Single Phase Full Wave AC Voltage Controller (Bidirectional Controller)

Single phase full wave ac voltage controller circuit using two SCRs or a single triac is generally used in most of the ac control applications. The ac power flow to the load can be controlled in both the half cycles by varying the trigger angle'α'**.** The RMS value of load voltage can be varied by varying the trigger angle 'α'**.** The input supply current is alternating in the case of a full wave ac voltage controller and due to the symmetrical nature of the input supply current waveform there is no dc component of input supply current i.e., the average value of the input supply current is zero. A single phase full wave ac voltage controller with a resistive load is shown in the figure below. It is possible to control the ac power flow to the load in both the half cycles by adjusting the trigger angle'α'. Hence the full wave ac voltage controller is also referred to as to a bi-directional controller.

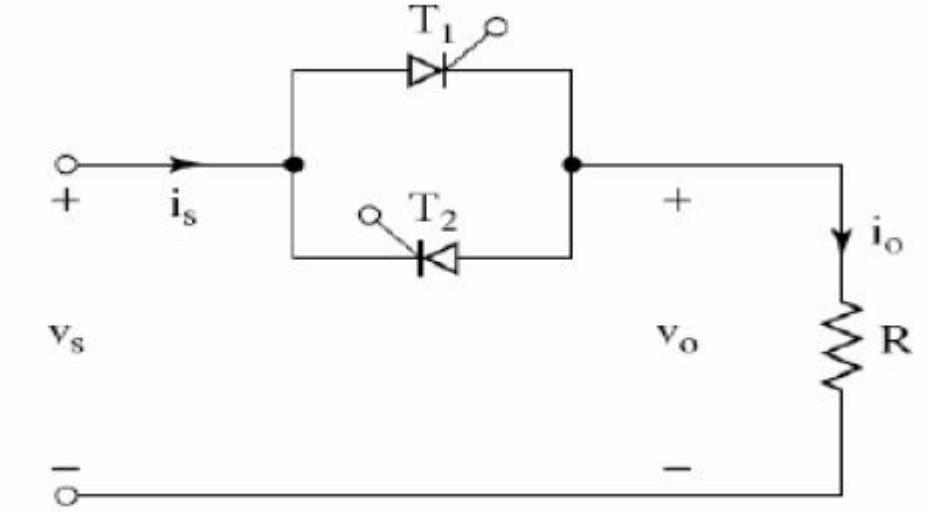


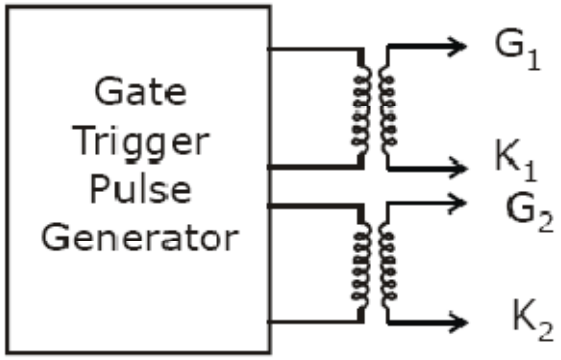
Fig. Single Phase Full Wave AC Voltage Controller (Bidirectional Controller) with R Load

The thyristor 1 *T* is forward biased during the positive half cycle of the input supply voltage. The thyristor 1 *T* is triggered at a delay angle of 'α' $(0 \le \alpha \le \pi$ radians$)$. Considering the ON thyristor 1 *T* as an ideal closed switch the input supply voltage appears across the load resistor *L R* and the output voltage *O S v = v* during $\omega t = \alpha$ to π radians. The load current flows through the ON thyristor 1 *T* and through the load resistor *L R* in the downward direction during the conduction time of 1 *T* from $\omega t = \alpha$ to π radians. At $\omega t = \pi$, when the input voltage falls to zero the thyristor current (which is flowing through the load resistor *L R*) falls to zero and hence 1 *T* naturally turns off . No current flows in the circuit during $\omega t = \pi$ to $(\pi + \alpha)$ .The thyristor 2 *T* is forward biased during the negative cycle of input supply and when thyristor 2 *T* is triggered at a delay angle $(\pi + \alpha)$, the output voltage follows the negative halfcycle of input from $\omega t = (\pi + \alpha)$ to 2π .When 2 *T* is ON, the load current flows in the reverse direction (upward

direction) through 2 *T* during $\omega t = (\pi + \alpha)$ to 2π radians. The time interval (spacing) between the gate trigger pulses of 1 *T* and 2 *T* is kept at π radians or 1800. At $\omega t = 2\pi$ the input supply voltage falls to zero and hence the load current also falls to zero and thyristor 2 *T* turn off naturally.

Need For Isolation

In the single phase full wave ac voltage controller circuit using two SCRs or Thyristors 1 *T* and 2 *T* in parallel, the gating circuits (gate trigger pulse generating circuits) of Thyristors 1 *T* and 2 *T* must be isolated. Figure shows a pulse transformer with two separate windings to provide isolation between the gating signals of 1 *T* and 2 *T* .



Single Phase Full Wave AC Voltage Controller (Bidirectional Controller) With RL Load

In this section we will discuss the operation and performance of a single phase full wave ac voltage controller with RL load. In practice most of the loads are of RL type. For example if we consider a single phase full wave ac voltage controller controlling the speed of a single phase ac induction motor, the load which is the induction motor winding is an RL type of load, where R represents the motor winding resistance and L represents the motor winding inductance. A single phase full wave ac voltage controller circuit (bidirectional controller) with an RL load using two thyristors 1 *T* and 2 *T* (1 *T* and 2 *T* are two SCRs) connected in parallel is shown in the figure below. In place of two thyristors a single Triac can be used to implement a full wave ac controller, if a suitable Traic is available for the desired RMS load current and the RMS output voltage ratings. The thyristor 1 *T* is forward biased during the positive half cycle of input supply. Let us assume that 1 *T* is triggered at $\omega t = \alpha$, by applying a suitable gate trigger pulse to 1 *T* during the positive half cycle of input supply. The output voltage across the load follows the input supply voltage when 1 *T* is ON. The load current *O i* flows through the thyristor 1 *T* and through the load in the downward direction. This load current pulse flowing through 1 *T* can be considered as the positive current pulse. Due to the inductance in the load, the load current *O i* flowing through 1 *T* would not fall to zero at $\omega t = \pi$, when the input supply voltage starts to become negative. The thyristor 1 *T* will continue to conduct the load current until all the inductive energy stored in the load inductor L is completely utilized and the load current through 1 *T* falls to zero at $\omega t = \beta$, where β is

referred to as the Extinction angle, (the value of ωt) at which the load current falls to zero. The extinction angle β is measured from the point of the beginning of the positive half cycle of input supply to the point where the load current falls to zero. The thyristor 1 *T* conducts from $\omega t = \alpha$ to β . The conduction angle of 1 *T* is $\delta = (\beta - \alpha)$, which depends on the delay angle α and the load impedance angle ϕ . The waveforms of the input supply voltage, the gate trigger pulses of 1 *T* and 2 *T* , the thyristor current, the load current and the load voltage waveforms appear as shown in the figure below.

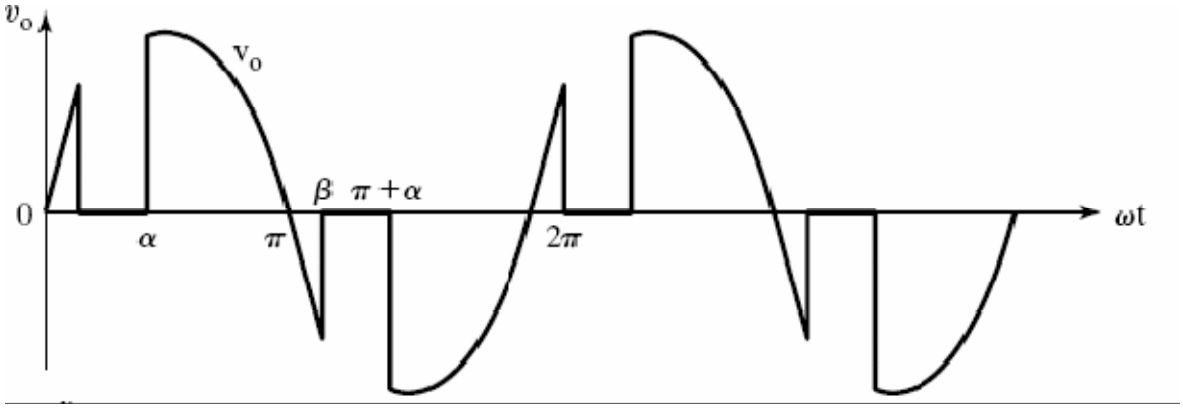


Fig. Single Phase Full Wave AC Voltage Controller (Bidirectional Controller) with RL Load