COLLEGE OF ENGINEERING AND TECHNOLOGIES
ALMUSTAQBAL UNIVERSITY

AC Power Converter

EET 307

Lecture 8

- Phase Control -

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Introduction

- 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.

Introduction

- 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 wt) 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.

Introduction

- 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.

- 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.

Introduction

- 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.

Type of AC Voltage 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.

Type of AC Voltage Controllers

- 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).

Principle of AC Phase Control

- The basic principle of ac phase control technique is explained with reference to a single phase half wave ac voltage controller (unidirectional controller) circuit shown in the below figure.

- The half wave ac controller uses one thyristor and one diode connected in parallel across each other in opposite direction that is anode of thyristor T1 is connected to the cathode of diode D1 and the cathode of T1 is connected to the anode of D1 .

Principle of AC Phase Control

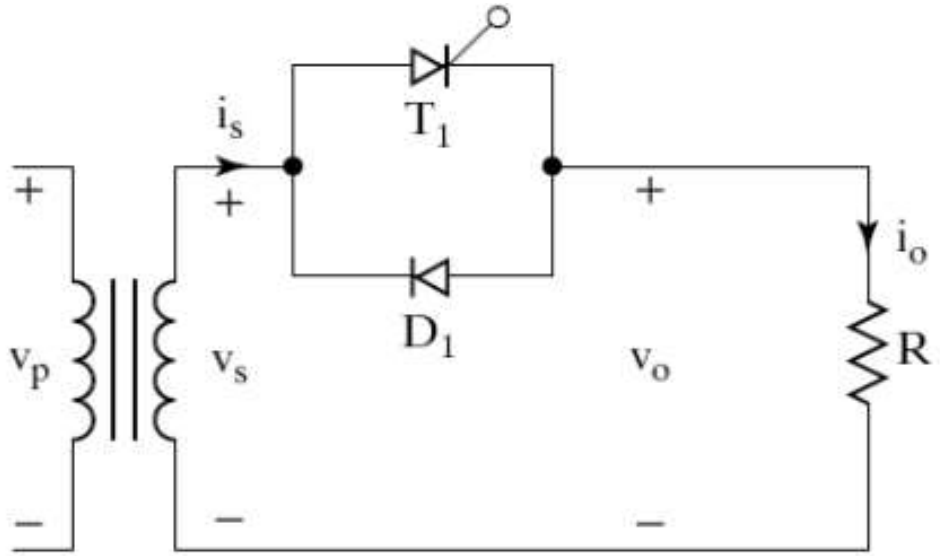
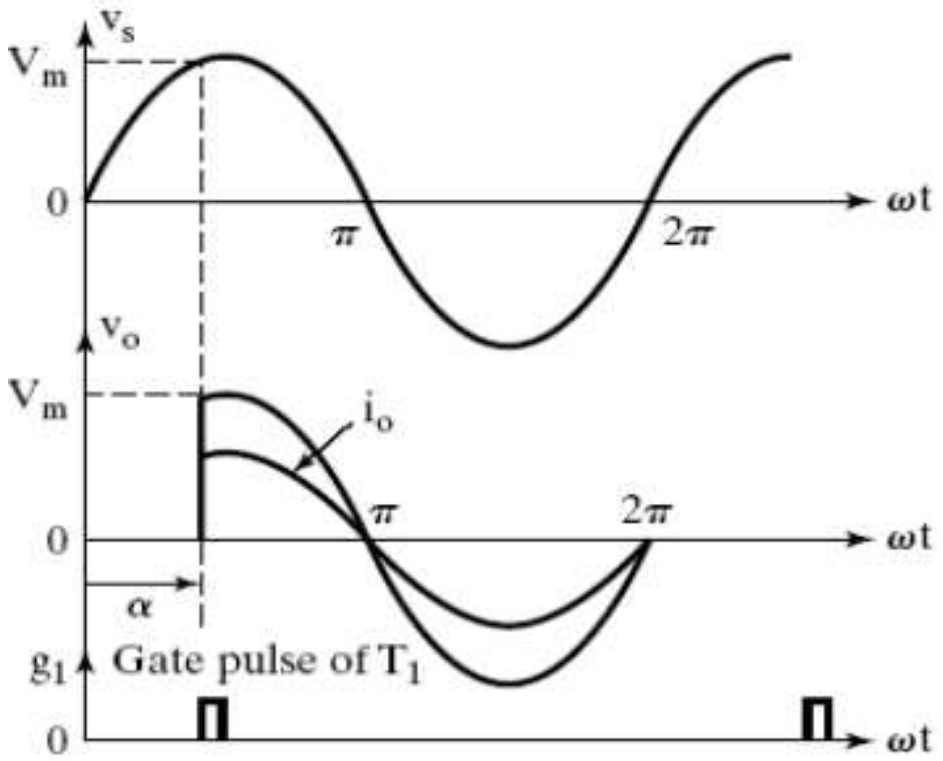


Fig.: Halfwave AC phase controller (Unidirectional Controller)



Principle of AC Phase Control

- The output voltage across the load resistor ‘R’ and hence the ac power flow to the load is controlled by varying the trigger angle ‘α’.

- The trigger angle or the delay angle ‘α’ refers to the value of wt or the instant at which the thyristor T1 is triggered to turn it ON, by applying a suitable gate trigger pulse between the gate and cathode lead.

- The thyristor T1 is forward biased during the positive half cycle of input ac supply.

Principle of AC Phase Control

- It can be triggered and made to conduct by applying a suitable gate trigger pulse only during the positive half cycle of input supply.

- When T1 is triggered it conducts and the load current flows through the thyristor T1, the load and through the transformer secondary winding.

- By assuming T1 as an ideal thyristor switch it can be considered as a closed switch when it is ON during the period $\omega t = \alpha$ to π radians.

Principle of AC Phase Control

- The output voltage across the load follows the input supply voltage when the thyristor T1 is turned-on and when it conducts from $\omega t = \alpha$ to π radians.

- When the input supply voltage decreases to zero at $\omega t = \alpha$, for a resistive load the load current also falls to zero at $\omega t = \alpha$ and hence the thyristor T1 turns off at $\omega t = \alpha$.

Principle of AC Phase Control

- Between the time period $\omega t = \alpha$ to 2π, when the supply voltage reverses and becomes negative the diode D1 becomes forward biased and hence turns ON and conducts.

- The load current flows in the opposite direction during $\omega t = \alpha$ to 2π radians when D1 is ON and the output voltage follows the negative half cycle of input supply.