Chapter Eight

AC TO AC Converters

8.1: Introduction: -

Ac-ac converters broadly define a set of power electronic topologies that are employed to obtain ac output of variable amplitude and frequency from fixed ac input without employment of bulky reactive components. A converter that gives variable amplitude ac is known as AC regulator or AC controllers and that employed for variable-frequency ac is known as cyclo-converter. Depending on the operation of thyristors, cyclo-converters can be naturally commutated (NCC) or forcefully commutated (FCC). Variation of the frequency in the NCC is restricted to only half of the supply frequency.

8.2 AC regulator or AC controllers

8.2.1: Single phase SCR full-wave AC-regulator

The current of SCR flow in only one direction, therefore two SCRs are connected in an inverse parallel configuration to control AC current.

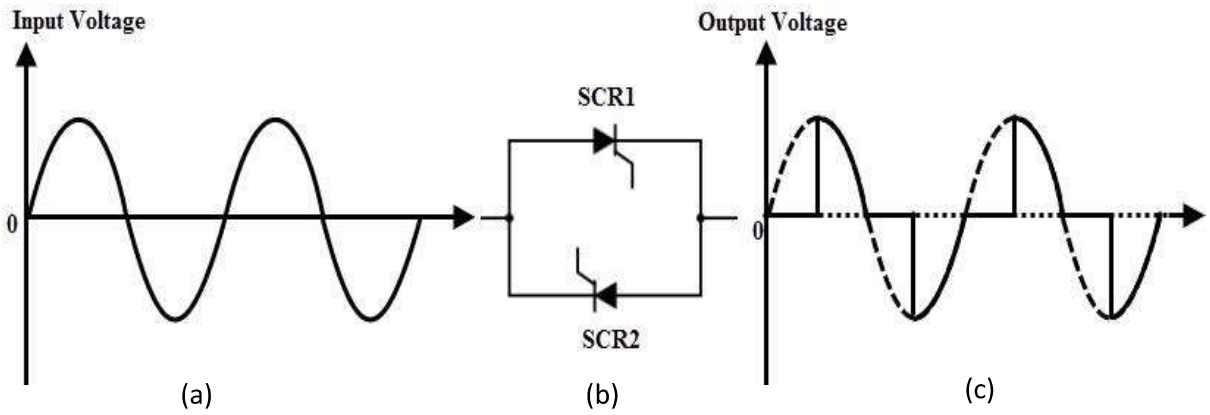


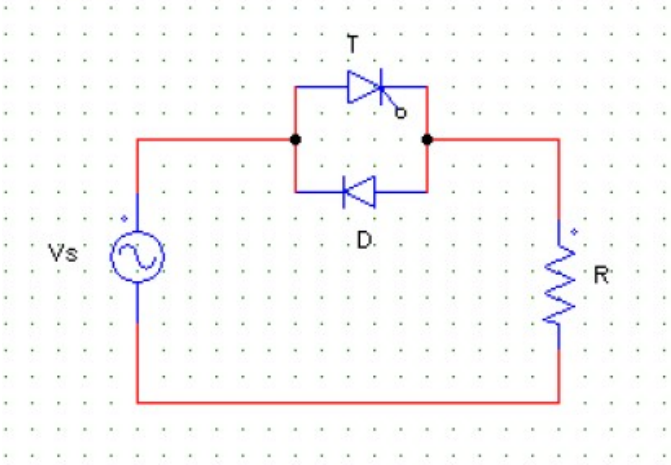
Fig. (8-1) AC back to back switch (a) input wave (b) power circuit (c) output wave

Advantage of Back to back switch

1- Reliability
2- Low loses
3- Speedy turn-on and turn off

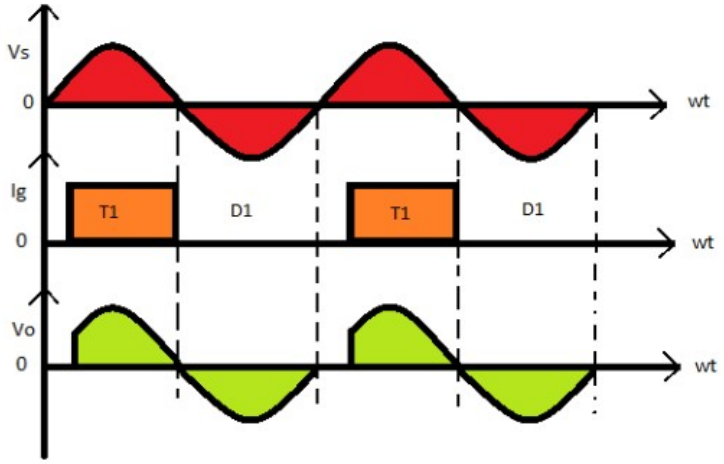
8.2.2: Single phase half-wave Ac-controller

This convertor consists of an inverse parallel pair (SCR and Diode) as shown in figure bellow, also called THYRODE.



Working:

- In positive half cycle of AC supply SCR S is turn ON at ωt=α. during this load voltage is positive now SCR will be turn OFF due to natural commutation at ωt=π. load current and source current are positive.
- In negative half cycle of AC supply Diode D1 will turn ON at ωt=π. During these cycle load voltage is negative. and load current and source current are negative.
- By controlling the firing angle α of the SCR we can control AC load voltage.



The conduction time is controlled by raring α

$$v_{o\,rms} = \frac{v_m}{\sqrt{2}}\left[\frac{(\pi-\alpha)+0.5\sin(2\alpha)}{\pi}\right]^{0.5}$$

Power factor P.F = $\frac{P_{o\,rms}}{V.A}$ where, A= the rms value of load current,

V=$\frac{v_m}{\sqrt{2}}$

$$p_{o\,rms} = \left[\frac{(\pi-\alpha)+0.5\sin(2\alpha)}{\pi}\right]^{0.5}$$

The average value of SCR current

$$I_{scr} = \frac{I_m}{2\pi}[1+\cos\alpha]$$

$$I_m = \frac{v_m}{R}$$

$$I_{scr} = \frac{V_m}{2\pi R}[1+\cos\alpha]$$

EX.8-1] Thyristor AC Controllers with 7Ω resistive load is connected to ac voltage source $v_{in} = 350sin315t$, if the conduction time of each thyristor is (2.5msec), calculate the load power.

Ans.

$$\emptyset_c = \omega \times t_c = 315 \times 2.5 \times 10^{-3} = 0.7875\,rad = 45°$$

$$\alpha = 180 - \emptyset_c = 180 - 45 = 135° = 2.354\,rad$$

$$v_{o\,rms} = \frac{v_m}{\sqrt{2}}\left[\frac{(\pi-\alpha)+0.5\sin(2\alpha)}{\pi}\right]^{0.5}$$

$$v_{o\,rms} = \frac{350}{1.414}\left[\frac{(3.15-2.354)+0.5\sin(2*135)}{3.14}\right]^{0.5} = 75.3\text{ v}$$

The load power $p_L = \frac{V_{O\,rms}{}^2}{R} = \frac{75.3^2}{7} = 810\,watts$