Technology Learning Software

AC Chopper

The AC voltage magnitude can be changed by two methods. The well-known first method is by means of step-up and step-down transformers. In this method, change in voltage depends on the value of transformation ratio of the transformer. The second method of changing magnitude of an AC voltage is by means of a solid-state switch. In this method, the AC input voltage is switched on and off periodically by means of suitable switch. Voltage changing circuits employing semiconductor devices as a static switch are known as AC Choppers.

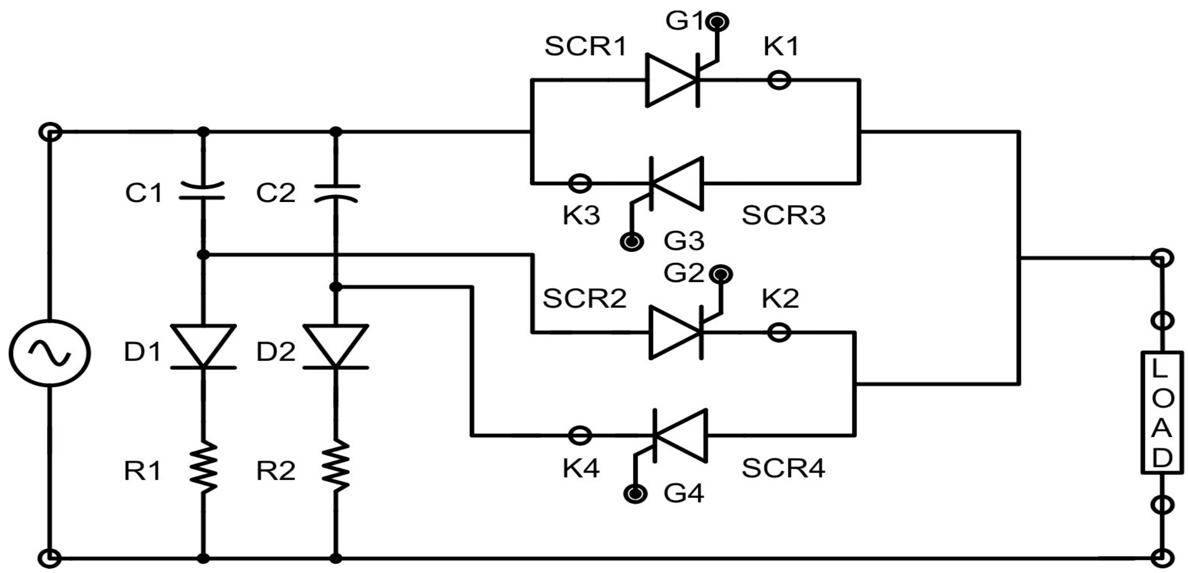

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Figure shows the commonly used single-phase AC Chopper circuit. In this circuit, SCR T_1 and T_2 are the main SCR whereas, SCR T_3 and T_4 are the auxiliary SCRs. C_1 and C_2 are the commutating capacitors. Diode D_1 and D_2 provide the charging path for the capacitors.

Thyristors T_1 and T_3 from the first pair for producing the positive alternation, and T_2 and T_4 constitute the second pair for producing the negative alternation of the input AC voltage .Figure shows the load – voltage waveforms. For the sake of simplicity, circuit operation is described in various operating modes.

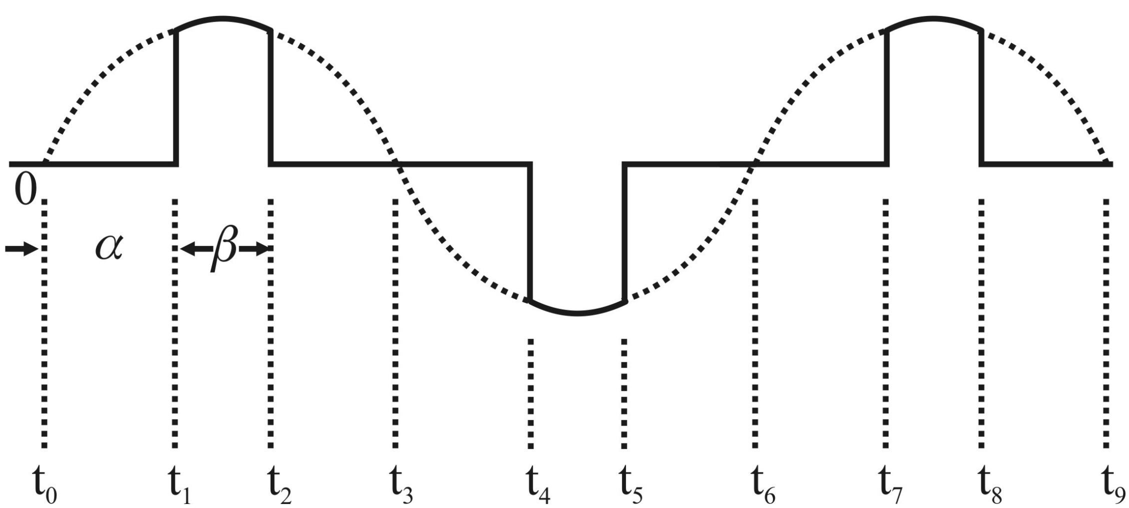
(1) **Mode 0 Operation:** Initially, during the positive half –cycle of the supply voltage, capacitor C_2 charges through the path 15-C_2-D_2-R_2-0, with the polarity shown in fig. Similarly, during the negative half-cycle of the supply voltage, capacitor C_1 charges through the path 0-R_1-D_1-C_1-15, with the polarity shown in fig. The voltage across these capacitors is used for commutation of main SCRs T_1 and T_2.

(2) **Mode 1 Operation:** As shown in fig., during the first positive half cycle of the supply voltage, thyristor T_1 is triggered at instance $t_1$with a firing angle α. The current flow through the path 15-SCRT_1-LOAD-0. When the instantaneous voltage reaches the instant T_2, auxiliary thyristor T_3 is

triggered. As soon as thyristor T_3 is triggered, capacitor C_1will start discharging through the path CB-T_3-T_1-CA. When the discharging current of capacitor C_1 becomes more than the forward current of SCR T_1, SCR T_1 becomes turned-off. The auxiliary SCR T_3 will be automatically turned off at instant t_3 because of the zero current at this instant. Hence, SCRs T_1 and T_3 form the first pair for producing the positive alternation of the input AC voltage.

(3) **Mode 2 Operation :** For the formation of negative half alternation, second pair of thyristor T_2 and T_4 are used. The main SCR T_2 is triggered at the instant t_4.as shown in fig during the first negative half cycle of input voltage. The current flow through the path 0-LOAD –SCRT_2-15. When the instantaneous voltage reaches the instant t_5, SCR T_4 is triggered. As soon as thyristor T_4 is triggered, capacitor C_2 wills discharging through the path CC-T_2-T_4 (A-K)-CD. When this discharging current is more than the load current, SCR T_2 becomes turned off. At instant t_6, SCR T_4 is automatically turned off as the current passing through it becomes zero.

Again at instant t_7, SCR T_1 is triggered to produce the next positive alternation. This is a continuous process and repeated again to generate an AC voltage across the load. The load power can be changed simply by varying the pulse width (or conduction angle) β. The main advantage of this type of AC Chopper is that whatever the pulse width β, the fundamental input power factor is always unity. The circuit is generally used for obtaining a regulated AC output voltage.



Waveform of AC Chopper