Voltage Controllers

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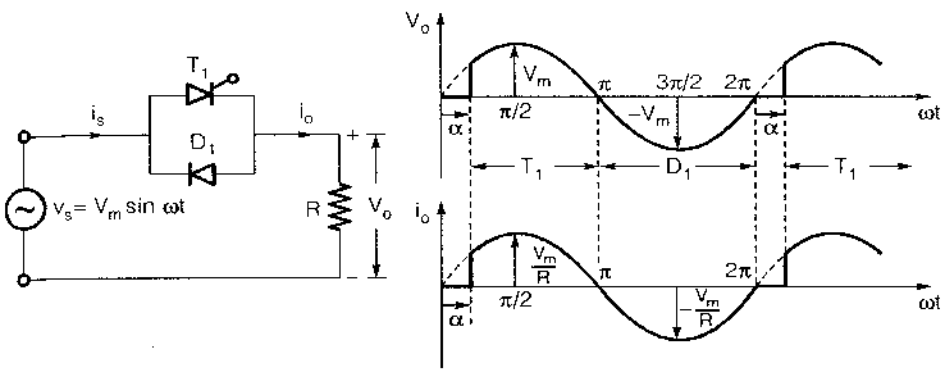
AC Voltage Controllers

A.C. voltage controllers are thyristor based devices which convert fixed alternating voltage directly to variable alternating voltage without, change in the frequency.

1. Single phase half wave ac voltage controller



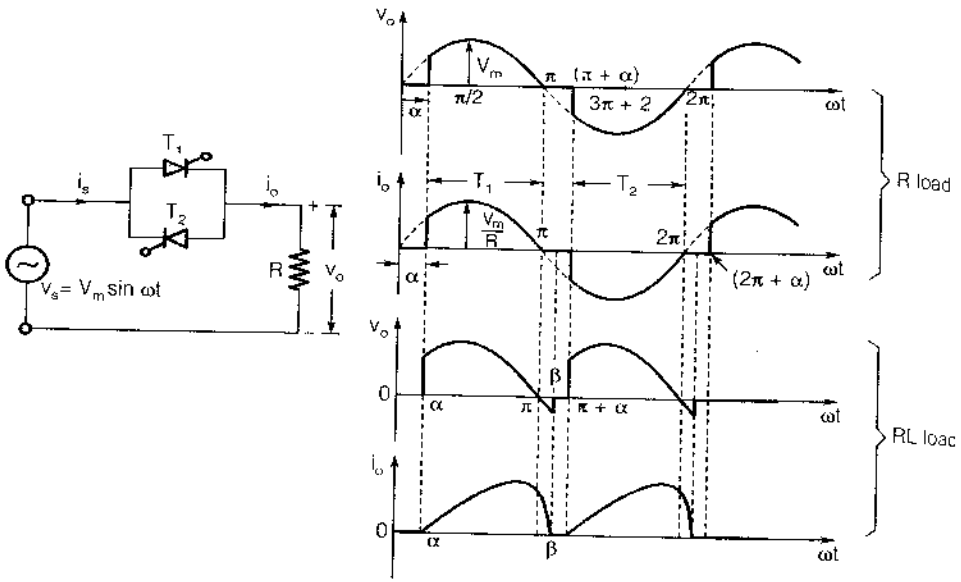
- RMS value of output voltage

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

- Average value of output voltage

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

2. Single phase full wave ac voltage controller



- RMS value of output voltage for R load

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

- RMS value of output voltage for RL load

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

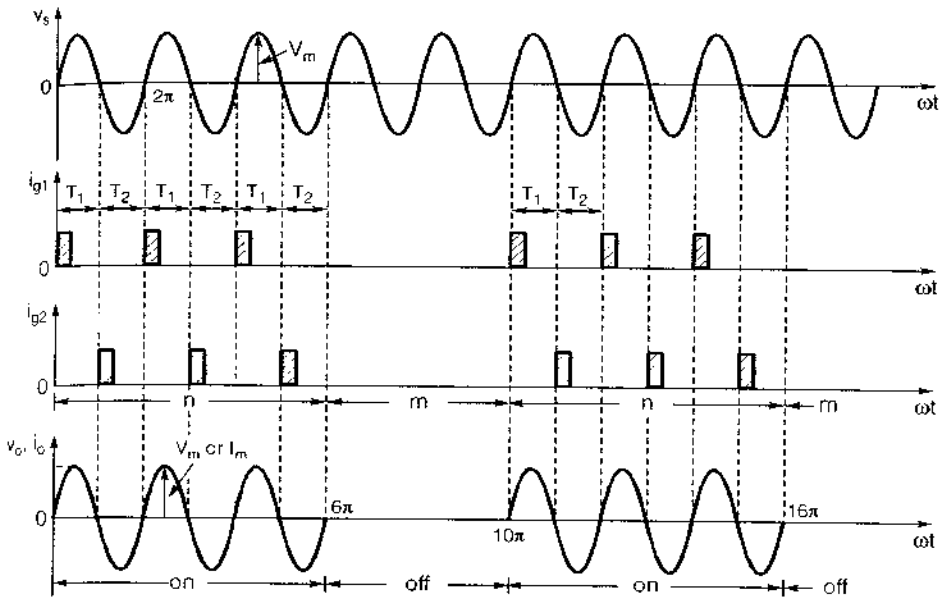
Remember:

- For RL load, output voltage is controllable only when $\alpha > \phi$ where $\phi = \tan^{-1}\frac{\omega L}{R}$.
- Range of α for getting controllable output voltage

$$\phi \le \alpha \le 180°$$

- Average value of output voltage would be zero.

Integral Cycle Control



Integral cycle control for n on-cycles and m off cycles

- Rms value of output voltage

$$V_{or} = \frac{V_m}{\sqrt{2}}\sqrt{\frac{n}{n+m}} = V_s\sqrt{k}$$

where, $k = \frac{n}{n+m}$ = duty cycle of ac voltage controller

V_{or} = RMS value of output voltage
V_s = RMS value of source voltage

- Power delivered to load

$$P = \frac{kV_s^2}{R}$$

- Input power factor

$$p.f. = \sqrt{\frac{n}{n+m}} = \sqrt{k}$$

Note:

- Integral cycle control method is used only for those load which have high time constant.
- AC voltage controller is used for domestic and industrial heating, speed control of 1ϕ and 3ϕ AC drives, starting of induction motors.
- Disadvantage of AC voltage controller is introduction of objectionable harmonics in the supply current and load voltage waveforms.

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