Controlled Three Phase Half Wave Rectifiers

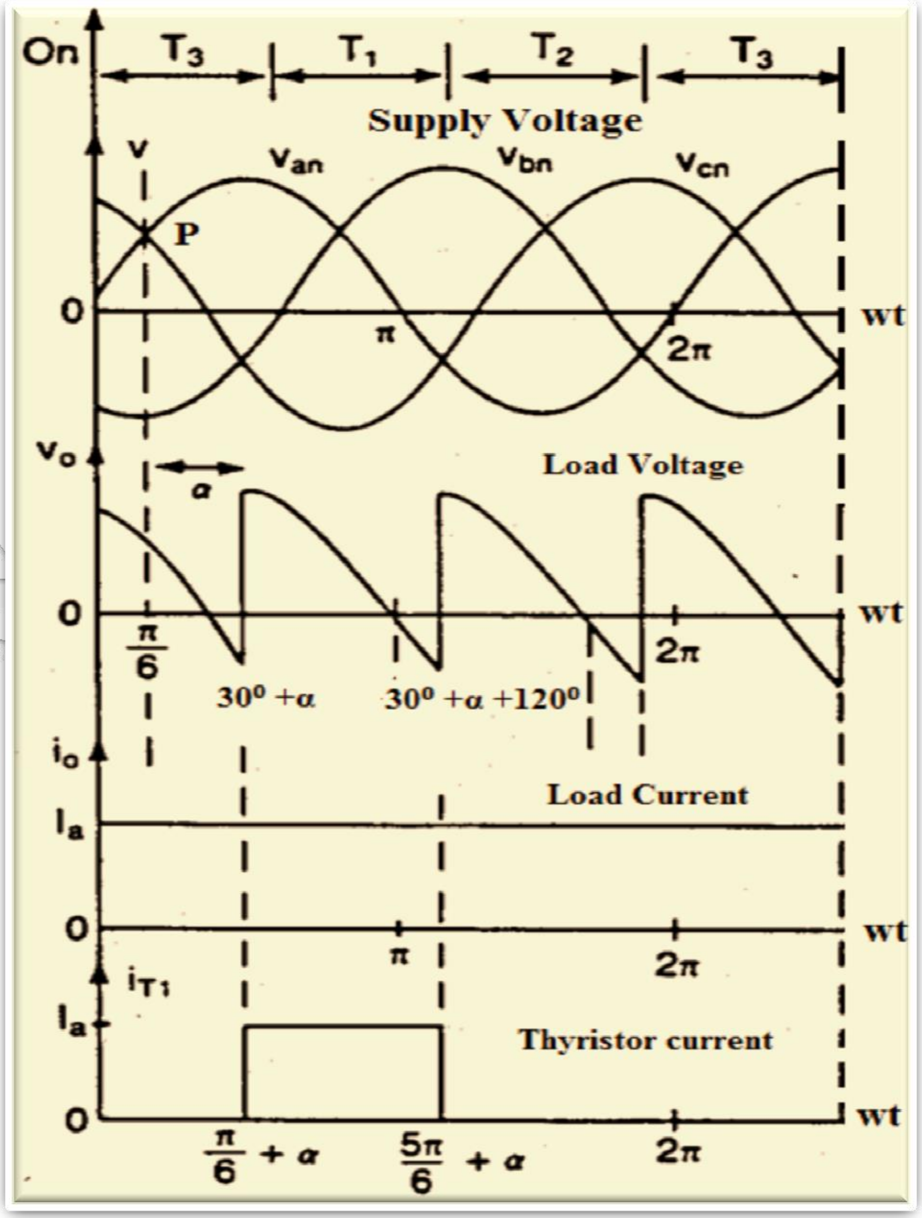
For RL Load

Let

$$V_{an} = V_m \sin\omega t$$

$$V_{bn} = V_m \sin(\omega t\text{-}2\pi/3)$$

$$V_{cn} = V_m \sin(\omega t\text{-}4\pi/3)$$



$$T_1 \textit{ is triggered at } \omega t = \left(\frac{\pi}{6} + \alpha\right) = \left(30^0 + \alpha\right)$$

$$T_2 \textit{ is triggered at } \omega t = \left(\frac{5\pi}{6} + \alpha\right) = \left(150^0 + \alpha\right)$$

$$T_3 \textit{ is triggered at } \omega t = \left(\frac{7\pi}{6} + \alpha\right) = \left(270^0 + \alpha\right)$$

Each thytistor conducts for 120^0 or $\frac{2\pi}{3}$ radians

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For RL Load

Load current is always continuous. The <u>dc component</u> of the output voltage is the average value, and load current is the resistor voltage divided by resistance.

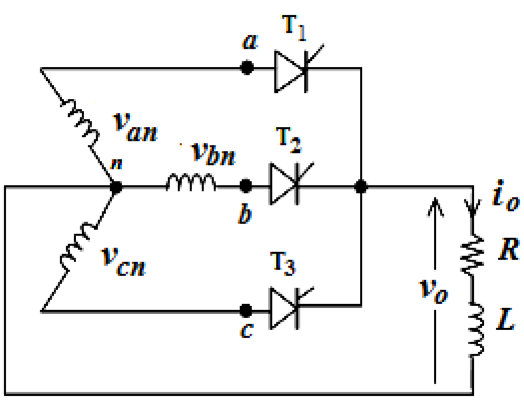
$$V_{dc} = \frac{3}{2\pi}\int_{\frac{\pi}{6}+\alpha}^{\frac{5\pi}{6}+\alpha} V_m \, sin\omega t \, d\omega t = \frac{3\sqrt{3}V_m}{2\pi} cos\,\alpha$$

$$I_{dc} = \frac{V_{dc}}{R} = \frac{3\sqrt{3}V_m}{2\pi R} cos\,\alpha$$

The *rms* component of the output voltage and current waveforms are determined from

$$V_{rms} = \sqrt{\frac{3}{2\pi}\int_{\frac{\pi}{6}+\alpha}^{\frac{5\pi}{6}+\alpha} (V_m sin\omega t)^2 d\omega t} = \sqrt{3}V_m\sqrt{\frac{1}{6}+\frac{\sqrt{3}}{8\pi}cos2\alpha}$$

$$I_{rms} = \frac{V_{rms}}{\sqrt{R^2+(\omega L)^2}} = \frac{\sqrt{3}V_m}{\sqrt{R^2+(\omega L)^2}}\sqrt{\frac{1}{6}+\frac{\sqrt{3}}{8\pi}cos2\alpha}$$



Controlled Three Phase Half Wave Rectifiers

For Resistive Load

In the case of a three-phase half wave controlled rectifier with resistive load, the thyristor T_1 is triggered at ωt=(30°+α) and T_1 conducts up to ωt=180°. When the phase supply voltage decreases to zero, the load current falls to zero and the thyristor T_1 turns off. Thus T_1 conducts from ωt=(30° + α) to (180°).

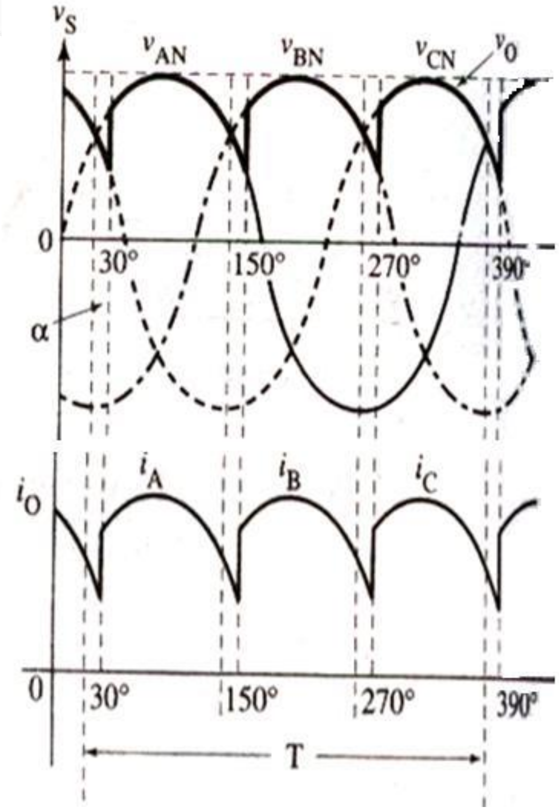
1- *when α≤30°*

$$V_{dc} = \frac{3}{2\pi}\int_{\frac{\pi}{6}+\alpha}^{\frac{5\pi}{6}+\alpha} V_m \sin\omega t \, d\omega t = \frac{3\sqrt{3}V_m}{2\pi}\cos\alpha$$

$$I_{dc} = \frac{V_{dc}}{R} = \frac{3\sqrt{3}V_m}{2\pi R}\cos\alpha$$

$$V_{rms} = \sqrt{\frac{3}{2\pi}\int_{\frac{\pi}{6}+\alpha}^{\frac{5\pi}{6}+\alpha} (V_m \sin\omega t)^2 d\omega t} = \sqrt{3}V_m\sqrt{\frac{1}{6}+\frac{\sqrt{3}}{8\pi}\cos2\alpha}$$

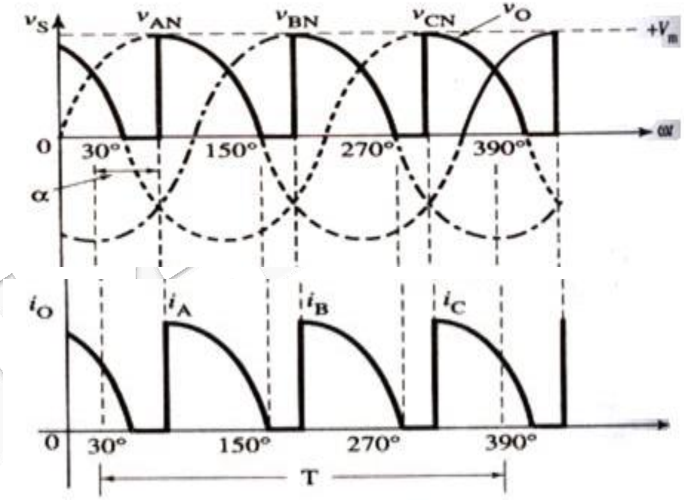
$$I_{rms} = \frac{V_{rms}}{R} = \frac{\sqrt{3}V_m}{R}\sqrt{\frac{1}{6}+\frac{\sqrt{3}}{8\pi}\cos2\alpha}$$



Controlled Three Phase Half Wave Rectifiers

For Resistive Load

2- *when α≥30°*

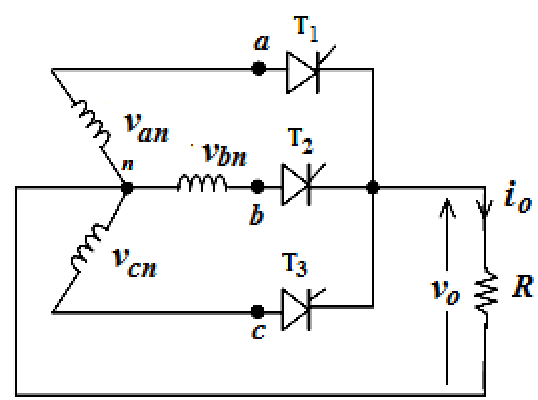


$$V_{dc}=\frac{3}{2\pi}\int_{\frac{\pi}{6}+\alpha}^{\pi} V_m\, sin\omega t\; d\omega t=\frac{3V_m}{2\pi}\left(1+\cos\left(\frac{\pi}{6}+\alpha\right)\right)$$

$$I_{dc}=\frac{V_{dc}}{R}=\frac{3V_m}{2\pi R}\left(1+\cos\left(\frac{\pi}{6}+\alpha\right)\right)$$

$$V_{rms}=\sqrt{\frac{3}{2\pi}\int_{\frac{\pi}{6}+\alpha}^{\pi}(V_m sin\omega t)^2 d\omega t}=\sqrt{\frac{3V_m{}^2}{4\pi}\int_{\frac{\pi}{6}+\alpha}^{\pi}(1-cos2\omega t)d\omega t}$$

$$V_{rms}=V_m\sqrt{\frac{3}{4\pi}\left(\frac{5\pi}{6}-\alpha+\frac{1}{2}\sin\left(\frac{\pi}{3}+2\alpha\right)\right)}=$$



$$I_{rms}=\frac{V_{rms}}{R}=\frac{V_m}{R}\sqrt{\frac{3}{4\pi}\left(\frac{5\pi}{6}-\alpha+\frac{1}{2}\sin\left(\frac{\pi}{3}+2\alpha\right)\right)}$$

Controlled Three Phase Half Wave Rectifiers with Freewheeling Diode