Design and Simulation of a Simple DC Voltage Stabilization Circuit Using Zener Diode in eSim

eSim Research Migration Project

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Abstract

This project focuses on the design and simulation of a basic DC voltage stabilization circuit using a Zener diode in the eSim environment. The circuit includes a DC source, a current-limiting resistor, a reverse-biased Zener diode, and a load resistor. When the input voltage exceeds the Zener breakdown value, the diode conducts and keeps the output voltage nearly constant. DC simulations were performed to verify regulation. The results show that the output remains close to the Zener voltage even when the input changes, confirming correct circuit operation.

1 Introduction

Many electronic systems require a fixed supply voltage to work reliably. One of the simplest ways to achieve this is by using a Zener diode regulator, which clamps the output voltage once the diode enters breakdown.

The aim of this project is to recreate this well-known circuit in the open-source eSim platform so that students can easily study how voltage regulation works without depending on commercial simulation tools. The focus is not on advanced performance but on clearly demonstrating the basic principle of DC voltage stabilization.

2 Circuit Description and Working Principle

The circuit is made of four simple parts:

- a DC voltage source
- a series resistor to limit current
- a Zener diode connected in reverse bias
- a load resistor at the output

When the supply voltage is below the Zener voltage, the diode stays off and the output follows the input. Once the input becomes high enough, the Zener diode starts conducting and clamps the output voltage close to its rated value.

The extra voltage from the source drops across the series resistor, while the load continues to receive a nearly constant DC voltage. This is how the circuit maintains regulation even when the input changes.

3 Implementation in eSim

1. The circuit was built and simulated in eSim using the following steps:

2. A 12-V DC source, a 5.1-V Zener diode, and suitable resistors were selected.

3. The schematic was drawn in KiCad through the eSim interface, clearly showing all connections.

4. A DC operating-point analysis was run to observe steady-state voltages.

5. The output voltage was measured using node probes and the virtual multimeter.

This setup allowed direct verification of whether the Zener diode was working in its regulation region.

4 Results and Discussion

The simulation shows that when 12 V is applied at the input, the output voltage settles close to 5.1 V, which is the Zener diode's breakdown rating. This confirms that the diode is regulating correctly and that the series resistor is dropping the extra voltage.

The output reading remains steady, even when the input is varied within a reasonable range. Since this is a DC circuit, no time-varying waveforms appear—the performance is judged entirely from the operating-point results and voltage measurements.

Overall, the circuit behaves exactly as expected from theory and successfully demonstrates basic DC voltage stabilization in eSim.

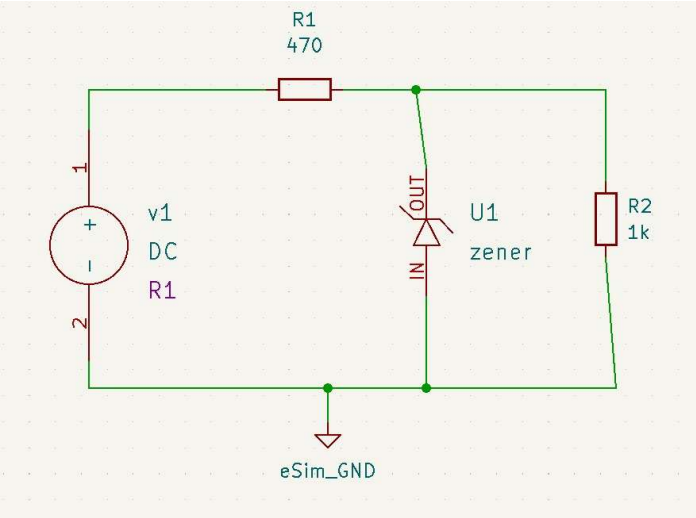

Figure 1: Schematic

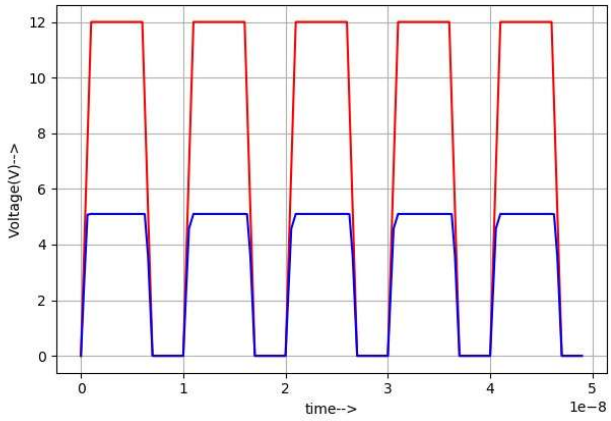

Figure 2: Blue: Output Regulated Voltage, Red: Input PWM

5 Conclusion

This project successfully recreated a simple Zener-diode voltage regulator using eSim. The circuit maintains a nearly constant output voltage when supplied from a higher DC source, proving that the regulator works as intended.

The work provides a clear and easy-to-understand example of voltage regulation that can be used for learning and practice in analog electronics.

References

1. R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory
2. Zener Diode Datasheet
3. eSim Official Documentation (https://esim.fossee.in)