

5.2 SINGLE-PHASE HALF-WAVE AC VOLTAGE CONTROLLER

- It consists of one thyristor in antiparallel with one diode.
- Then SCR is forward biased during positive half cycle, it is turned on at firing angle α .
- Load voltage at once jumps to $V_m \sin \omega t$, likewise load current becomes $V_m \sin \alpha$.
- Thyristor get turned off at $\omega t = \pi$ for R load. After $\omega t = \pi$, negative half cycle forward biases diode D1, therefore D1 conducts from $\omega t = \pi$ to 2π .
- Only positive half cycle onduction can be controlled, by varying firing angle. negative half cycle cannot be controlled. So single-phase half wave voltage controller is also called single phase unidirectional voltage controller. From the Figure it is understood that positive half cycle is not identical with negative half-cycle for both voltage and current waveforms. As a result, dc component is introduced in the supply and load circuits which is undesirable.

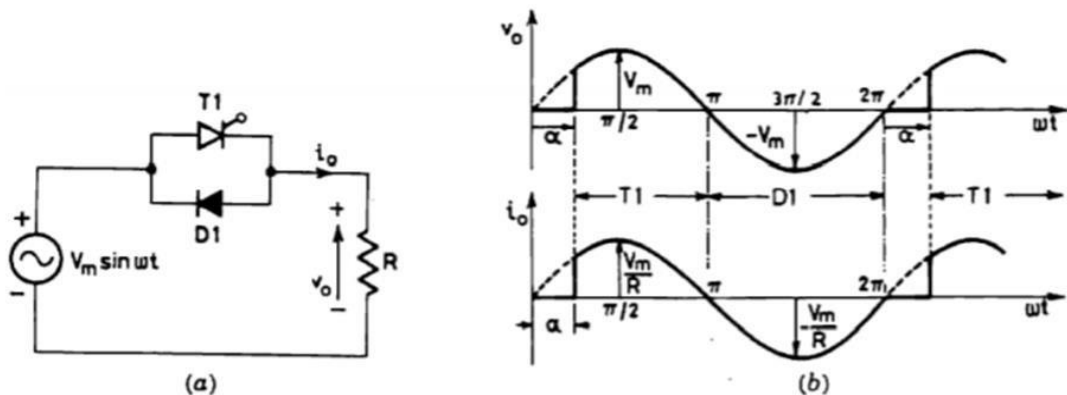


Figure 5.2.1 Single Phase AC voltage controller

RMS VALUE OF OUTPUT VOLTAGE OF SINGLE PHASE UNIDIRECTIONAL VOLTAGE CONTROLLER:

$$V_{or} = \pi \left[\frac{1}{2\pi} \int_{\alpha}^{2\pi} V_m^2 \sin^2 \omega t d(\omega t) \right]^{\frac{1}{2}}$$

$$V_{or}^2 = \frac{V_m^2}{4\pi} \int_{\alpha}^{2\pi} (1 - \cos 2\omega t) d(\omega t)$$

$$V_{or}^2 = \frac{V_m^2}{4\pi} \left[(2\pi - \alpha) + \frac{\sin 2\alpha}{2} \right]$$

$$V_{or} = \frac{V_m}{2} \left[\frac{1}{\pi} \left[(2\pi - \alpha) + \frac{\sin 2\alpha}{2} \right] \right]^{\frac{1}{2}}$$

$$I_{or} = \frac{V_{or}}{R}$$

AVERAGE VALUE OF OUTPUT VOLTAGE:

$$V_o = \left[\frac{1}{2\pi} \int_{\alpha}^{2\pi} V_m \sin \omega t d(\omega t) \right]$$

$$V_o = \frac{V_m}{2\pi} (-\cos \omega t)_{\alpha}^{2\pi}$$

$$V_o = \frac{V_m}{2\pi} (\cos \alpha - 1)$$

SINGLE PHASE FULL WAVE AC VOLTAGE CONTROLLER

- It consists of two SCRs connected in antiparallel.
- During positive halfcycle T1 is triggered at firing angle α , it conducts from $\omega t = \alpha$ to π for R load.
- During negative half cycle, T2 is triggered at $\omega t = \pi + \alpha$, it conducts from $\omega t = \pi + \alpha$ to 2π .

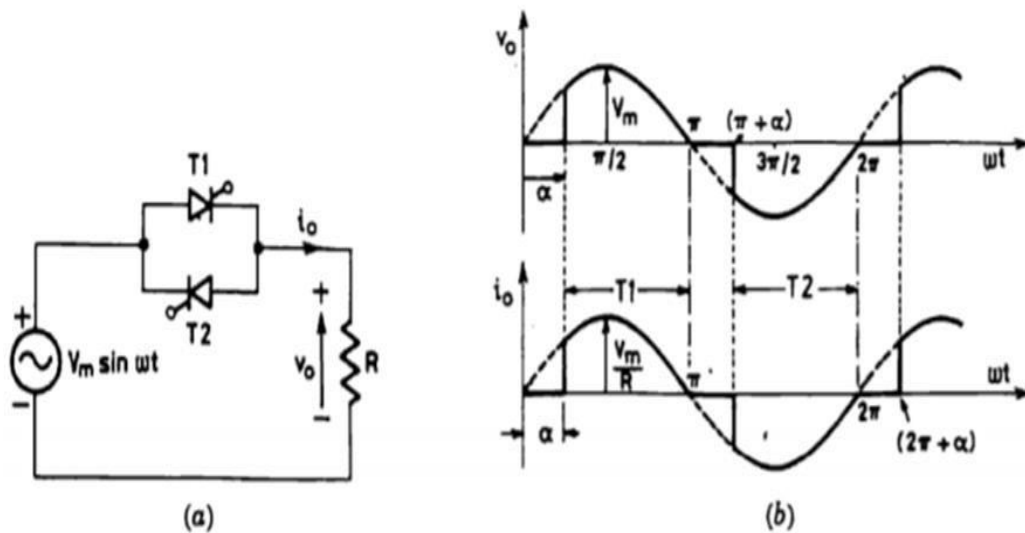


Figure 5.2.2 Single-phase full-wave ac voltage controller

[Source: "Power Electronics" by P.S.Bimbra, Khanna Publishers Page: 397]

- It has been stated above that ac voltage controllers are phase-controlled converters, the phase relationship between the start of load current and the supply voltage is controlled by varying the firing angle. These are called phase- controlled ac voltage controllers or ac voltage controllers. Single phase full-wave ac voltage controller is also called single phase bidirectional voltage-controller.