Experiment No. 9
Single-Phase Half Wave Controlled rectifiers

Experiment aim

The aim of Experiment is to analyze the operation (Switching) of single phase controlled with resistive and inductive load.

Apparatus

1. Power electronic trainer.
2. Oscilloscope.
3. AVO meter.

Introduction

Phase controlled AC-DC converters employing thyristor are extensively used for changing constant ac input voltage to controlled dc output voltage. In phase-controlled rectifiers, a thyristor is turned off as AC supply voltage reverse biases it, provided anode current has fallen to level below the holding current.

Controlled rectifiers have a wide range of applications, from small rectifiers to large high voltage direct current (HVDC) transmission systems. They are used for electrochemical processes, many kinds of motor drives, traction equipment, controlled power supplies, and many other applications.

Single-Phase Half-Wave Controlled Rectifier

As shown in Fig. (1), the single-phase half-wave rectifier uses a single thyristor to control the load voltage. The thyristor will conduct, ON state, when the voltage $v_T$ is positive and a firing current pulse $i_G$ is applied to the gate terminal. Delaying the firing pulse by an angle $\alpha$ does the control of the load voltage. The firing angle $\alpha$ is measured from the position where a diode would naturally conduct. In Fig. (1), the angle $\alpha$ is measured from the zero crossing point of the supply voltage $v_s$. The
load in Fig. (1) is resistive and therefore current $i_d$ has the same waveform as the load voltage. The thyristor goes to the non-conducting condition, OFF state, when the load voltage and, consequently, the current try to reach a negative value. The load average voltage is given by:

$$V_{av} = \frac{1}{2\pi} \int_{0}^{\alpha} V_{max} \sin \omega t d(\omega t) = \frac{V_{max}}{2\pi} (1 + \cos \alpha)$$

Where $V_{max}$ is the supply peak voltage.

![Fig.(1):Single thyristor rectifier with resistive load.](image)

Fig.(2-a) shows the rectifier waveforms for an R L load. When the thyristor is turned ON, the voltage across the inductance is

$$v_L = v_s - v_R = L \frac{di_d}{dt}$$
The voltage in the resistance $R$ is $v_R = R \times i_d$. While $v_S - v_R > 0$. On the other hand, $i_d$ decreases its value when $v_S - v_R < 0$. The load current is given by:

$$i_d(\omega t) = \frac{1}{\omega L} \int_\alpha^{\omega t} v_L d\theta$$

![Diagram](image)

**Fig(2):** Single thyristor rectifier with: (a) resistive-inductive load; and (b) active load.
Procedure

1. Connect the single phase half wave controlled rectifier circuit shown in Fig.(1) on the power electronic trainer.
2. Turn on the power
3. Plot the input and output waveforms on the same graph paper.
4. Measure the average and RMS output voltage by connect the AVO meter across load resistance.
5. **Turn off the power**
6. Add the inductive load on the output as shown in Fig(2). With L=10mH measure the output voltage and plot the output waveform.
7. Repeat step 6 & 7 with connect the freewheeling diode across the load.

Discussion and calculations

1. Compare between the practical and theoretical results for input and output voltages and currents.
2. What does parameters of the single phase controlled rectifiers.
3. Give same application of the single phase controlled rectifiers.