Performance Analysis of Silicon and Germanium Diodes in Low-Frequency Rectifier Circuits

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Abstract **- This paper presents a comparative study of silicon and germanium diodes in half-wave and full-wave rectifier circuits operating at low frequencies. Key parameters such as forward voltage drop, peak inverse voltage (PIV), ripple factor, and efficiency were analysed using simulation and experimental methods. The results show that while germanium diodes offer lower forward voltage drop, silicon diodes exhibit higher reliability and better performance under reverse-bias conditions. This study provides a reference for selecting appropriate diode types in low-frequency power supply designs and electronic applications.**

Index Terms **- Silicon diode, Germanium diode, Half-wave rectifier, Full-wave rectifier, Ripple factor, Efficiency.**

1. INTRODUCTION

Electronic Devices and Circuits (EDC) form the foundation of modern electronics. Among these, semiconductor diodes play a critical role in rectification, signal processing, and protection circuits. The performance of a diode in a circuit is influenced by its material properties. This study aims to investigate how silicon and germanium diodes behave in rectifier circuits, focusing on practical outcomes like output voltage, ripple, and efficiency.

2. MATERIALS AND METHODS

2.1 Components Used

- 1N4007 Silicon Diode
- OA79 Germanium Diode
- Step-down Transformer (230V to 12V AC)
- Load resistor (1kΩ)
- Oscilloscope and Multimeter

2.2 Circuit Design

Two types of rectifier circuits were implemented:

- Half-wave rectifier
- Full-wave rectifier (using centre-tap transformer)

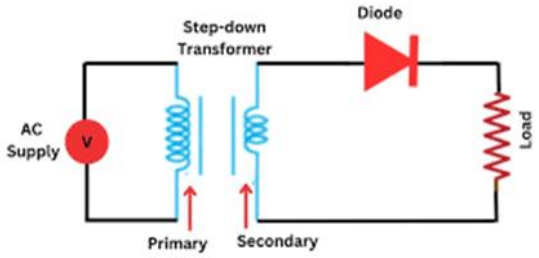

Fig. 1. Half-Wave Rectifier

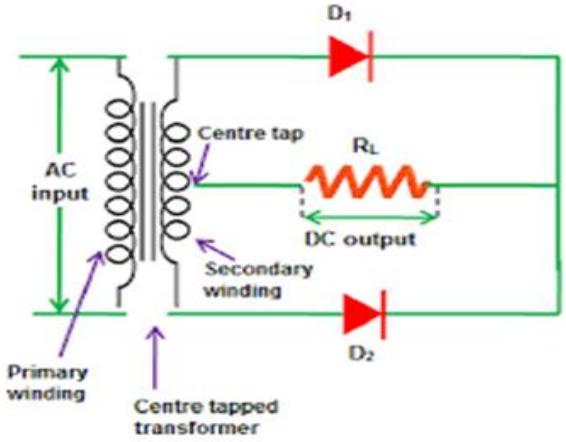

Fig. 2. Center tapped Full-Wave Rectifier

Each design was tested using both types of diodes. Output waveforms and values were recorded with and without filters.

3. RESULTS AND DISCUSSION

Parameter	Silicon Diode	Germanium Diode
Forward Voltage Drop	0.7V	0.3V
Peak Inverse Voltage (PIV)	High	Low
Ripple (Half-wave, no filter)	High	Slightly lower
Efficiency (Full-wave)	74%	70%

- Silicon diodes showed better performance in blocking reverse current, making them suitable for high-voltage applications.
- Germanium diodes provided faster conduction due to lower barrier potential but were more prone to leakage.

4. SIMULATION

Simulation was done using Multisim. The results aligned with the experimental findings, validating the design parameters.

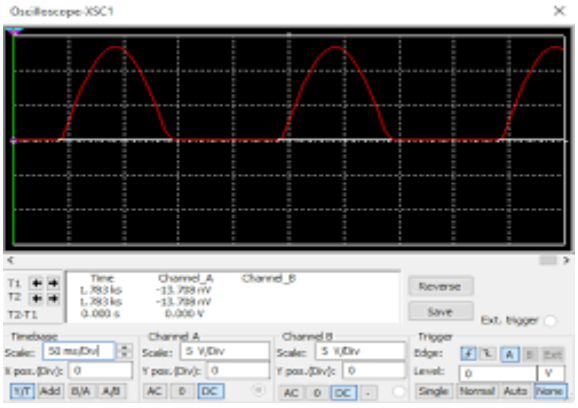

Fig. 3. Half-Wave Rectifier Wave forms in Multisim

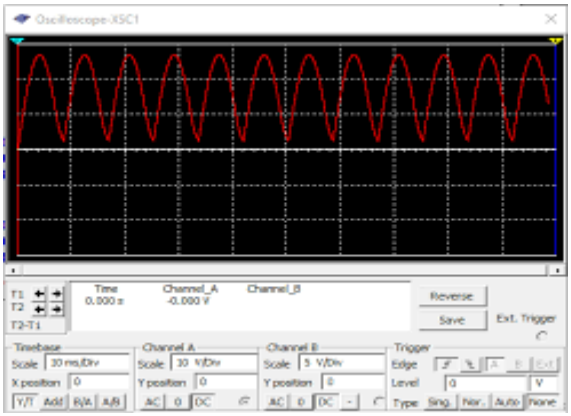

Fig. 4. Half-Wave Rectifier Wave forms in Multisim

5. CONCLUSION

Silicon diodes are better suited for applications where reverse voltage protection is crucial, while germanium diodes can be useful in low-voltage signal detection due to their lower forward voltage drop. The study highlights key considerations for circuit designers in selecting diode materials based on application needs.

REFERENCE

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