RECTIFIER

Concept of Phase Angle Control

As we know that SCR is 3 terminal devices i.e. Anode, Cathode & Gate. To turn it 'ON' by the gate at some angle with respect to the applied voltage, this firing angle is measured with respect to the given reference at which the firing pulses are applied to the thyristor gates. The reference point is the point at which the application of the gate pulses results in the maximum mean positive DC terminal voltage of which the converter is capable i.e. a firing angle of 0˚ corresponds to the conditions when each thyristor in the circuit is fired at the instant its anode voltage becomes at positive in each cycle, under this condition, therefore, the converter operates in exactly the same manner as it was an uncontrolled rectifier circuit. The symbol 'α' is known as firing angle. Hence the most common method to turn ON the thyristor is achieved by varying the firing angle of the thyristor. This method of thyristor control is known as phase angle control. This method is very efficient for the controlling the average power to the load such as lamps, heaters, motors, dc transmission.

(1) Single Phase Half Wave Controlled Rectifiers With Resistive Load: Single-phase half wave controlled rectifier means that the single SCR is used to convert the ac to dc. During the positive half cycle of the input voltage, thyristor T1 is forward biased and current flows through the load when the thyristor is fired, at ωt = α. The thyristor conducts only when the anode is positive with respect to cathode and a positive gate signal is applied, otherwise, it remains in the forward blocking state and blocks the flow of the load current.

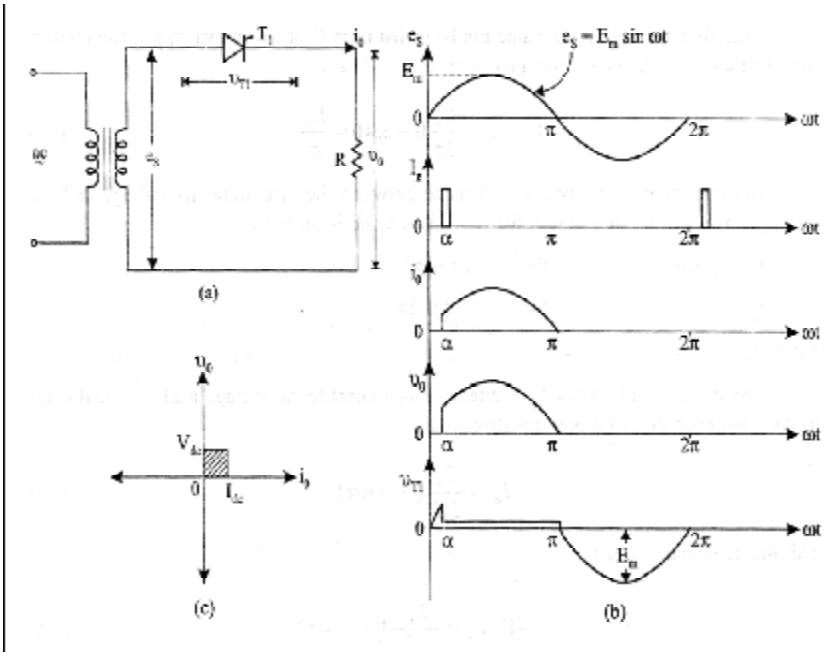


Fig. Single Phase Half Wave Controlled Rectifiers With Resistive Load

In the negative half cycle, i.e., at ωt = π, the thyristor is in the reverse biased condition and no current flows through the load. Thus, varying the firing angle at which the thyristor starts conducting in positive half controls the average dc output voltage –cycle. The waveforms of the above circuit are shown in fig the output load voltage and current is positive, i.e., they are one quadrant; it is called a half –wave semi converter.

The average dc output voltage across load is given by

$V_{dc} = E_m (1+\cos \alpha) / 2\pi$ …….. **(1)**

And

V_{dc} (max.) = E_m / π

Average current is given by

$I_{dc} = E_m (1+\cos \alpha) / 2\pi R$ …….. **(2)**

And, the dc output power is

$P_{dc} = V_{dc} X I_{dc}$ …….. **(3)**

2. Single Phase Half Wave Controlled Rectifiers With RL Load : The single phase half wave controlled rectifier with inductive load is as shown in the following figure.

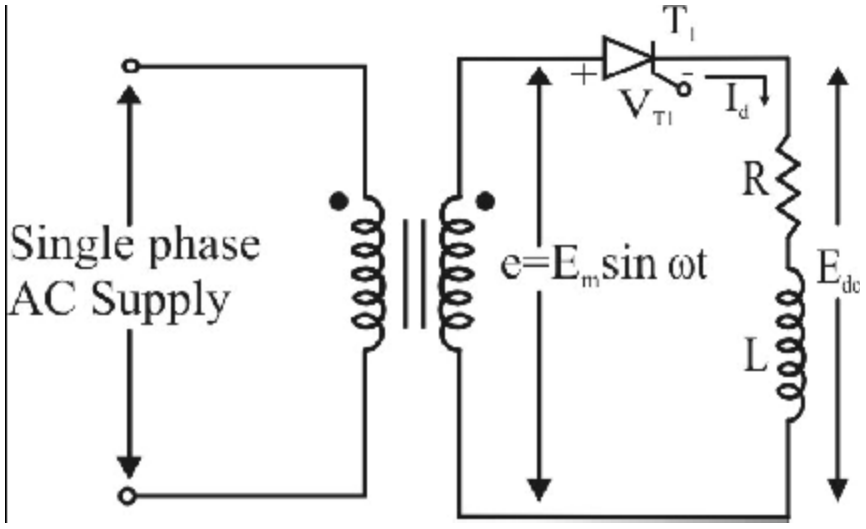
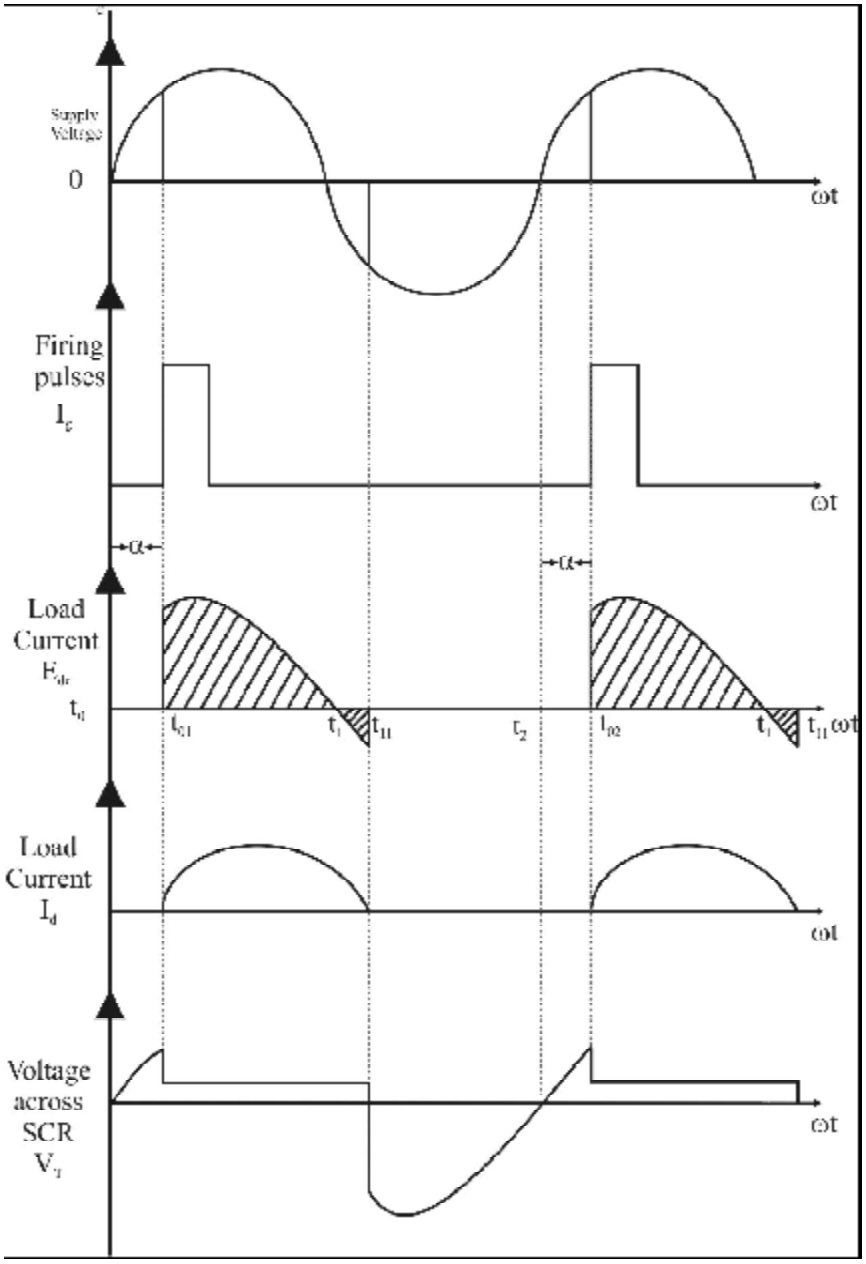


Fig. Single Phase Half Wave Controlled Rectifiers With RL Load



Waveform

The operation of the circuit on the inductive load changes slightly. At instant t_{01}, when the thyristor is triggered, the load current will increase in a finite time through the inductive load. Due to the inductive load, the increase in current is gradual. Energy is stored in the inductor during time t_{01} to t_1. At t_1 the supply voltage reverses but the thyristor is kept conducting because the current through the inductor cannot be reduced to zero.

During negative half cycle the current continuous to flow till the energy stored in the inductor dissipated through the load resistance & a part of energy is fed-back to the source. Hence due to energy stored in the inductor current continuous to flow up to

instant t_{11}. At instant t_{11} the load current is zero & due to negative supply voltage thyristor turns OFF.

(3) Single Phase Half Wave Controlled Rectifiers With RL- Load & Freewheeling diode:

Effect of Freewheeling Diode:

As we know that due to the inductance, the current continues to flow during the negative half cycle. To avoid this unwanted flow of current through the load a diode is connected in parallel with the load to commutate the current away from the rectifier whenever goes into the reverse state. Circuit & waveform of single phase half wave controlled rectifier with L-load & freewheeling diode.

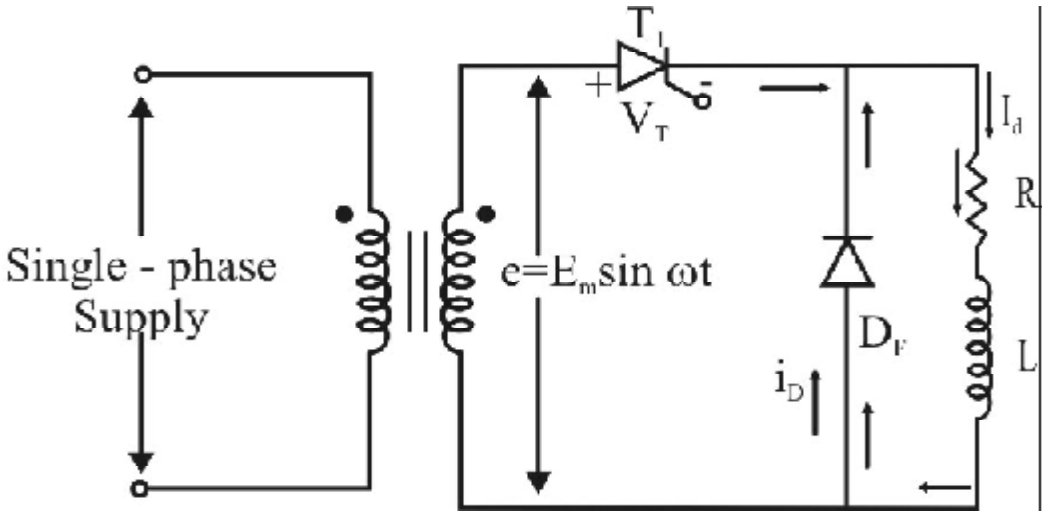
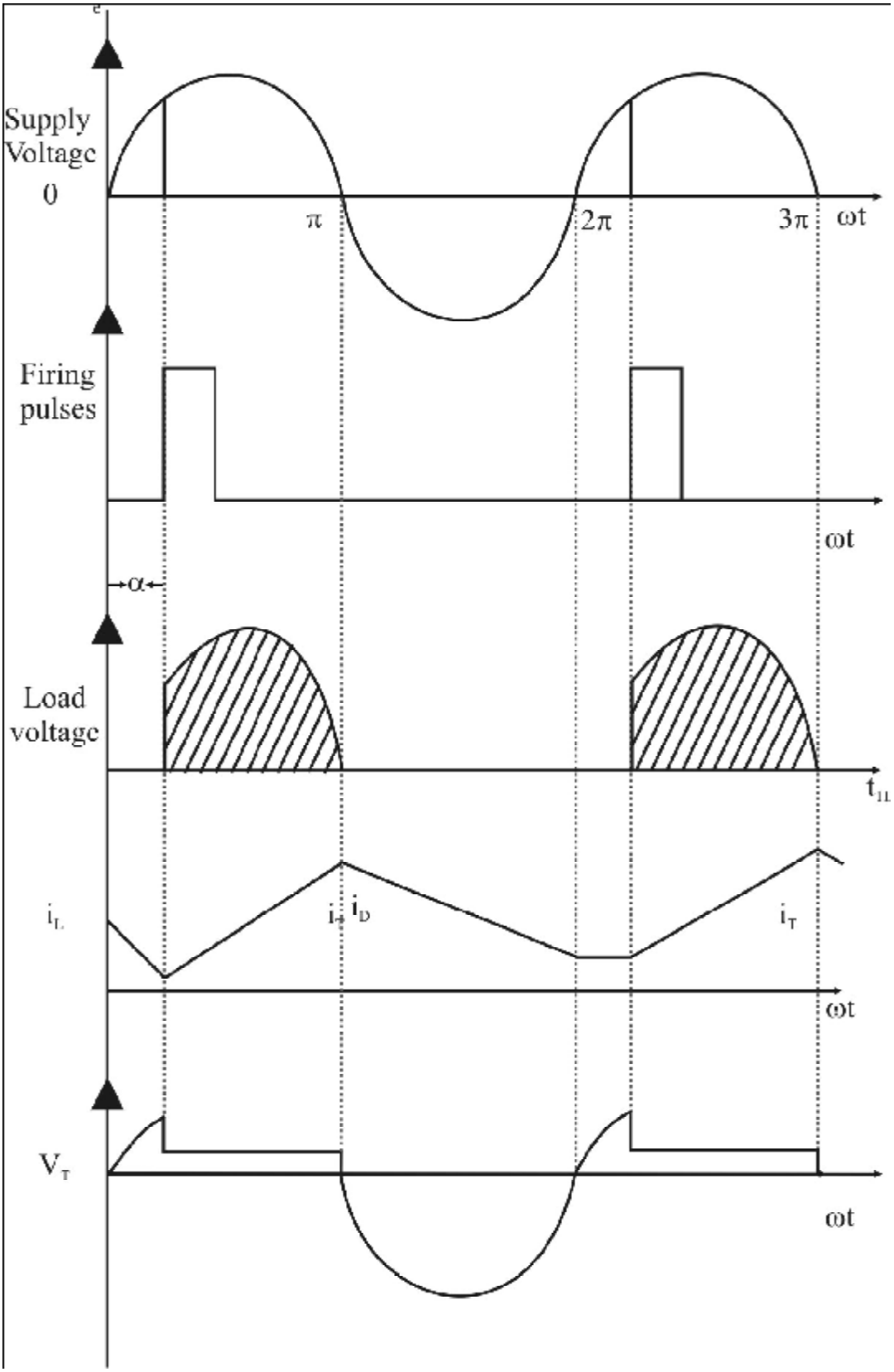


Fig Single Phase Half Wave Controlled Rectifiers With RL- Load & Freewheeling diode


e
Supply Voltage
0
π
2π
3π
ωt
Firing pulses
ωt
α
Load voltage
t
i_L
i_T i_D
i_T
ωt
V_T
ωt

Waveform

This diode serves two main functions:

1. It prevents reversal of load voltage except for small diode voltage drop.

2. It transfers the load current away from the main rectifier by allowing all of its thyristors to regain their blocking states. The following figure shows the half wave controlled rectifier with a freewheeling diode.