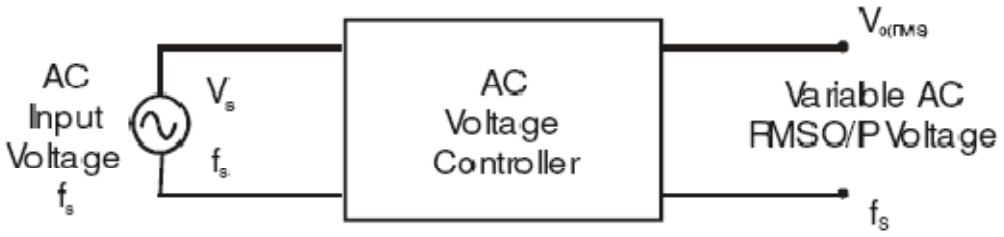
Introduction of AC Voltage Controller

AC voltage controllers (AC line voltage controllers) are employed to vary the RMS value of the alternating voltage applied to a load circuit by introducing Thyristors between the load and a constant voltage AC source. The RMS value of alternating voltage applied to a load circuit is controlled by controlling the triggering angle of the Thyristors in the AC voltage controller circuits. In brief, an AC voltage controller is a type of thyristor power converter which issued to convert a fixed voltage; fixed frequency AC input supply to obtain a variable voltage AC output. The RMS value of the AC output voltage and the AC power flow to the load is controlled by varying (adjusting) the trigger angle 'α'



There are two different types of thyristor control used in practice to control the AC power flow

- On-Off control
- Phase control

These are the two AC output voltage control techniques. In On-Off control technique Thyristors are used as switches to connect the load circuit to the AC supply (source) for a few cycles of the input AC supply and then to disconnect it for few input cycles. The Thyristors thus act as a high speed contactor (or high speed AC Switch).

Phase Control

In phase control the Thyristors are used as switches to connect the load circuit to the input AC supply, for a part of every input cycle. That is the AC supply voltage is chopped using Thyristors during a part of each input cycle. The thyristor switch is turned on for a part of every half cycle, so that input supply voltage appears across the load and then turned off during the remaining part of input half cycle to disconnect the AC supply from the load.

By controlling the phase angle or the trigger angle 'α' (delay angle), the output RMS voltage across the load can be controlled.

The trigger delay angle 'α' is defined as the phase angle (the value of ωt) at which the thyristor turns on and the load current begins to flow.

Thyristor AC voltage controllers use AC line commutation or AC phase commutation.

Thyristors in AC voltage controllers are line commutated (phase commutated) since the input supply is AC. When the input AC voltage reverses and becomes negative during the negative half cycle the current flowing through the conducting thyristor decreases and falls to zero. Thus the ON thyristor naturally turns off, when the device current falls to zero.

Phase control Thyristors which are relatively inexpensive, converter grade Thyristors which are slower than fast switching inverter grade Thyristors are normally used. For applications up to 400Hz, if Triacs are available to meet the voltage and current ratings of a particular application, Triacs are more commonly used. Due to AC line commutation or natural commutation, there is no need of extra commutation circuitry or components and the circuits for AC voltage controllers are very simple.

Due to the nature of the output waveforms, the analysis, derivations of expressions for

performance parameters are not simple, especially for the phase controlled AC voltage controllers with RL load. But however most of the practical loads are of the RL type and hence RL load should be considered in the analysis and design of AC voltage controller circuits.

Type of AC Voltage Controllers

The AC voltage controllers are classified into two types based on the type of input AC supply applied to the circuit.

- Single Phase AC Controllers.
- Three Phase AC Controllers.

Single phase AC controllers operate with single phase AC supply voltage of 230V RMS at 50Hz in our country. Three phase AC controllers operate with 3 phase AC supply of 400V RMS at 50Hz supply frequency.

Each type of controller may be sub divided into

- Uni-directional or half wave AC controller.
- Bi-directional or full wave AC controller.

In brief different types of AC voltage controllers are

- Single phase half wave AC voltage controller (uni-directional controller).
- Single phase full wave AC voltage controller (bi-directional controller).
- Three phase half wave AC voltage controller (uni-directional controller).
- Three phase full wave AC voltage controller (bi-directional controller).

Applications of AC Voltage Controllers

- Lighting / Illumination control in AC power circuits.
- Induction heating.
- Industrial heating & Domestic heating.
- Transformer taps changing (on load transformer tap changing).
- Speed control of induction motors (single phase and polyphase AC induction motor control).
- AC magnet controls.