Input power is ; Constant

and independent of speed

For wide variation in speed N_s has to be changed

$$\overline{I_M} \;;\quad \frac{\overline{E_1}}{2\,\pi\,F\,L_M} \;;\quad \frac{V_s}{2\,\pi\,F\,L_M}$$

What is the relationship between the magnitude of o/p voltage and frequency?:

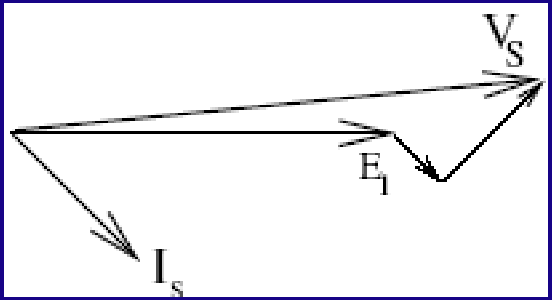


$$T \propto F_{SR}\, F_r \sin \angle_{F_{SR}}^{F_r}$$

$$\propto \Phi\, I_r'$$

$$\propto I_M\, I_r'$$

$$\overline{I_M} = \frac{\bar{E}_1}{2\pi F L_M}$$



Generally R_S and x_{Sl} are small

Also at relatively high 'F' (25 - 50Hz)

$$|E_1| \approx |V_S| \qquad \therefore\ \overline{I_M} = \frac{\overline{V_S}}{2\pi F L_M}$$

Case 1: V_s constant & $\downarrow$ F to $\downarrow$ N_s

$|I_M| \uparrow \Rightarrow \Phi$ tends to $\uparrow$

All magnetic circuits operated at the knee point

If magnetising AT $\uparrow$, core gets saturated.

$\Rightarrow$ I/p 'I' becomes peaky and core loss $\uparrow$

Case 2: Keeping V_s constant and $\uparrow$ F to $\uparrow$ $\underline{\underline{N_s}}$

$$\Rightarrow I_M = \frac{V_S}{2\pi F L_M} \downarrow \quad \Rightarrow \Phi \downarrow$$

Ns increases Nr increases

to increase the speed of the induction machine we can increase the frequency or weaken the field

$\Rightarrow$ If $V_S = V_{rated}$ & F is $\uparrow$ above F_{rated}

N_S and $\therefore$ N_r also $\uparrow$ above rated.

$\Rightarrow |\Phi| \downarrow$

$\Rightarrow$ similar to field weakening mode of DC motor

[V_a constant & I_F $\downarrow$]

$\Rightarrow$ Possible mode of operation

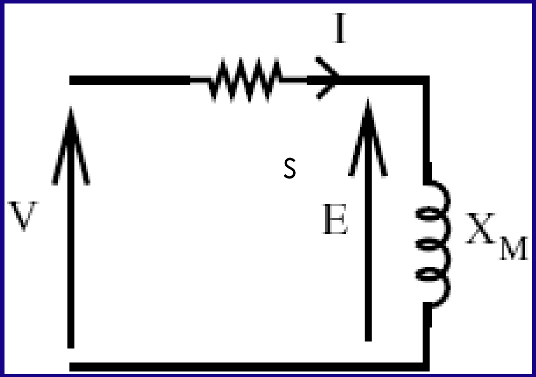
$\Rightarrow$ DC / AC converter should have the feature

that $|V_S| = V_{rated}$

and 'F' should be able to $\uparrow$.

Case 3 : In S.E. DC motor, Φ (I_F) was kept constant from 0 to N_{rated}.

$\Rightarrow$ Constant Φ operation

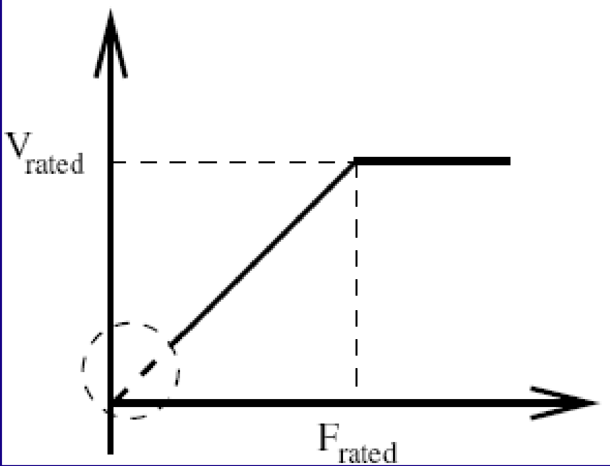


$$I_M \propto \Phi \; ; \quad \frac{V}{2\pi F L_M}$$

If $\frac{V}{F}$ is held constant, 'Φ' remains constant.

At low 'F', $x_{Sl} \rightarrow 0$, circuit is DC

$V = E + I_s R$



⇒ DC - AC converter should have another feature

⇒ Variable voltage & variable 'F' (VVVF)

Majority of DC-AC converters used in AC drives

High frequency induction heating, surface hardening

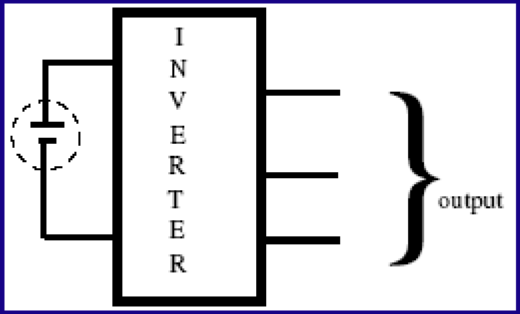
Types of Inverters :

If the input to the inverter is a voltage source

$\Rightarrow$ Battery or large 'C' [input 'Z' $\rightarrow$ 0]

$\Rightarrow$ Voltage Source Inverter [V.S.I]

$\Rightarrow$ 'I' can reverse & not 'V'

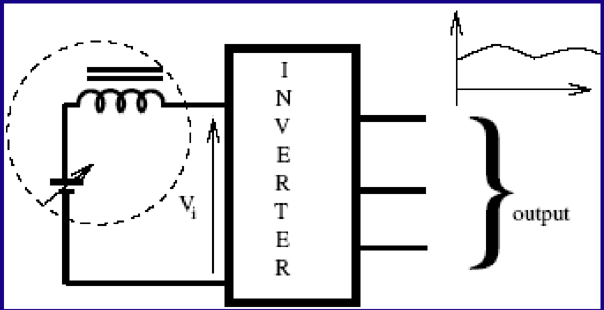


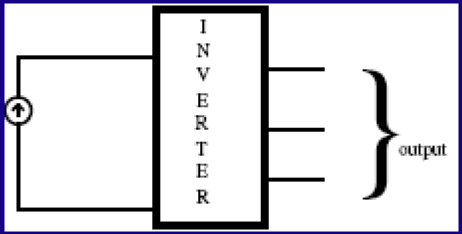
$\Rightarrow$ If it's a current source

$\Rightarrow$ Current Source Inverter [C.S.I]

$\Rightarrow$ 'V_i' can reverse and not 'I'

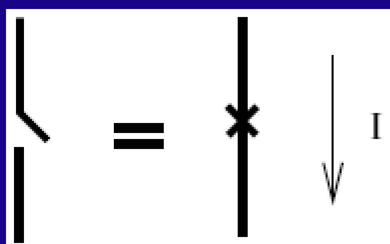
$\Rightarrow$ Input L is very high

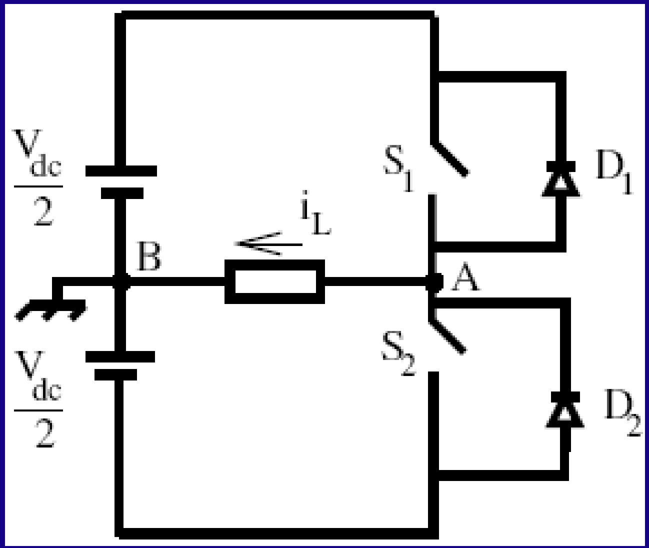




Circuit configuration of V.S.I :

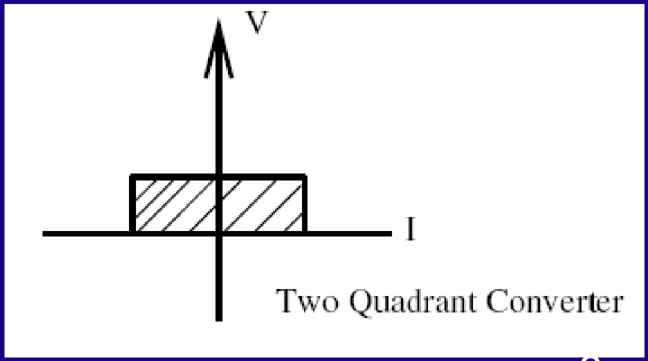
Basic Block: $\frac{1}{2}$ Bridge





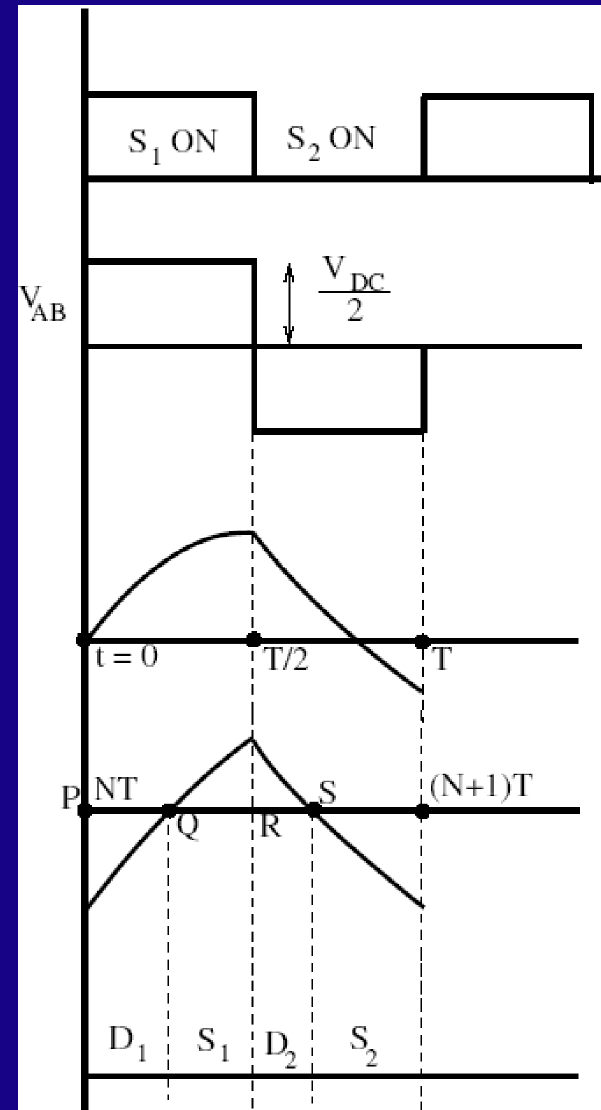
Since 'i' can reverse, switches should be able to carry bi-directional I

$\Rightarrow$ Connect a diode in anti parallel



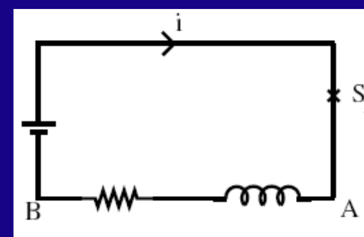
<u>In VSI</u> :

Switching signals for S_1 & S_2 (same leg) are always <u>complimentary</u>. (ideal condition)



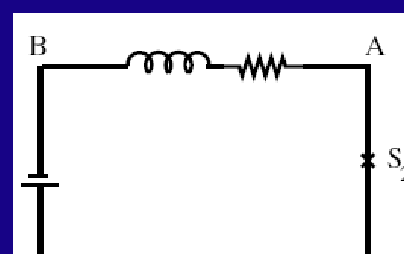
<u>S_1 ON</u> :

For $\frac{T}{2}$ duration, $V_{AB} = \frac{V_{DC}}{2}$



<u>load</u> = R-L

$$i = \frac{V}{R}\left[1 - e^{-\frac{t}{\tau}}\right]$$



<u>S_1 OFF and S_2 ON</u> :

$$V_{AB} = -\frac{V_{DC}}{2}$$

'i' will decay and become negative.

Observations :

Time for which S_1/S_2 is ON will determine the frequency of 'V_0 '.

$\Rightarrow$ if $\frac{T}{2}$ = 10 msec, F = 50 Hz

= 100 msec, F = 5 Hz

At Steady State :

P-Q : V applied to the load = +ve

i_L is -ve [i flowing from B to A]

$\Rightarrow$ 'D_1' is carrying 'I'

Q-R : 'V' and 'I' are +ve

'S_1' is carrying 'I'

R-S : 'V' is -ve and 'i' is +ve

'D_2' is carrying 'I'

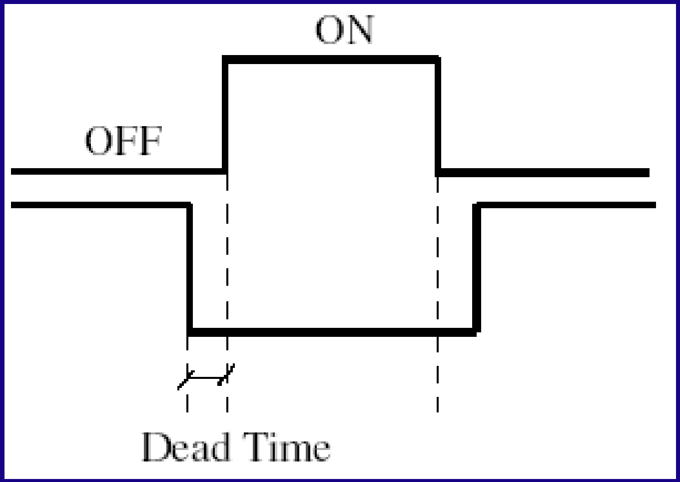
S-T : 'V' and 'I' are -ve

'S_2' is carrying 'I'

If load is not purely resistive, switch should have a diode across it.

<u>Dead Time</u> :

To avoid shoot through across DC Bus



$\Rightarrow$ Input 'V' = V_{DC}

Output V = $\frac{V_{DC}}{2}$

$\Rightarrow$ Has 3rd, 5th, 7th ... all odd harmonics.

THD $\approx$ 48 %