Lab Report 2

Experimental Analysis of Diode Rectification

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Abstract—Following the previous lab sessions, and in the aim of a complete understanding of the behaviour of semi-conductor diodes, This lab session was introduced to analyze the half wave rectification circuit. Theory was put to comparison with the results to build an enhanced understanding of the application of semi-conductor diode in power electrical circuits.

Keywords—*Wave rectification, semi-conductors, diode, AC to DC*

1. Introduction

The application of diodes in wave rectification is widely used in power electronics, to meet the needs of each part of the circuit. The types of wave rectification has many forms, but the outcome is simple: produce a signal with the desired wave sign.

2. Experimental Objectives

- Observe the two In/Out Voltages.
- Analyse the resulting wave with respect to the intial wave.
- Extract the characteristics of the waves.

3. Theoretical Background

Following the understanding from theory and experiment of the diode, the diode is only by-pass for positive value of signal. Transforming the understanding from DC to AC, it's simply only the positive wave that can be passed trough the diode. Based on this principle, a circuit of rectification will be build.

Using the results gained from the Lab report 1, specifically about the value of the threashold voltage. $V_d = 0.7$V.

Half-Wave Rectifier Analysis

Given:

$$e(t) = 12\sin(\omega t), \quad f = 50\,\text{Hz}, \quad \omega = 2\pi f = 100\pi$$

$$V_{\text{th}} = 0.7\,\text{V}, \quad R = 1000\,\Omega$$

Current through Diode:

$$i(t) = \begin{cases} \dfrac{e(t) - V_{\text{th}}}{R}, & e(t) > V_{\text{th}} \\ 0, & \text{otherwise} \end{cases}$$

Voltage across Resistor:

$$v_R(t) = \begin{cases} e(t) - V_{\text{th}}, & e(t) > V_{\text{th}} \\ 0, & \text{otherwise} \end{cases}$$

Source Voltage Average and RMS:

$$V_{\text{avg, source}} = \frac{1}{T}\int_0^T e(t)\,dt = 0$$

$$V_{\text{rms, source}} = \sqrt{\frac{1}{T}\int_0^T [e(t)]^2 dt} = \frac{12}{\sqrt{2}} \approx 8.49\,\text{V}$$

Resistor Voltage Average and RMS (Evaluated):

$$\theta_{\text{on}} = \arcsin\left(\frac{0.7}{12}\right) \approx 0.0584\,\text{rad}$$

$$V_{\text{avg, R}} = \frac{1}{2\pi}\int_{\theta_{\text{on}}}^{\pi-\theta_{\text{on}}} [12\sin(\theta) - 0.7]\, d\theta \approx 3.78\,\text{V}$$

$$V_{\text{rms, R}} = \sqrt{\frac{1}{2\pi}\int_{\theta_{\text{on}}}^{\pi-\theta_{\text{on}}} (12\sin(\theta) - 0.7)^2\, d\theta} \approx 6.7\,\text{V}$$

4. Methodology

The experimental procedure consisted of the following.

1. Construct the circuit shown in Fig. 1
2. Analyse the two waves in the oscilloscope.

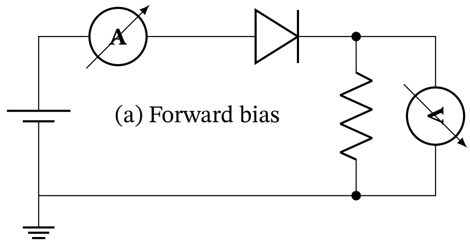

Figure 1. Half wave rectification using diode

5. Results and Analysis

A series of recordings were made in order to report the oscilloscope outputs as follows. It's worth to note that the value of 12V of AC voltage source was not available, instead 10V AC was fed into the circuit.

$V_{\text{t, avg}}$	0
$V_{\text{t, max}}$	10.4
$V_{\text{t, rms}}$	6.83
$V_{\text{R, max}}$	9.4
$V_{\text{R, avg}}$	2.993
$V_{\text{R, rms}}$	4.454

Table 1. Voltage values

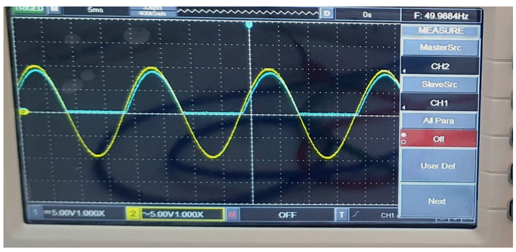

Figure 2. Wave visualizations for Input and output voltages

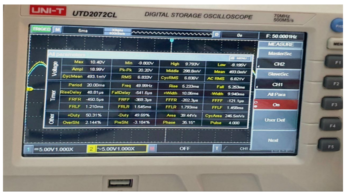

Figure 3. Input voltage characteristic values

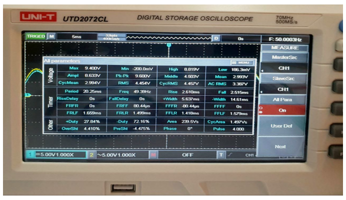

Figure 4. Output voltage characteristic values

The transformer role in this circuit was to reduce the amplitude of the initial electric wave. Although it was not used in this lab session, due to some safety measurements, we can still observe the application of such electromagenatic components in other circuits.

6. Simulink Simulation

Using Matlab Simulink software, a simulation of the circuit was performed to increase the reliability of the results.

Figure 5. Simulink circuit

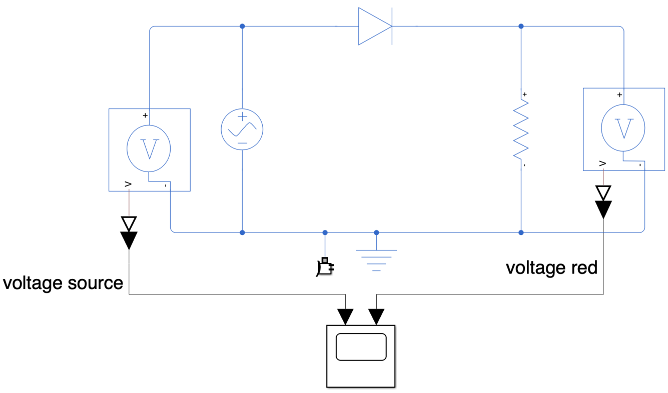

Figure 6. Simulation output

The experimental results confirm the theoretical and the simulation results, with respect to the laboratory capabilities and the limited source value AC.

7. Conclusion

This lab session successfully demonstrated the principle of half-wave rectification in AC circuits, as a part of generating DC voltage from AC source. A good understanding of the working principle of this circuit will help guide the upcoming lab sessions with the aim of building power circuits.

A diode can be used to generate positive sinusoidal pulses, for many applications and uses. By adding more specific components to the circuit, a more advanced function can be satisfied for different power systems.

Author Contributions

Dhia Eddine Kessad Mouh: Writing, Simulink Simulation.
Chalabi Anis: Theoretical background.
Drias Imad Eddine: Conclusion and analysis.
Mordjane Mohamed Mehdi: Conclusion and analysis.